

The Use of Manipulative in Teaching Elementary Mathematics

Evangeline Bungao- Abarquez

Teacher – III, MaEd., Ed.D., Department of Education, Bohol Division, Bohol, Philippines

Corresponding Author: Evangeline Bungao- Abarquez, E-mail: vangeline101413@gmail.com

ARTICLE INFORMATION

Received: October 05, 2020

Accepted: November 18, 2020

Volume: 3

Issue: 11

DOI: 10.32996/ijllt.2020.3.11.3

KEYWORDS

Manipulative, pretest, posttest, elementary mathematics, quasi-experimental design

ABSTRACT

The purpose of this study is to investigate the effect of manipulative (concrete learning materials) in teaching elementary mathematics. The study employed a pretest posttest quasi experimental design. The study was conducted in two grade 3 sections of San Agustin Elementary School in the school year 2016-2017. The experimental group was taught mathematics using the manipulative while the control group was taught mathematics using the conventional method. Data were collected and analyzed from both the experimental and control groups using T-test, Paired T-test, and standard deviation. As a result of the research, the pretest and posttest scores of experiment and control groups were found to differ significantly in favor of posttest in both groups. There was a significant mean gain difference in the pupils' pretest and posttest scores in mathematics exposed to manipulative and conventional method. Generally, the use of manipulative in teaching mathematics is more effective than the use of conventional method.

1. Introduction

The quality of teaching (NCTM 2000) is the key factor in the achievement of all children in mathematics. Teaching mathematics is challenging and animating because significant changes are taking place in mathematics education. New insights learned and children who are growing up in an ever-changing society command a different approach to the teaching of mathematics. According to Cathcart (2006), all children can succeed in mathematics if their teachers are aware of how to modify instructional experiences to meet their needs.

The National Council of Teachers of Mathematics admitted that much criticism had been leveled at school mathematics during the 1980's. International studies showed that children in the United States did not cope very well on tests of mathematics proficiency compared with children in some countries. This same condition is prevailing in the Philippines.

In the global arena, the Philippines ranked forty-second among the forty-five countries in the Trends in International Mathematics and Science Study (TIMSS) year 2003. The Philippines has not ameliorated its ranking since 1999 and did not participate in 2007 and 2011 TIMSS. This shows that the Philippine Education System is in dire need of improvement specifically in the learning area of mathematics.

Leongson (2003) discovered that Pilipino pupils excel in knowledge acquisition but fare considerably low in lessons requiring higher order thinking skills. This condition is disappointing in the performance of pupils in national and international surveys on mathematics competencies.

In present times, pupils in the Primary Level face this present challenge in school. They have to face the situation where Seat works, Assignments, Quizzes, and Quarterly Examinations are taken as a battlefield in a classroom. One of the subjects that pupils are having hard time to cope up with, is mathematics. Pupils on the average don't perform well in this subject because they find the problems difficult to solve. (Jones, 2014) said that pupils struggle most when asked to apply math knowledge, for example to problem solving. Ontario Education Minister Liz Sandals called the results "a problem" (Alphonso, C. & Hammer, K., 2014). This statement and results raised concerns for educators like the researcher and motivated to investigate

different instructional strategies to teach math more effectively. The use of manipulative as a teaching tool is very popular in most classrooms but how effective is it?

Quarterly Tests in Grade Three Mathematics reveal low performance of pupils of San Agustin Elementary School. Based on their first quarter grade this year, out of 40 pupils in one of the sections of Grade 3, 7 pupils got a very low grades that ranges from 68 to 71 average grade in mathematics. Apprehensive to the importance and relevance of the problem in Mathematics being pose, this study was conducted.

2. Review of Related Literature

Several researches in examining different types of concrete manipulative tends to focus on the perceptual richness of concrete objects and how details of an object may hinder or aid learning. Manipulative is categorized either concrete or virtual. This study tends to discover the effectiveness of using concrete manipulative in teaching elementary Mathematics.

Manipulative can come in a variety of forms and they are often defined as “physical objects that are used as teaching tools to engage students in the hands-on learning of mathematics” (“Using manipulative,” 2009). Manipulative can be purchased at a store, brought from home, or teacher and student made. The manipulative can range from dried beans and bottle caps to Unifix cubes and base-ten blocks. They are used to introduce, practice, or remediate a math concept. “A good manipulative bridges the gap between informal math and Journal of Instructional Pedagogies formal math. To accomplish this objective, the manipulative must fit the developmental level of the child” (Smith, 2009, p. 20). Kindergarten children should have individual counters, whereas older students could use colored wooden rods that represent different numbers. The manipulative must fit the mathematical ability of the child or it is useless. The simple act of moving manipulative is likely not sufficient for promoting learning as cited by Carbonneau, Marley, and Selig (2013). Without explicit instruction, children may not move objects in a manner that appropriately represents the mathematics concept being taught.

Manipulative can be used in teaching a wide variety of topics in mathematics, including the objectives from the five NCTM standards: problem solving, communicating, reasoning, connections, and estimation. The materials should “foster children’s concepts of numbers and operations, patterns, geometry, measurement, data analysis, problem solving, reasoning, connections, and representations” (Seefeldt & Wasik, 2006). Teachers could use counters, place-value mats, base-ten blocks, and fraction strips while teaching from the numbers and operations standard. The counters could be used to teach one-on-one correspondence, ordinal numbers, and basic addition and subtraction. The fraction strips could be used to add and subtract fractions or to show equivalent fractions. Pattern blocks, attribute blocks and scales could be used to assist students in the learning basic algebra. Student could use geo boards when trying to identify simple geometric shapes. They could also use geometric solid models when learning about spatial reasoning. Teachers could use standard and non-standard rulers and measuring cups to represent length or volume in measurement lessons. The students could also use tiles when trying to find the area or perimeter of an object. When it comes to data analysis and probability, students could use spinners to find the probability of landing on a designated area. They could also use number cases or dice to find the probability of rolling a certain number or combination of numbers (“Using manipulatives”, 2009). The numbers of ways that manipulative can be used are limitless.

The National Council of Teachers of Mathematics (NCTM, 2000) has recommended that students be provided access to manipulative in order to develop mathematical understanding. In addition, teacher education textbooks often contain sections suggesting that teachers use manipulatives during mathematics instruction (e.g., Billstein, Libeskind, & Lott, 2009; Copley, 2000). In the cases of national organizations and textbooks, when an instructional strategy is prescribed to a professional audience, an underlying assumption is that sound scientific evidence supports the recommendation.

The use of manipulatives is recommended by the NCTM because it is supported by both learning theory and educational research in the classroom. “Manipulatives help students learn by allowing them to move from concrete experiences to abstract reasoning”. When students manipulate objects, they are taking the first steps toward understanding math processes and procedures. “The effective use of manipulatives can help students connect ideas and integrate their knowledge so that they gain a deep understanding of mathematical concepts”.

In Carbonneau and Marley (2012) as cited by Carbonneau, Marley, and Selig (2013) emphasized that Math manipulative-based instructional techniques are approaches that include opportunities for students to physically interact with objects to learn target information. In the same study (Gürbüz, 2010)) mention that studies have found that using manipulative in math instruction, when compared with instruction that did not use manipulative, may benefit student.

Over the past few decades, researchers have studied the use of manipulative in several different grade levels and in several different countries. The majority of the studies indicate that mathematics achievement increases when manipulative is put to good use. Many studies also suggest that manipulative improve children’s long-term and short-term retention of math.

Cain-Caston’s (1996) research indicates that using manipulative helps improve the environment in math classrooms. When students work with manipulative and then are given a chance to reflect on their experiences, not only is mathematical learning enhanced, but math anxiety is also greatly reduced. Chang (2008) examined the work of research scientist Jennifer Kaminski and he found that children better understand math when they use concrete examples.

It is believed by Carbonneau, Marley, and Selig (2013) that instructional strategies that use manipulatives may be effective because of physical enactment. The use of manipulatives in teaching Mathematics may increase student’ retention because the encoding and subsequent retrieval of target information may occur via nonverbal coding or a motoric channel as concretized the same study.

Puchner, Taylor, O’Donnell, and Fick (2008) conducted a case study which analyzed the use of manipulatives in math lessons developed and taught by four groups of elementary teachers. There four researchers decided to study the way teachers use the manipulatives rather than studying the outcomes of the students. “The study found that in three of four lessons studied manipulative use was turned into an end in and of itself rather than a tool, and that in the fourth lesson manipulative use hindered rather than helped the student learning” (Puchner,2009)

Taylor, O’Donnell, and Fick (2008) believe that manipulatives may increase students’ performance because of the “deeply embedded focus in U.S. mathematics teaching on the procedure and the product”. In the study of Mayer (2004) as cited in Carbonneau, Marley, and Selig (2013) manifested that empirical research has provided evidence contradicting this notion with results indicating that providing learners with instructional guidance on topics rather than allowing them to work within a purely unstructured context results in higher levels of student performance.

Shaw (2002) also believes that using mathematics manipulatives and models offers many benefits. Just as a picture can be worth a thousand words, manipulatives can provide visual representations of ideas, helping students to know and to understand mathematics. Manipulatives enhance the abilities of students at all levels to reason and communicate. Working with manipulatives deepens understanding of concepts and relationships, makes skills practice meaningful, and leads to retention and application of information in new problem-solving situations. In turn, the valuable time spent on manipulative and model-based lessons has the sustained, long-term effect of building student confidence and deepening mathematics understanding.

3. Research Methodology

3.1 Research Design

This study utilized the quasi- experimental group designed to assess the use of manipulative in teaching Grade three pupils in Mathematics. The experimental group was subjected to treatment using the manipulative activities while the other group was exposed to the conventional method where the activities prepared by the teachers were customarily done to address the general needs regardless of the kind of learners they have.

Both the experimental and the control groups have the pretests to determine the academic performance of the pupils in Mathematics before the employ of the experiment. After which, the use of manipulative activities was employed in the experimental group for a span of one month. The conventional method alone was utilized in the control group.

3.2 Research Respondents

The respondents of this study were the grade three pupils of San Agustin Elementary School of Talibon, officially enrolled for the school year 2016-2017.

Table 1. Research Respondents

Section	No. of Students
Section 1	38
Section 2	42
TOTAL	80

This study was limited to the eighty pupils or two sections of the San Agustin Elementary School. They comprise 10 percent in

the school population of school year 2016-2017. One section was under the experimental group while the other was the control group. The pupils in all sections were heterogeneously grouped.

3.3 Research Environment

The study was conducted at San Agustin Elementary School, San Agustin, Talibon, Bohol. It is approximately six kilometers from the town of Talibon, during the first semester of the school year 2016-2017. The school is a Public-School Institution directed towards the development of her students such that each will be equipped with academic excellence, skills, abilities, and competencies that one can utilize in building communities in the province and beyond.

The department houses two classrooms for Pre-school: one for Pre-school and one for Kindergarten, as well as nineteen classrooms for Grades 1 to 6, with three sections for each level except for the grade level which has four sections. The said department is headed by one Principal who is assisted by a Master Teacher. There are 21 class advisers. Currently, six teachers are handling Math subjects. Moreover, teachers expose pupils to various competition such as the MTAP (Mathematics Teachers Association of the Philippines) which is held every year.

3.4 Research Instruments

The variables discussed in the preceding sections were measured with the use of this instrument:

A teacher-made test was designed. It contained forty multiple-choice items covering the second grading topics. The topics included in the test were Multiplication (Multiplication facts of 6,7,8,9, and 10, Properties of Multiplication, Multiplying numbers with and without regrouping, Solving one-two step word problems including money) and Division (Dividing numbers by 1-2 digit divisors, Dividing numbers by 10 and 100 divisors, Estimating quotient, Finding the average, Solving one-two step word problems including money). This was administered before the treatment and after the treatment. The test was used as pre-test and post-test. The test was to measure the students' ability to recall, relate, and apply any information received during the treatment. Moreover, it was used to test whether the students have acquired the needed skills in mathematics, specifically, problem solving skills, analytical skills and critical thinking skills. The instruments are based on various reference books and were presented to the academic coordinator, and to other Mathematics teachers in the school for comments and suggestions. The test was administered to the grade 2 pupils of San Agustin Elementary School and Grade 3 pupils in San Agustin Elementary School to validate the instrument.

3.5 Research Procedure

3.5.1 Gathering of Data

The research procedure consists of the following phases: 1) Preparation and Validation of Instruments. All the instruments needed were prepared prior to the conduct of the study. The pretest was validated in one of the grade 2 sections of San Agustin Elementary School, Talibon and two sections in grade 3 of San Agustin Elementary School, Talibon; 2) Preparation of Lesson Plans. The researcher prepared lesson plans for the experimental and control group. The curriculum guides and teaching guides in Mathematics 3 served as a guide in the preparation of the lessons. Sample lesson plans of the experimental and control group are found in appendices

Lesson plans will be subjected to evaluation by the Coordinator and some teachers in the school handling Math subjects. Comments and suggestions by the coordinator guided the researcher in revising the lesson plans. 3) the Experimental Teaching. Before the start of the study, the use of manipulative and conventional tests was administered to both experimental and control group. Pretest was given to both classes to identify the respondent's academic readiness. The results of the pretest were collated for analysis after the experiment. The experimental group was taught employing the use of manipulatives activity while the control group was taught using conventional method. After the discussion of every lesson, both the control group and experimental group were given posttest. The experimentation lasted for 1 month. Finally, the statistical treatment of data was executed to interpret the findings.

3.5.2 Treatment of Data



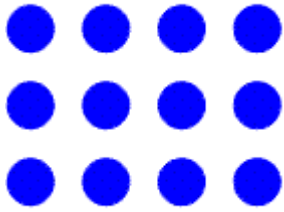

For the profile of the pretest and posttest, simple percentage, and mean are to be determined. To determine the difference between groups, the t-test of independent samples was used. Paired t-test and standard deviation were also used to analyze the data.

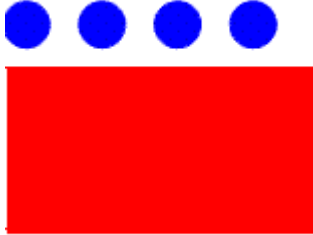




4. Presentation, Analysis and Interpretation of Data


This chapter presents the discussion, analyses and interpretation of the gathered data on the performance in Mathematics between the two groups of San Agustin Elementary School pupils exposed to the Use of Manipulatives and the Conventional Method of teaching the subject.

Table 2. Manipulatives Appropriate in Teaching Grade 3 Pupils in Mathematics

There are many types of math manipulatives available to teachers. Many can be used in multiple ways. It's a good idea to have a variety of types available in school or ready in a classroom to help with teaching the variety of math concepts.

Manipulatives	Lessons /Topics	Image
Tiles	<p>Multiplies 2-digit number by 2-digit numbers without regrouping. Group the class into 5 groups. Give each group an activity card. Each card should contain a word problem and 21 tiles. Problem: Jack, John and Jason gathered shells at the seashore. Each of the students gathered 14 shells. How many shells did the three of them gather? -Let them use the tiles in representing the number of shells each student gather. Example: Jack = 14 tiles; John = 14 tiles; Jason = 14 tiles -Each student represents a group of tiles. How do we read this? (3 groups of 14.) -Let them represent it in repeated addition: $14+14+14 = \underline{\hspace{2cm}}$ -How do we write it in multiplication form? $3 \text{ groups of } 14 = 3 \times 14$ -Have them add each group of tiles to get the final answer.</p>	
Base Ten Blocks	<p>I introduced first the base-10 blocks by explaining that single cubes represent the number one, the long bars represent 10 and the large squares represent 100. Students experiment with creating numbers using the blocks, such as using a 100 square, three bars and five single cubes to show 135. Practice exchanging smaller blocks for larger ones. Ten long bars turn into a 100 square, and 13 individual cubes turn into a 10 bar and three singles.</p> <p>For multiplication, students build groups of blocks and find the total. For 10 times three, they create either 10 groups of three or three groups of 10 to determine that the answer is 30.</p> <p>In a division lesson, students start with the large number and determine how many even groups they can make based on the divisor. For 87 divided by nine, they make groups of nine to see how many are left.</p>	
Counters	<p>I demonstrate the fact $4 \times 3 = 12$ using an array of counters, centicubes, dots or symbols as shown below. Use both array (3 rows of 4 items / 4 columns of 3 items) and equal groups (3 groups of 4 items / 4 groups of 3 items) so that students build links between previous 'equal groups' understandings and the powerful array model of multiplication.</p> <div style="text-align: center;">  </div> <p>Note that the array can also be rotated to appear as 4 rows of three, so that $4 \times 3 = 12$ and $3 \times 4 = 12$. Rearrangement does not change the relationship between the three numbers.</p> <p>Cover portions of the pictures or materials and ask questions such as "how many rows of four makes twelve?" ($? \times 4 = 12$) as a missing multiplication question and as a division question ($12 \div 4 = ?$).</p>	

		
<p>Student Rekenreks (Up To 10)</p> <p>Jelly Beans</p> <p>Egg Carton</p>	<p>You can also use beads or raisins or any small objects.</p> <p>Math seems to be more real when the pupils are able to tangibly touch and play with the concepts.</p> <p>They had fun! And it helped that when they were finished, they got to eat a bean or two.</p> <p>Pupils learned first,</p> <p>Skip Counting is the beginning of understanding multiplication. The pupils skip counted out their multiplication facts, creating a physical times table that they could see the quantities. They counted out the colors 3 x 3 was three groups of 3 each making nine beans in the cup. We used an egg carton lid to organize our counting.</p> <p>Multiplication Facts are easy to “get” when our pupils can “see” the groups. Your pupils can discover what 5 x 4 was by creating 4 groups of 5 and then counting out the number of beans that they collected. We used Easter Egg containers to help our kids “group” the beans.</p> <p>Division seems to be a harder concept for our pupils to get. So I counted out a pile of beans (ex: 21 beans) and asked them to split them equally into the three containers. After they split the beans up we discussed how $7 \times 3 = 21$ and $21 / 3 = 7$.</p>	  
<p>Dice</p>	<p>Instruct the pupils to roll the dice what number comes after, before ?</p> <p>What number is ten more, ten less</p> <p>Skip count by using two hundreds chart if needed</p> <p>Read and write the numbers</p> <ul style="list-style-type: none"> Tell pupils that each member of the group shall roll the dice twice and record it in the paper. Tell them that the first number is the multiplicand while the second number is the multiplier. <p>-After all the members of the group finished rolling the dice, tell them to multiply the numbers.</p> <p>-Let them post their papers on the board for checking.</p>	

<p>Cuisenaire Rods</p>	<p>After learning addition facts. Since each number represents one cubic centimeter, pupils can add up the rods by placing them side-by-side on a centimeter track. Pupils love this track!</p> <p>Next is teaching multiplication by having pupil place the number of rods side-by-side to see the total on the track.</p> <p>For example, a green rod equals six cm. So 4 green rods equal 24. $4 \times 6 = 24$</p> <p>An orange rods equals ten cm. So 3 orange rods equal 30. $3 \times 10 = 30$</p>	
------------------------	---	---

As indicated in table 2, there are appropriate manipulatives in teaching grade 3 pupils in Mathematics.

Manipulatives can come in a variety of forms and they are often defined as “physical objects that are used as teaching tools to engage students in the hands-on learning of mathematics” (“Using manipulatives,” 2009). Manipulatives can be purchased at a store, brought from home, or teacher and student made. The manipulatives can range from dried beans and bottle caps to Unifix cubes and base-ten blocks. They are used to introduce, practice, or remediate a math concept. “A good manipulative bridges the gap between informal math and formal math. To accomplish this objective, the manipulative must fit the developmental level of the child” (Smith, 2009). Kindergarten children should have individual counters, whereas older students could use colored wooden rods that represent different numbers. The manipulative must fit the mathematical ability of the child or it is useless.

The counters could be used to teach one-on-one correspondence, ordinal numbers, and basic addition and subtraction. The fraction strips could be used to add and subtract fractions or to show equivalent fractions. Pattern blocks, attribute blocks and scales could be used to assist students in the learning basic algebra. Student could use geo boards when trying to identify simple geometric shapes. They could also use geometric solid models when learning about spatial reasoning. Teachers could use standard and non-standard rulers and measuring cups to represent length or volume in measurement lessons. The students could also use tiles when trying to find the area or perimeter of an object. When it comes to data analysis and probability, students could use spinners to find the probability of landing on a designated area. They could also use number cases or dice, a small cube that is made of plastic, wood, etc. that has one to six dots on each side and that is used usually in pairs in various games in math, to find the probability of rolling a certain number or combination of numbers (“Using manipulatives”, 2009). The numbers of ways that manipulatives can be used are limitless.

Base Ten Blocks are a great way for students to learn about place value in a spatial way. The units represent ones, rods represent tens, flats represent hundreds, and the cube represents thousands. Their relationship in size makes them a valuable part of the exploration in number concepts. Students are able to physically represent place value in the operations of addition, subtraction, multiplication, and division.

Rods are used to develop a variety of math skills. Each rod’s color corresponds to a different length. The shortest rod, is 1 centimeter long; the longest, is 10 centimeters long. When the rods are arranged in order of length into a pattern commonly called a “staircase,” each rod differs from the next by 1 centimeter. This allows you to assign a value to one rod and then assign values to the other rods based on the relationships between the rods. With Cuisenaire Rods, pupils can explore spatial relationships by making flat designs on a table or by stacking them to make three-dimensional designs. They soon discover how some combinations of rods are equal in length to other, single rods. This understanding provides a context for investigating symmetry.

Since the early 1900s, manipulatives have come to be considered essential in teaching mathematics at the elementary-school level. In fact, for decades, the National Council of Teachers of Mathematics (NCTM) has recommended the use of manipulatives in teaching mathematical concepts at all grade levels.

The NCTM calls for manipulatives to be used in teaching a wide variety of topics in mathematics such as; sorting—a pre-mathematical skill that aids in comprehension of patterns and function ,ordering—a pre-mathematical skill that enhances number sense and other math-related abilities, distinguishing patterns—the foundation for making mathematical generalizations, recognizing geometric shapes and understanding relationships among them ,making measurements, using both nonstandard and standard units with application to both two and three-dimensional objects understanding the base-ten system of numbers, comprehending mathematical operation (addition, subtraction, multiplication, division)

The theory of experiential education revolves around the idea that learning is enhanced when students acquire knowledge through active processes that engage them (Hartshorn and Boren, 1990). Manipulatives can be key in providing effective, active, engaging lessons in the teaching of mathematics.

Manipulatives help students learn by allowing them to move from concrete experiences to abstract reasoning (Heddens, 1986; Reisman, 1982; Ross and Kurtz, 1993). The use of manipulatives helps students hone their mathematical thinking skills. According to Stein and Bovalino (2001), “Manipulatives can be important tools in helping students to think and reason in more meaningful ways. By giving students concrete ways to compare and operate on quantities, such manipulatives as pattern blocks, tiles, and cubes can contribute to the development of well-grounded, interconnected understandings of mathematical ideas.”

Manipulatives must be used correctly to help young children extremely. Children must understand the mathematical concept being taught rather than simply moving the manipulatives around. Smith (2009) stated that there are probably as many wrong ways to teach with manipulatives as there are to teach without them. The math manipulatives should be appropriate for the students and chosen to meet the specific goals and objectives of the mathematical program. “The complexity of the materials provided will increase as children’s thinking and understanding of mathematical concepts increase” (Seefeldt & Wasik, 2006).

It is also important for teachers to allow their students to have free time to play with the manipulatives. After the students have explored the manipulatives, “the materials cease to be toys and assume their rightful place in the curriculum” (Smith, 2009). Carol Seefeldt and Barbara Wasik also think that teachers should provide children with opportunities to work with materials with open-ended objectives that have no specific preset goals. These opportunities allow the children the chance to explore their own questions and generate a variety of answers. “These experiences help children think about their world in alternative ways and help them understand that there are multiple ways to solve problems. Generating multiple solutions to problems in an essential strategy in mathematics” (Seefeldt & Wasik, 2006).

Table 3. Performance Profile of the Two Groups

Groups	Passing Percentage Criterion (75%)	Mean Score	Standard Deviation	Computed t-value	P-value	Description
Control Group (n = 38)	30 (40 items)	11.500	5.646	20.198	0.000	<i>Below Average</i>
Experimental Group (n = 42)	30 (40 items)	14.643	5.373	18.523	0.000	<i>Below Average</i>

$\alpha = 0.05$ level of Significance

This table shows the mathematics pretest performance among grade 3 pupils in both control and experimental group where most students started the study with a failing score.

In Table3, it is shown that in each of the control and experimental groups, the mean score is far from the passing percentage criterion of 30 considering their respective standard deviations of 5.646 and 5.373 which are large enough. The mean score

of the control group (11.500) is 3.277 z's below the 30 points cut-off. Likewise, the mean of the experimental group (14.643) is 2.858 z's below the mean . Both are considered Below Average. Also, of importance are the computed t-values in each group. Both yielded a p-values (0.000) which is less than the 0.05 level of significance. This implies that the groups are truly Below Average and are therefore comparable.

Based on the result, instructional strategies that use manipulatives are often suggested as effective approaches to improve student mathematics performance (Gürbüz, 2010; Sherman & Bisanz, 2009). Math manipulative-based instructional techniques are approaches that include opportunities for students to physically interact with objects to learn target information (Carbonneau & Marley, 2012).

Table 4. Posttest Performance Profile of the Two Groups

Groups	Passing Percentage Criterion (75%)	Mean Score	Standard Deviation	Computed t-value	p-value	Description
Control Group (n = 38)	30 (40 items)	20.211	4.527	13.330	0.000	<i>Below Average</i>
Experimental Group (n = 42)	30 (40 items)	32.119	6.352	2.162	0.037	<i>Above Average</i>

$\alpha = 0.05$ level of Significance

When compared, the posttest mean performance of the two groups of pupils, yielded noted differences with the 30-point criterion.

The computed t-values gave p-values (0.000 and 0.037) which are less than 0.05 level of significance. This implies that there is indeed a difference between the mean performance of each group and the criterion score of 30. This time though the mean (20.211) of the control group is nearer the criterion score, its posttest mean performance is still Below Average. The pupils' in the experimental group got a mean (32.119) higher than the criterion. The scores of the group has a standard deviation of 6.352 with a z-value of 0.333. This proves that the posttest mean performance (32.119) of the pupils in the experimental group is higher (Above Average) in the posttest. This could potentially mean that concrete manipulatives have a positive impact on the grade 3 pupils' mathematical scores and performance. In addition to each pupil improving from pretest to posttest, it is interesting to understand that pupils scored dipped lower than the baseline after the conventional method was taught; after the manipulative approach was used, all scores increased. According to Carbonneau (2013), students who physically join blocks to make a larger block are expected to have a better conceptual understanding than those that use written and verbal learning (p. 10). "The process of moving systematically through the four stages of cognitive development is aided by the manipulation of concrete objects" (as cited in Carbonneau). According also to Dennis (2011), using manipulatives when solving math problems may enhance a student's ability to identify the correct operation to solve problems (p. 18). There's a need to explore manipulatives as a mean to teach math. "Efforts must be intensified by incorporating manipulatives as a learning resource" (Thompson as cited in Dennis, 2011).

Table 5. The Pretest-Posttest Improvement Profile

Groups	Pretest Mean (SD)	Posttest Mean (SD)	Mean Difference	Computed t-value	P-value	Description
Control Group (n = 38)	11.500 (5.646)	20.211 (4.527)	8.711	10.840	0.000	Significantly Improved
Experimental Group (n = 42)	14.643 (5.373)	32.119 (6.352)	17.476	18.598	0.000	Significantly Improved

$\alpha = 0.05$ level of Significance

Each of the control and experimental groups has significantly improved as seen in the t-test results on Table 5.

For the control group, the mean difference of 8.711 was found to be significant considering a computed t-value (10.840) which corresponds to a p-value (0.000) less than 0.05 level of significance. The same situation was found in the profile experimental group. The difference between the group's pretest and posttest means of 17.476 was found significant since its computed t-value also yielded a p-value less than 0.05. Thus the groups have significantly improved their mean performance.

As the results indicate on mean difference, the pupils showed improvement between the pretest and the posttest, after the lesson using manipulatives. The conventional method seemed to actually have a lesser effect on pupils scores, whereas the manipulative based approach showed a higher effect on pupil's learning and performance. There is hope that, with simple, cheap, improvised manipulatives, they could improve pupil's understanding and mastery and can easily be adapted in the classroom (Akkan, 2012)

A t-test was likewise done to know whether there is a significant difference between the mean gains derived from the pretest and posttest scores of the groups. Results are found in Table 6.

Table 6. Difference in the Mean Gains of the Two Groups

Groups	Tests	Mean Score (Description)	Mean Gain (SD)	Mean Gain Difference	Computed t-value	P-value	Description
Control Group (n = 38)	Pretest	11.500 (Below Average)	8.711 (4.953)	8.765	7.017	0.000	Significantly Different
	Posttest	20.211 (Below Average)					
Experimental Group (n = 42)	Pretest	14.643 (Below Average)	17.476 (6.090)				
	Posttest	32.119 (Above Average)					

$\alpha = 0.05$ level of Significance

Table 6 shows the t-test results of the hypothesis test verifying whether there is a difference in the mean gains of the groups. Difference in the mean gains in favor of the experimental group may imply effectiveness in the use of manipulatives in

teaching Mathematics. Mean gain also refers to the difference between the mathematics pretest and posttest means in each group. The results show that,

The difference of 8.765 between mean gains of 8.711 and 17.476 for the control and experimental groups respectively was then tested using the t-test. The test gave a t-value of 7.017 with 0.000 as its p-value. Since this p-value is less than 0.05 level, the null hypothesis of no difference in the mean gains was rejected. Hence the mean gains are significantly different. This result suggests that since the mean gain of the experimental group is higher than the mean gain of the control group, there is reason to believe that the use of manipulatives in the teaching of mathematics in Grade 3 is effective.

The findings showed that there was a significant difference between the pretest and posttest scores when pupils were taught in the conventional method and between the pretest and posttest score when the pupils were taught with manipulatives. The positive gains of the students using the concrete manipulatives show that concrete manipulatives really help pupils understand the concept of each lesson. According to Moyer-Packenham, Ulmar and Anderson (2012), both static and dynamic forms of pictorial representations can positively influence learning for low-achieving pupils when learning mathematical concepts.

It was revealed that the application of manipulatives effectively in the course of teaching process, contributes to increasing the mathematics exam grades of students, creating an outstanding performance of students in classes, decreasing anxiety against mathematics, rising cognitive flexibility and positively affecting their attitudes towards mathematics (Bullmaster, 2013; Clements, 1999; Driscoll, 1983; Ojose & Sexton, 2009; Raphael & Wahlstrom, 1989; Sowell, 1989; Suydam, 1986).

This result is supported by Munger (2007) that "Analysis of covariance revealed that the experimental group using mathematical manipulatives scored significantly higher in mathematical achievement on the posttest scores than the control group" Additional studies have shown that students who use "manipulatives in specific mathematical subjects are more likely to achieve success than students who don't have the opportunity to work with manipulatives".

Pupil's feedback in the use of manipulative in learning mathematics:

Pupils on the other hand, believed that learning is easy because they used manipulatives in solving. As P1 said that,

"Sayon raman sabton ang activity kay simple words man ang gamit ni maam. Inig buhat namo sa activity kay naa mi mga kauban. Mas ganahan ko makat.on sa math ug naa koy kauban mo.solve unya kami pa gyud ang mag.arrange sa mga popsicle sticks ug mga candy.hehe

Ug mag test si maam kay lisod pero ug amuang buhaton iyang gihatag nga ipa solve gamit ang popsicle sticks kay sayon ra.nindota!" (The activity was easy because our teacher used simple words, easy to understand. We have groupmates in doing the activity and we liked it when we solve it together especially that we were the one who will arrange the popsicle sticks and more. Very nice!)"

According to the studies of Cain-Caston (1996) and Heuser (2000), when students work with manipulatives and then are given a chance to reflect on their experiences, not only is mathematical learning enhanced, math anxiety is greatly reduced. Exploring manipulatives, especially self-directed exploration, provides an exciting classroom environment and promotes in students a positive attitude toward learning (Heuser, 1999; Moch, 2001). This statement was supported by P2, when he felt happy and enjoy and learned more in the activities given.

"Ganahan ko kaayo sa activity namo ganiha kay nakamao ko.na enjoy ko pag.ayu kay mag.tinabangay mi ug answer sa akong mga kagrupo.unya magshare sad mi ug mga answer .unya daghan mi ug namauhan kay tudluan man mi sa among leader unsaon ug sayop mi.unya mas dali mi makamao sa multiplication ug butang among gamiton inig solve.(I liked so much the activities a while ago.I enjoyed so much.We help one another in answering and solving the problem.and we learned a lot because we shared answer and our leaders coached us to get the correct answer if we did not know how to solve it. We learned more when we used things in solving math.)"

This feedback supports the idea of Reyes (2012) that group discussion allows the students to share and listen to the different views about a given problem, thus giving them confidence to solve problems correctly. This also confirmed the study of Elladora (2009) that group discussion and practicing problem solving enable students to develop a functional understanding of the subject matter, thus enhanced their problem-solving skills and critical thinking skills. This may suggest that students have learned and developed the essential skills needed in the 21st century.

P3 cited below, that a jelly beans activity was fun. Although it's about multiplication, the lesson where they find it hard, still they enjoy learning. They think the jelly beans candy as their motivation to finish the activity because they will eat the candies after.

"Ganahan man ko sa tanang activity ni maam pero mas ganahan ko atong find the product of 28x2 gamit ang candy ..lingaw kayo mi.unya gikaon namo ang candy pagkahuman. Salamat ma'am.(I liked all the activities but I liked this- a jelly beans in the egg carton-solve: 28x2- activity most , we enjoy it so much and after we got the answer we ate the candies.hehehe..thank you ma'am)"

Mastering multiplication is not easy. It takes a lot of dedication and practice, which as teachers, we all know can be hard for our students. Not all students are able to learn their multiplication tables by rote memorization. It's especially hard when they know they have to memorize the entire multiplication table.

At this point, Kelly (2006) underlines the need to provide the teachers with a sound basis of information about when, why and how to use manipulatives. It was also stated that teachers need to explain the objectives to the students explicitly and introduce the manipulatives, giving the necessary information, during the process of teaching. Thus, the manipulatives will go beyond being instruments of play and entertainment from the perspective of the students and will be transformed into materials contributing to their learning just like P4 said,

*"Wala ko kayo ganahi sa activity nga gamit ang cake kay wala namo kaayo ma.slice ug tarong maong nadugmok ang cake.hehehe
Pero bisan na dugmok siya na divide ghaon namo ang cake wala lang siya na sakto gyud ug slice, dili perfect ang pagka.slice namo sa cake kay among kutsilyo gigamit kay dili pang cake man gud.(I liked least with the activity using cake because we did not sliced it properly. The knife we used was not for cakes Its not perfect. But even if it was not properly sliced, we still divide it and we still got the correct answer.)"*

In the study by Enki (2014), the students pointed out that, as opposed to former traditional instruction methods, learning through activities including the use of manipulative gave them pleasure and increased their motivation and allowed them to learn while having fun. Positive feedbacks of this kind are indicators of a positive attitude towards the mathematics lesson and the usage of manipulative in mathematics instruction.

P5 rated the activity 1, the highest rating because the pupils liked and learned more from the activities. This was proved when he said,

"1 akong rating kay nindot man ang mga activity gihatag ni maam .mas ganahan ko maminaw ug mas ganahan ko mag solve sa math namo kay daghan ug kalaen laeng butang among gamiton labina gyud ug pagkaon.enjoy gamiton ang mga materials nga among gi,prepare kay colorful unya interesting kaayo among math challenge .(My rating is 1 because I like the activities so much. we enjoy solving. I like to solve math because we used different things in solving like foods. The math challenge was very interesting because of the materials we used in solving)"

Dr. Jean Shaw,2002 states that when small or large learning groups explore new ideas or explain understandings, they have something to talk about when they have manipulative and models to work with. Discussions and learning become more focused. Multisensory experiences provide access to ideas and concepts, and offer multiple entry points in discussions and reasoning, ensuring that all students in the group are active participants.

P6 suggested that there must be hands-on activities in teaching mathematics always, for it will help them a lot in solving mathematics problem.

"Unta kanunay ta nga mag.activity ug ingon ani para makamao mi ug dali unya sayunan rami sa math. Unya magkatawa katawaav sad mi sa among mga kagrupo kay sige raman mi ug lingkod nindot ug mubarog na sad mi muadto sa among grupo.mas nindot ug magtinabangay kay daghan mi ug idea unya naa sad mi focus kay naa man mi leader nga mag monitor (hopefully we will always use manipulative in solving math so that itwill be easy for us to learn.math and aside from that we like to learn with our groupmates because we always sit down whole day we want something new in a day. We learn more when

we solve together, we have more idea when we are many and we can focus because we have leader that monitor us.)

“This result was supported by Kelly (2006) which emphasizes that manipulatives should be used not occasionally but all along, as they enhance the conceptualization process of the students positively. As Ojose and Sexton (2009) put it, long-term application of manipulatives leads to assimilation of abstract mathematical concepts through observation of models and thus, to an increase in the achievement of students.

5. Summary, Concussion and Recommendations

This chapter presents the summary of the study, the conclusions, made on the basis of the findings and the recommendations. The main objective of this study is to determine the effects of the use of manipulatives In Mathematics of the grade three pupils in San Agustin Elementary School during the school year 2016-2017.

Two sections of the grade three level were chosen as the research participants, the control group and the experimental group. The control group was taught using the conventional method in teaching while the experimental group was taught using the manipulatives.

5.1 Summary

1. A number of pupils were considered below average during the pre-test. On the other hand, a number of pupils exposed to conventional method were also considered below average during the pre-test.
2. There was a significant mean gain in the pupils’ pretest and posttest scores in mathematics exposed to manipulatives and conventional method.
3. There was a significant difference in the students’ pre-test and post-test mean gain score in mathematics between those exposed to the use of manipulatives and conventional method.
4. The posttest showed a marked increase in the performance of the pupils in the experimental group after the given intervention. Like experimental group, the performance of the control group has increased after they were taught using the conventional method. The increase of the scores in the experimental group is higher than the increase in the control group. Generally, the use of manipulatives in Math has helped improve the academic performance of the pupils.

5.2 Conclusion

The use of manipulative in teaching mathematics is more effective than the use of conventional method. This method is useful in catering to the diverse learning styles and needs of learners.

It is important for children to have a variety of materials to manipulate and the opportunity to sort, classify, weigh, stack and explore if they are to construct mathematical knowledge. “In order to have opportunities to learn math, children need firsthand experiences related to math, interaction with other children and adults concerning these experiences and time to reflect on the experiences” (Seefeldt&Wasik,2006). Educational research indicated that the most valuable learning occurs when students actively construct their own mathematical understanding, which is often accomplished through the use of manipulatives.

5.3 Recommendations

Based on the findings and conclusion of this study, these are recommended by the researcher:

1. Teachers may provide the pupils more manipulative to be used for the different learning activities given to pupils.
2. Elementary Math teachers may include the use of manipulative in their repertoire of alternative classroom teaching strategies.
3. Replication of this study maybe made covering other topics in grade three mathematics.
4. The use of manipulative in the primary grade can be used in:
 - a. Teaching other fields of mathematics
 - b. Teaching students with learning disabilities
5. Teachers may adapt the lesson plan made on the use of manipulative in teaching grade three mathematics.
6. A further research about the use of manipulatives in teaching elementary mathematics.

References

- [1] Anderson, J. A. (1994). Examining teaching styles and student learning styles in science and math classrooms. *Multicultural education: Inclusion of all*, 93-105.
- [2] Bay, O. (2013). *Our World of Math 2*. Vibal Publishing House Inc. Lahug, Cebu City.
- [3] Bender, W. (2005). *Differentiating Math Instruction*. Corwin Press. Sage Publications Co., California.
- [4] Brooks, J. G., & Brooks, M. G. (1999). *In search of understanding: The case for constructivist classrooms*. ASCD.
- [5] Bullmaster, M. L. (2013). A synthesis of research on effective mathematics instruction. *Touro College Graduate School of Education*, 1-15.
- [6] Cain-Caston, M. (1996). Manipulative queen. *Journal of instructional psychology*, 23(4), 270.
- [7] Caine, G. (2012). *Guiding The Innate Constructivist*. Educational Leadership, vol. 60, no. 1.
- [8] Capuyoc, A. (2012). *Real Revolution In Education*. Manila Bulletin.
- [9] Carbonneau, K. J., Marley, S. C., & Selig, J. P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. *Journal of Educational Psychology*, 105(2), 380.
- [10] Castor, M. (2006). Growing Up With Math" FNB Educational, Inc., Quezon City.
- [11] Chang, K. (2008). Study suggests math teachers scrap balls and slices. *The New York Times*, 25.
- [12] Chappuis, S., & Stiggins, R. J. (2002). Classroom assessment for learning. *Educational leadership*, 60(1), 40-44.
- [13] Clements, H. (1999). Concrete manipulatives, concrete. *Contemporary Issues in Early Childhood Ideas*,
- [14] Clements, D. H., & McMillen, S. (1996). Rethinking concrete manipulatives. *Teaching Children Mathematics*, 2(5), 270-279.
- [15] Currie, S. (2005). The Mathtubs are Coming!. *TEACHING PRE K 8*, 35(4), 52.
- [16] Dacey, L. (2005). *Levelled math problems, level 1*. Huntington Beach, CA: Shell Education.
- [17] Franklin, J. (2001). Trying too hard? How accountability and testing are affecting constructivist teaching. *Education Update*, 43(3), 1.
- [18] Friedrich, F. (2009). In Wikipedia, the free encyclopedia. Retrieved December.
- [19] Gardner, H. E. (2011). *Frames of mind: The theory of multiple intelligences*. Hachette Uk.
- [20] Cathcart, W. G. (1971). The relationship between primary students' rationalization of conservation and their mathematical achievement. *Child Development*, 755-765.
- [21] Goldin, A. (1990). Constructivist Views on the Teaching and Learning of Mathematics. *Journal for Research in Mathematics Education*. Monograph, 4
- [22] Hammerman, E., & Musial, D. (Eds.). (2007). *Integrating science with mathematics & literacy: New visions for learning and assessment*. Corwin Press.
- [23] Haylock, D., & Manning, R. (2014). *Mathematics explained for primary teachers*. Sage.
- [24] Heritage, M. (2010). *Formative assessment: Making it happen in the classroom*. Corwin Press.
- [25] Holloway, J. H. (2000). How does the brain learn science?.
- [26] Hull, T. H., Balka, D. S., & Miles, R. H. (2011). *Visible Thinking in the K 8 Mathematics Classroom*. Corwin Press.
- [27] Hyerle, D. (2008). *Visual tools for transforming information into knowledge*. Corwin Press.
- [28] Kamii, C. (1999). *Young children reinvent arithmetic: Implications of Piaget's theory*. Teachers College Press.
- [29] Kelly, C. A. (2006). Using manipulatives in mathematical problem solving: A performance-based analysis. *The mathematics enthusiast*, 3(2), 184-193.
- [30] Lynette, R. (2009). *Critical and Creative Thinking Activities 2"* Evan-Moor Educational Publisher, California USA.
- [31] Martin, W. G. (2000). *Principles and standards for school mathematics* (Vol. 1).
- [32] Martinez, J. G. (1996). *Math without fear: A guide for preventing math anxiety in children*. Allyn & Bacon.
- [33] Marzano, R. J., Norford, J. S., Paynter, D. E., Pickering, D. J., & Gaddy, B. B. (2001). *A Handbook for Classroom Instruction That Works*. Association for Supervision and Curriculum Development, 1703 North Beauregard Street, Alexandria, VA 22311-1714 (ASCD Product No. 101041: members, \$26.95; nonmembers, \$31.95).
- [34] Mercado, E. (2010). *Math for Smart Kids*. Diwa Learning Systems Inc., Philippines.
- [35] Munger, D. (2007). Children learn and retain math better using manipulatives. *Journal for Research in Mathematics*, 1-4.
- [36] Nivera, G. (2011). *Math for All*. Salesiana Books by Don Bosco Press, Phils.
- [37] Piaget, J. (2003). Part I: Cognitive Development in Children--Piaget Development and Learning. *Journal of research in science teaching*, 40.
- [38] Puchner, L., Taylor, A., O'Donnell, B., & Fick, K. (2008). Teacher learning and mathematics manipulatives: A collective case study about teacher use of manipulatives in elementary and middle school mathematics lessons. *School Science and Mathematics*, 108(7), 313-325.
- [39] Reyes, E. (1989). *Helping Children Learn Mathematics*. 4th Edition, Simon and Schuster Company, USA, 1989
- [40] Seefeldt, C., & Wasik, B. A. (2007). *Early education: three-, four-, and five-year-olds go to School*. Recording for Blind & Dyslexic.
- [41] Smith, S. S. (2009). *Early Childhood Mathematics Boston. Pearson Education Using manipulative materials (2009)*. Retrieved October, 9, 2016.
- [42] Stigler, W. (2010). *Formative Assessment*. Corwin, California.
- [43] Strong, R. (2004). *Educational Leadership*. Alexandria, Virginia: Richard Papale.
- [44] Tomlinson, A. (2007). *Teaching as Jazz*. Educational Leadership, Volume 64 No. , Alexandria, Virginia : Richard Papale.
- [45] Tulio, D. (2008). *Historical, Philosophical and Legal Foundations of Education 2 Second Education*. Mandaluyong City

- [47] Turner, J. C., & Meyer, D. K. (2004). A classroom perspective on the principle of moderate challenge in mathematics. *The Journal of Educational Research*, 97(6), 311-318.
- [48] Westwater, A., & Wolfe, P. (2000). The Brain-Compatible Curriculum. *Educational Leadership*, 58(3), 49-52.
- [49] Wright, R. J., Stanger, G., Stafford, A. K., & Martland, J. (2014). *Teaching number in the classroom with 4-8 year olds*. Sage.