

INVESTIGATING THE EFFECTIVENESS OF GEOBOARD MANIPULATIVES ON JSS 1 STUDENTS' PERFORMANCE IN PLANE GEOMETRY. A STUDY OF KATSINA METROPOLIS

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Abstract

This study investigated the effectiveness of geoboard manipulatives on Katsina State Junior Secondary school students' academic performance in plane geometry. One secondary school was purposefully selected from Katsina Metropolis, and a sample of 30 students was selected from the school using simple random sampling technique. The instrument for data collection was pretest posttest Geometry Achievement Test (GAT), the test was constructed by the researcher, the instrument was validated by two mathematics experts and the reliability of the instrument was ascertained by using test and retest method. The research was guided by three objectives, three research questions and three hypotheses. The research questions were answered using the mean and the hypotheses were tested using t statistic at $\alpha = 0.05$ level of significant. The analysis was done using SPSS version 23. Findings from the research established the effectiveness of the use of geoboard in teaching plane geometry in junior secondary school, because there was a significant difference in the mean of the experimental and control groups, which was 56.87 and 45.00 respectively. Hence the conclusion that teachers at the junior secondary school level should always make use of geometric manipulatives when teaching geometry. The paper also recommended that mathematics curriculum for junior secondary school should stress the use of manipulatives, teachers of mathematics in secondary school should be encouraged to use manipulatives and also learn to improvise whenever the materials are not available., seminars and workshops should be organized for mathematics teachers on the use and production of mathematics manipulatives and government should make funds available for the purchase of materials to produce manipulatives in secondary schools.

Keywords: Geoboard, Geometry, Manipulatives, Performance, Dimension.

Introduction

Mathematics is the science of numbers and shapes and what they meant. It is a subject that deals with the study of numbers, shapes, logic, quantity and arrangements. It seeks out patterns, formulate new conjectures and establish truth by rigorous deduction from appropriately chosen axioms and definitions. Mathematics gives us a way to understand patterns to quantity relationships and to predict the future. It helps us understand the world. It is useful in estimating cost of travelling, understanding sports, calculating interest on loans, etc. The knowledge of mathematics helps us have better problem solving skills, think analytically and have better reasoning abilities. Mathematics is one of the main subject of our life. Information on mathematics helps us make better choices in our everyday life and this helps to make life better and simpler. It is a natural way to organize and think. When you use

your microwave or washing machine, you need mathematics to set the appropriate time. In cooking, baking, construction, finance etc we need mathematics. It is a powerful and incredible tool for us.

The general aim of teaching mathematics as stated in the 1977 National Policy on Education and cited by NOUN course guide (2022) are:

- To generate interest in mathematics and to provide a solid foundation for everyday living.
- To develop computational skills and foster the desire and ability to be accurate to a degree relevant to the problem at hand.
- To develop precise, logical and abstract thinking.
- To develop ability to recognize problems and solve them with related mathematical knowledge.
- To provide necessary mathematical background for further education.
- To stimulate and encourage creativity.

The four main branches of mathematics are algebra, geometry, calculus and statistics and probability.

Geometry

Geometry is one the branches of mathematics that deals with the study of shapes and their properties. Abiola's mini dictionary of mathematics define geometry as a branch of mathematics that is concerned with the properties of curves, surfaces and solids in shapes. Geometry is concerned with the properties and relations of points, lines, surfaces and solids. it has to do with shapes and arrangement of something, for instance the geometry of a cup is its total surface area, its volume etc. There are three major branches of geometry, they are Euclidean, non-Euclidean and projectile geometry. This paper concentrate on Euclidean geometry. Euclidean geometry is the most common type of geometry and it is the one that is taught in primary and secondary schools in Nigeria. It is the study of plane and solid figure on the basis of axioms and theorems by the Greek mathematician Euclid. Plane geometry deals with two dimensional shapes and planes and solid geometry deals with three dimensional objects. This study focuses on the use of geoboard when teaching plane shapes in junior secondary schools.

In mathematics classroom today, it is very hard to see teachers using manipulatives when teaching, what they mostly use are board, chalk or marker and textbooks this is not too good for mathematics teaching. Some educators believe that students learn concepts and solve problem better when using hands-on, concrete models when learning. Moyer (2001), defined manipulatives as physical objects designed to represent explicitly and concretely mathematical ideas that are abstract. Teaching mathematics through the use of workbooks and memorization is ineffective and it must be replaced with an environment that offers the opportunity for students to think as they manipulate objects. Manipulatives are objects that is designed so that a learner can perceive some mathematical concepts by manipulating it. Ernest & Okyere (2016) define manipulatives as objects that appeal to several senses and that can be touched, moved about, rearranged and otherwise handled by children. It is a piece of equipment created so that a learner can use it to manipulate some mathematical ideas to understand it (Mukthar, Muhammad & Faruk 2023).

Review of Theoretical Framework.

The study linked to this research work is the theory of Constructivism learning. Constructivism learning theory was propounded by John Piaget in 1973. It is a theory about how we learn and the thinking process, rather than about how a student can memorize and recite a quantity of information. In constructivism theory, teachers organize the learning process according to students' interest and needs, to incite to ask questions, to produce the new ideas, to make estimations and observations, to work in collaboration and to test their ideas (Kim, 2005). According to the theory of constructivism, learning is a process of establishing a link between the new information and the information that exists in individuals during this process (Ayaz&Sekeci, 2015). The theory is based on the idea that students create their own learning based on their previous experiences. They take what they are being taught and add it to their previous knowledge and experiences, creating a reality that is unique to them. This theory sees learning as an active process. Manipulatives are a form of constructivism because manipulating learning materials is a form of active learning. It is an educational theory that promotes people constructing their own learning through actively doing something. Teaching mathematics through constructivist methods allow students to deepen their knowledge beyond rote memorization, develop meaningful context to comprehend the content and take command of the learning process as an active participant rather than mere observer.

By planning your mathematics lesson in a way that proceed from concrete to pictorial and to abstract representation of concepts, content mastery will be more accessible to the students. With concrete objects in a mathematics class, students gain deeper and long lasting understanding of mathematics concepts. For instance, students understand fractions better when you bring an orange or bread into the class and you divide it in their presence, they learn shapes better when you cut cardboard into different shapes and sizes. Geoboard is one of these manipulatives. Hillary (2008), defined geoboard which was invented in the early 90s by a man called Gattegmo as a manipulative tool for teaching geometry in schools. Geoboard is made out of plywood and nails, it uses string or rubber bands to create a variety of shapes. It comes in a variety of sizes, depending on the available materials. The nails are put into a flat plywood, and rubber bands are placed around the nails to form different shapes. They are for practicing shape recognition and naming of shapes. They can also be used to teach topics like graph, decimals, geometry, arithmetic and many other topics in mathematics.

Review of Related Literature on the Effect of Manipulatives on Students Performance in Mathematics

Mathematics teachers are always interested in looking for ways of improving their teaching and making their lesson interesting and less abstract. Many research work in Nigeria and all over the world are in support of the fact that to make mathematics lesson interesting and less boring, teachers must make use of manipulatives. Maria (2014), define manipulatives as artifacts used in mathematics education, these are handled by students in order to explore, acquire or investigate mathematical concepts or processes and to perform problem solving activities drawing on perceptual evidence. Istiandaru, Istihapson, Rully&Fariz (2017), define manipulatives as a kind of teaching aid designed to represent abstract mathematical ideas concretely. Manipulatives can be concrete or virtual, concrete manipulatives are physical artifacts that can be concretely handled by students and offer a large and deep set of sensory experiences, while virtual manipulatives are digital artifacts that resemble physical objects

and can be manipulated usually with a mouse in a similar way as concrete manipulatives. They are materials or objects from the real world that students move around to show a mathematical concept. Students of all grade and level benefit by first being introduced to mathematical concepts through physical exploration.

In a research work conducted by Ahurime (2007) in Edo state on how manipulatives affect mathematics achievement of students in Nigeria schools, sixty-six JSS 2 students were selected from Ebelle secondary school as the sample of the research, the 66 students were divided into experimental and control groups, the two groups were taught using geometric manipulatives and traditional methods respectively, the two groups were tested and it was found out that students taught topics in geometry using manipulatives perform better than those taught without manipulatives. Neidea, Realyn&Leneth(2023), conducted a research on the use of geoboard to improve mathematical performance of grade III pupils in Cateel Central Elementary School Philippines, the researchers selected 61 pupils of grade III, divided them into 31 for experimental and 30 for control group. Pretest and posttest method was used to gather the information needed from the pupils, the result of the test was analyzed and the study revealed that the use of geoboard improves the performance of grade III pupils. Also Olajide, Ekwueme&Ndioho (2020), conducted a research on geoboard application on geometry teaching and secondary school students' performance in Degema local government area of Rivers State, the population of the study were all the SSS 1 students in Degema local government, the 100 students that were selected for the study were divided into experimental and control groups, the two groups were taught with geoboard manipulatives and traditional method respectively, the two groups were given GMPT, the mean of the two groups were compared and the result established a significant difference between the mean of the experimental and the control group, the experimental group gained a higher mean score than the control group. This paper seeks to investigate the effectiveness of the use of geoboard manipulatives on junior secondary school students' performance in plane geometry.

Statement of the Problem

Teaching mathematics through the use of textbooks, workbook and memorization is ineffective and these are not adequate as far as JSS mathematics is concerned, this traditional method should be replaced with a classroom environment that offers the opportunity for the pupils to think as they manipulate objects. Students who use manipulatives to solve real life problems are able to construct their own knowledge about mathematical concepts and this will make them to acquire a higher understanding in mathematics.

Objectives of the study

The objectives of the study are:

- To determine the difference between the mean performance of JSS1 students in the pretest.
- To determine the difference between the mean performances of JSS I students taught areas and perimeter of plane shapes using geoboard manipulatives and those taught without the use of geoboard manipulatives.
- To determine the difference between the mean performance of male and female JSS I students taught using geoboard manipulatives.

Research Questions

The following research questions were raised and answered in this work.

1. What is the difference between the mean score of the control and experimental group before the administration of the treatment?
2. What is the difference between the mean score of the control and experimental group after the administration of the treatment?
3. What is the difference between the mean score of the male and female of the experimental group?

Research Hypotheses

The following null hypotheses were tested at $\alpha = 0.05$ level of significant.

1. There is no significant difference between the mean of the control and experimental group before the administration of the treatment.
2. There is no significant difference between the mean of the experimental and control group.
3. There is no significant difference between the mean of male and female students of the experimental group.

Methodology

This study followed a Quasi experimental research design, using pretest and posttest method. The population consists of all the JSS I students in Katsina Metropolis. Only one school was purposefully selected for this research work. Thirty JSS I students were selected from the school, the students were divided into two groups, the control and experimental group. Geometry Achievement Test (GAT) was constructed by the researcher to collect the information needed from the student. The test was validated by two lecturers from the department of mathematics, F.C.E, Katsina and the reliability was tested by using test and re-test method. This test is a ten item objectives question, it will be used for the pretest and posttest. The GMT were given to the control and experimental group before the administration of the treatment, this is to ascertain the students' prior knowledge. The test was marked and recorded, after which the two groups were taught area and perimeter of plane shapes, the experimental group were taught using geoboard, while the control group were taught without the use of geoboard. The two groups were taught simultaneously to avoid interference, with the help of the class mathematics teacher. The teaching was done for two weeks. After which the groups were given the posttest. The posttest was also marked and recorded. The mean of the two groups were computed and were also compared using t test. SPSS version 23 was used to analyze the data.

Data Analysis

Hypothesis 1: There is no significant difference between the mean score of the pretest of control and experimental group.

Table 1

Paired Samples Statistics						
		Mean	N	T	Df	Sig.(2-tailed)
Pair 1	PRECONT	24.60	15	.026	14	.980
	PREEXPT	24.47	15			

The table above compared the mean score of the control and experimental group, from the table the mean of the control and experimental group are 24.60 and 24.47, the t calculated is .026 and the p value is .980.

Hypothesis 2: There is no significant difference between the mean of the experimental and control group.

Table 2

Paired Samples Statistics						
		Mean	N	T	Df	Sig.(2-tailed)
Pair 1	POSTEXPT	56.87	15	4.712	14	.000
	POSTCONT	45.00	15			

From table 2 above, the mean of the experimental and control group are 56.87 and 45.00, the t calculated is 4.712 and the p value is .000.

Hypothesis 3: There is no significant difference between the mean of male and female students of the experimental group.

Table 3

Paired Samples Statistics						
		Mean	N	T	Df	Sig. (2-tailed)
Pair 1	MALEPOST	57.14	7	.081	6	.938
	FEMALEPOST	56.71	7			

From table 3 above, the mean of male and female student of the experimental group are 57.14 and 56.71, the t calculated is .081 and the p value is .938.

Discussion of Results

The first table compared the means of the control and experimental group before the administration of the treatment, the means 24.60 of the control group is approximately equal to 24.47 of the experimental, this is before the administration of the treatment, the t calculated is .026 and the p value .980 is greater than the level of significant $\alpha = 0.05$, the null hypothesis 1 is not rejected, this implies that the performance of the two groups are the same before the groups were taught separately. The result from table 2 above shows that the mean 56.87 of the experimental group is higher than the mean 45.00 of the control group, the t calculated is 4.712 and the p value is .000 which is less than the level of significant $\alpha = 0.05$. Therefore, the null hypothesis 2 is rejected, this implies that there is a significant difference between the mean scores of the experimental and control group, this shows that the JSS 1 students taught area and perimeter of plane shapes using geoboard perform better than those taught with traditional method. This is in line with the work of Olajide (2020) and Neiden (2023), which says that the use of geoboard has a positive influence on students' performance. Also from

table 3, the mean 57.14 of male student of the experimental group is approximately equal to 56.71, of the female student of the experimental group, the t test is .081 and the p value is .938, the p value .834 is higher than the level of significant $\alpha = 0.05$. Therefore, the null hypothesis 3 is not rejected, this implies that there is no significant difference between the performance of male and female students in the experimental group.

Conclusion

The findings from this research work revealed that there is a significant difference in the mean of students taught area and perimeter of plane shapes using geoboard and those taught without geoboard. This implies that the use geometric manipulatives in a mathematics class has a significant effect on JSS 1 students' performance. The paper therefore concluded that mathematics teachers at the junior secondary school level should always make use of geometric manipulatives when teaching geometry.

Recommendations

Based on the findings of this research work, the researcher wishes to make the following recommendations:

- Mathematics curriculum for junior secondary schools should stress the use of manipulatives.
- Teachers of mathematics in secondary schools should be encouraged to use manipulatives and also learn to improvise whenever the materials are not available.
- Seminars and workshops should be organized for mathematics teachers on the use and production of mathematics manipulatives.
- Government should make funds available for the purchase of materials to produce manipulatives in secondary schools.
- Parents and guardians should help students by providing playing materials that are mathematically inclined.

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