Volume-3, Issue-10, October-2019: 72-79 P-ISSN: 2659-1561
International Journal of Recent Innovations in Academic Research E-ISSN: 2635-3040

Research Article

Utilizing Manipulatives in Mathematics Classroom

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Received: Oct 19, 2019 **Accepted:** Oct 26, 2019 **Published:** Oct 30, 2019

Abstract: The use of manipulatives in teaching mathematics allows students to construct their own cognitive models for abstract mathematical ideas and processes. They also provide a common language to communicate these models to the teacher and other students and engage students to increase both interest in and enjoyment of mathematics. This research determined the effect of manipulatives in mathematics classroom of Filipino elementary pupils with an end goal of determining its implication to the teaching of Mathematics in the elementary level. Specifically, it dealt with the following: the pretest result of the control and experimental groups, the post-test results of the two groups; and the significant difference between the pretest and posttest results of the control and experimental groups. By employing the experimental type of research and using a researcher-made instrument, the researchers found that there is no significant difference between the pretest results of the experimental and control groups but there is a significant difference between the posttest results of the two study groups. Incorporating mathematics manipulatives in teaching gives better outcomes than the use of the traditional method of teaching. With this, school principals may encourage teachers to integrate mathematics manipulatives in teaching complex concepts. They may also conduct seminars, workshops and trainings that will help them develop mathematics manipulatives for classroom use.
Keywords: Control Group, Experimental Group, Manipulatives, Pre-Test, Post-Test.

1. Introduction

Mathematics as a discipline requires constant practice and study in order to have full understanding of the subject. However, it has been considered a rational discipline of excellence and one of the most useful and fascinating discussions of human knowledge. Every individual has his own strengths and weaknesses, so it is necessary for Mathematics teachers to provide learning materials which can be used by the students for a better learning of the subject.

Learning materials are texts, videos, software, and other resources that teachers use to assist students in meeting the expectations for learning. Before a learning resource is used in a classroom, it must be evaluated and approved either at the provincial or local level. Evaluation criteria may include curriculum fit, social considerations, and age or developmental appropriateness.

Manipulatives are concrete objects that can be viewed and physically handled by students in order to demonstrate or model abstract concepts. They represent a category of mathematical tools that are referenced in mathematics standards such as the Mathematics Process Standards

included in Principles and Standards for School Mathematics (NCTM) or the Standards for Mathematical Practice included in the Common Core State Standards for Mathematics (National Governor's Association *et al.*, 2010).

There has been an increase in the use of manipulatives, also called concrete materials, in the teaching of Mathematics (Boggan, Harper and Whitmire, 2010). Mathematics manipulative is described as a concrete or visual object that allows a student to explore Mathematics concepts using a hands-on and active approach. These objects may include blocks, shapes, cubes, money, counters or even paper (Mathematics A tube, 2012). The 21st Century provides students with a variety of manipulatives including virtual manipulatives. Virtual manipulatives are basically digital objects that resemble physical objects and can be manipulated, usually with a mouse, in the same ways as their authentic counterparts. Virtual manipulatives, which are usually modeled after concrete manipulatives, are often web based.

Walle and his colleagues (2013) define a mathematical tool as any object, picture, or drawing that represents a concept which the relationship for that concept can be imposed. Manipulatives are physical objects that students and teachers can use to illustrate and discover mathematical concepts, whether made specifically for mathematics or for other purposes. More recently, virtual manipulative tools are available for use in the classroom as well. These are treated as a tool for teacher modelling and demonstration. A mathematical manipulative is defined as any material or object from the real world that children move around to show a mathematics concept. They are concrete, hands-on models that appeal to the senses and can be touched by students. These materials should relate to a student's real world. An abacus, for instance, is not used in daily life, but items like stones, blocks, beans, marbles, rubber bands, and peanuts would be more appropriate. One of the best ways in which mathematical ideas may be developed or applied is through activities with physical materials or manipulatives.

The history of manipulatives for teaching mathematics extends at least two hundred years. More recent important influences have included Montessori, Piaget, Zoltan Dienes and Jerome Bruner. Each of these innovators and researchers has emphasized the importance of authentic learning experiences and the use of concrete tools as an important stage in development of understanding. The use of manipulatives in teaching mathematics has a long tradition and solid research history. Manipulatives not only allow students to construct their own cognitive models for abstract mathematical ideas and processes, they also provide a common language to communicate these models to the teacher and other students.

In addition to the ability of manipulatives to aid directly in the cognitive process, manipulatives have the additional advantage of engaging students and increasing both interest in and enjoyment of mathematics. Students who are presented with the opportunity to use manipulatives report that they are more interested in mathematics. The use of manipulatives facilitates the creation of a learning environment that encourages engagement and enables understanding. Florence (2012) argues that mathematics manipulatives can help engage students for a longer period of time by helping them stay focused on particular tasks. She believes that lecture based teaching can often seem boring but that manipulatives allow students to be actively involved in learning. Xie *et al.*, (2008) linked enjoyment and engagement in their study of the use of tangible objects in the learning process. Moyer as cited by Bouk and Flanagan (2010) believes that the benefits of virtual manipulatives include facilitating the introduction or revision of Mathematics ideas. It also aids the understanding of visual concepts through the use of visuals, scaffolding learning, and engaging students in

learning. Using manipulatives in Mathematics increases the students' confidence to complete difficult mathematics problems. This works to engage the kinesthetic side of the learner, thus aiding understanding.

The use of manipulative materials in mathematics classrooms supports this attempt to provide students with a more thorough understanding of mathematics by allowing students to discover and apply concepts presented in class. This is basically the reason why this research was conceived.

The researchers determined the effect of manipulatives in a mathematics classroom of elementary pupils. Elementary pupils were particularly chosen because the researchers believe that once the pupils are engaged in these materials, they will begin to enjoy what they are doing which will result to understanding of the basic concepts they need to know.

2. Objectives of the Study

This study determined the effect of manipulatives in mathematics classroom of Filipino elementary pupils of Batangas State University JPLPC–Malvar Laboratory School. These pupils were officially enrolled during the School Year 2016-2017. Specifically, this study sought answers to the following questions: What is the pre-test result of the experimental and the control groups? ; What is the post-test result of the two groups? ; Is there a significant difference on the performance of the two groups in their pre-test and post-test? and What is the implication of the findings of this study to the teaching of Mathematics in elementary level?

3. Methodology

This study employed the experimental method of research. According to Ardales (2008), if the aim of the researcher is to find out what caused the change or effect that has been made, the said method is best to use. In this approach the researcher intentionally and systematically controls and manipulates certain stimuli, treatments and conditions, and observes how the condition or the behavior of the subject is affected or changed. The abovementioned measures were executed by the researchers in gathering data needed in the course of the present study. The researchers deemed this method appropriate because its nature of dealing with cause and effect coincides with the aim of the present undertaking which is determining causal connections of using manipulatives in mathematics classroom. The experimental group was given a certain stimuli, then the behavior of the respondents was observed—whether it changed or not.

4. Results and Discussions

This chapter presents the data gathered together with the corresponding analysis and interpretation. The data are presented in textual and tabular form organized in a sequential manner, following the order of presentation of specific problems posed in the Chapter I.

4.1 Pretest Results of the Control and Experimental Groups

The experimental and control groups were given pretest to find out if both groups have comparable prior knowledge before the experimental period began. The test was composed of 25 multiple choice items and covered topics in finding the measure of angles, differentiate of spatial and solid figures.

Table 1 below presents the pretest results of the control and experimental groups. It depicts the mean scores of the respondents with their corresponding verbal interpretation. The mean

scores of the respondents were grouped and categorized as follows: 20.00-25.00 as outstanding, 15.00-19.99 as above average, 10.00-14.99 as average, 5.00-9.99 as below average and 0.00 - 4.99 as poor.

Table 1. Pretest Results of the Control and Experimental Groups

Study Groups	Mean	Verbal Interpretation
Control Group	14.86	Average
Experimental Group	14.71	Average

As indicated in table 1, the mean score of the control group was 14.86 which were classified as average. It obtained a mean difference of 0.15 from the experimental group which result to the mean of 14.71 and was also classified as average. The mean scores of the two groups show that the respondents have almost the same level of performance regarding the chosen topic before the experimental period occur. Although the control group scored higher than the experimental group, this still reflects that the two groups were almost the same with regards to their initial knowledge about the topic.

This finding is parallel to that of Angulo *et al.*, (2007) when they conducted their study on the effect of the activity-based material on the achievement in Mathematics of grade IV pupils. Their findings implied that the pretest result of the control and experimental group did not differ in terms of initial knowledge in the topics contained in the test.

4.2 Posttest Results of the Control and Experimental Groups

Both groups were given posttest after the experimental period had been conducted. The same 25 multiple choice item test was given to the experimental and control group to find out if the use of manipulatives had an effect to the Mathematics performance of the pupils. Table 2 presents the posttest results of the control and experimental groups with their corresponding verbal interpretation.

Table 2. Posttest Results of the Control and Experimental Groups

Study Groups	Mean	Verbal Interpretation
Control Group	17.14	Above Average
Experimental Group	19.29	Above Average

Table 2 reveals the mean score results of the two groups in the posttest. It can be gleaned from the table that the experimental group scored higher than the control group. A mean score of 17.14 which was interpreted as above average was observed in the control group. This shows that the respondents scored much higher in the test. On the other hand, the mean score of the experimental group was observed to be 19.29 which was also interpreted as above average. This result shows that the respondents of the experimental group obtained scores higher than the control group. It shows that both groups performed better compared to their pretest performance.

It can be also noted from the results that there was a big difference between the mean scores of the two groups of respondents. The experimental group obtained mean score which was higher than that of the control group. This signifies that the respondents who were taught using manipulatives performed better in the administered test. The mean difference of 2.15 between the posttest results of the two groups is significantly greater than the observed mean difference of 0.15 between the groups' pretest results. This shows that there is remarkable difference in the improvement of tests scores. This implies that the use of manipulatives in

teaching mathematics helps the students to better understand the topic than plain classroom lecture. It gives the impression that the use of manipulatives is more effective in increasing the mathematical performance of the pupils.

It was revealed by Florence (2012) that mathematics manipulatives can help engage students for a longer period of time by helping them stay focused on particular tasks. She believes that lecture based teaching can often seem boring but the manipulatives allow students to be actively involved in learning. To summarize the results of the pretest and posttest of respondents, table 4 was presented. It was done to provide a detailed comparison among the mentioned results of the control and experimental groups.

Table 3. Summary of the Pretest and Posttest Results of the Control and Experimental Groups

Study Groups	Pre-test	Post-test
Control Group	14.86	17.14
Experimental Group	14.71	19.29

Table 3 shows the summary of the pretest and posttest results of the control and experimental groups. As illustrated in the table, the control group obtained a pretest mean score of 14.86 and a posttest mean score of 17.14. An observed increase of 2.28 for the mean scores was evident. This shows that after the intervention period, there had been a fair increase of performance by the group. On the other hand, the experimental group had a pretest mean score of 14.71 and a posttest mean score of 19.29.The observed increase in between the pretest and posttest mean score of this group was found to be 4.58. This analysis further strengthens the finding that the observed greater increase in performance was present in the experimental group. This significantly proves the positive effect of integrating manipulatives in mathematics instruction.

This shares the same findings as to that Dijan (2011). Both studies utilized activities that may help increase the performance of the students. There was a minimal increase in the posttest results of the students in the control group. However, a huge increase in the posttest mean score of the experimental group was observed.

4.3 Comparison of the Pretest and Posttest of the Control and Experimental Groups

Pretest and posttest results of control and experimental groups were compared, analyzed and interpreted. The mean scores of the pretest and the posttest of the control and experimental groups were compared using the t-test for independent and correlated samples. The detailed results were presented on the succeeding tables and discussions. Table 4 shows the comparison between the mean scores of the pretest of the control and experimental groups. It reveals the computed t–value and tabular t–value.

Table 4. Comparison of the Pretest Result of the Control and Experimental Groups

Study Groups	Mean	SD	Computed t-value	Tabular t-value	Decision (Ho)	Interpretation
Control Group	14.86	3.67	0.924	2.101	Accept	Not Significant
Experimental Group	14.71	3.64				

As depicted in the table, the control group obtained the mean score of 14.86 while the experimental garnered the mean score of 14.71. The data were subjected to t-test to determine the significant difference. This meant that there was no significant difference between the pre-test of the control and experimental group. The result made the researchers accept the null hypothesis that there is no significant difference between the pretest results of the two groups. This further denotes that the control and the experimental groups were comparable in their test performance before the experiment.

The finding is similar to the study of Falculan (2014).which found out that there is no significant difference between the pretest scores of the experimental and control groups. This implied that the study groups have equally comparable prior knowledge before the experiment period was conducted.

Table 5. Comparison of the Posttest Result of the Control and Experimental Groups

Study Groups	Mean	SD	Computed t-value	Tabular t-value	Decision (Ho)	Interpretation
Control Group	17.14	4.18	2.600	0.041	Reject	Significant
Experimental Group	19.29	6.37				

The mean score of the control group was 17.14 with the standard deviation of 4.18; the experimental group had a mean of 19.29 with the standard deviation of 6.37. The computed t-value was 2.600; this was higher than the tabular t-value of 0.041 with 13 degrees of freedom at 0.05 level of significance. This meant that there was a significant difference between the posttest result of the control and experimental groups. With this finding, the null hypothesis was rejected. The findings showed that there was a significant difference between the test performances of the two groups after the experiment was conducted. The same finding was true in the study of Falculan (2014). She found-out that significant difference is evident in the posttest performance of the study groups; this further showed that using manipulatives in class discussions was more effective than the traditional method of teaching.

The finding also suggests that the mathematics manipulatives which was given to the experimental group is an effective and a helpful method in making pupils perform better in written evaluation. This was similar to the study of Lat *et al.*, (2011) when they determined the effect of multimedia presentations on the mathematics achievement of fourth year students.

The experimental group in their study also performed better in the administered posttest as compared to the control group. Similar to the study of Lat *et al.*, (2011), the findings of the current study led to the conclusion that the integration of mathematics manipulatives helps accelerate learning compared with the use of traditional symbolic means.

4.4 Implication of the Findings of the Study to Mathematics Instruction

The result of the study implies that the use of mathematics manipulatives was more effective than the use of traditional instructional materials in teaching Mathematics for grade - six pupils. The students easily understand the lesson whenever they were confined with interesting activities. They learn easily and comprehend complex concepts while enjoying and having fun in doing activities through mathematics manipulatives. The teacher may use

mathematics manipulatives as a new strategy in teaching mathematics. They may also use appropriate materials for each concept which they are about to deal with. Hence, new teaching strategies must be developed for better quality Mathematics education.

5. Conclusions and Recommendations

Based on the findings of the study, the following conclusions were drawn: The experimental group and the control group have average performance in the pretest. The experimental group and the control group have above average performance in the posttest. There is no significant difference in the pretest scores between the two groups but there is a significant difference in the posttest scores the two groups. The use of manipulatives in mathematics classroom is more effective than the plain lecture method which uses traditional instructional materials.

Based on the findings, the following were recommended. Mathematics division supervisors and school principals may encourage teachers to integrate mathematics manipulatives in teaching complex concepts. They may also conduct seminars, workshops and trainings that will help them develop the use of mathematics manipulatives as another strategy in teaching Mathematics. Teachers may use mathematics manipulatives during discussions especially on complex concepts to further enhance the learners' performance. They may be encouraged to provide activities that will be appreciated by students and develop their weak points. Mathematics instructors may prepare materials and constantly expose Mathematics major students in making use of mathematics manipulatives. Similar studies may be conducted to further verify the result of this study. This may be done in other schools with a different set of subjects and with other areas of specialization.

Conflicts of interest: The authors declare no conflicts of interest.

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Citation: Nora V. Marasigan, Elsie Mae M. Balba, Cris-Anne D. Dela Cruz and Jerome S. Manalo. 2019. Utilizing Manipulatives in Mathematics Classroom. International Journal of Recent Innovations in Academic Research, 3(10): 72-79.