

MATHEMATICS LEARNING OUTCOMES AND RETENTION: A STUDY ON THE EFFECTS OF GEOBOARD IN SECONDARY SCHOOLS IN BAYELSA STATE

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Abstract

The study investigated the effects of Geoboard on Secondary Students' Mathematics performance and retention in Ogbia, Local Government Area, Bayelsa State. Pre-test, post-test non-equivalent quasi-experimental design was employed for this study. Two research questions guided the study. Out of a total population of four hundred and fifty (450) Mathematics students in six (6) public secondary schools, a total of one hundred and sixty-three (163) students from three co-educational secondary schools purposively selected formed the sample size of the study. Geometry Performance Test (GPT) which also tested retention with a reliability index of 0.85 was developed. Research questions were answered with mean and standard deviation. The results revealed that Geoboard proved more effective than lecture method in students' understanding of geometry. Furthermore, the study noted that Geoboard are effective learning strategies for enhancement of students' retention in Geometry. It was recommended that Geoboard should be used by Mathematics teachers to teach geometry so as to enhance students' performance and retention in Mathematics.

Keywords: Geoboard Instruction, Mathematics Performance and Student Retention

INTRODUCTION

21st century is an era of digital tools in the academic environment. Due to the relevance of these tools in the society, human actions are largely determined by them. Human life in the society has been greatly enhanced by these tools also called technological resources. These tools have definite potentials to educate the mind and reshape learning capacities. The use of these technological facilities (digital tools or technological resources) has brought efficiency and convenience in the way we teach and learn. To teach more effectively, Ajayi (2020) claimed that teachers need to know more about digital pedagogy, new learning theories and differences in students that are associated with digital tools and activities and have a deeper understanding of variety of learning styles in 21st century. The present-day students are digitally oriented in their environment. The environment they are exposed to is media rich, electronic and digitally connected. This environment provides communication medium

with instant gratification. These set of students are called Digital Natives (Mickel, 2021). Teachers are therefore expected to migrate to digital world in order to be relevant in the educational system. Blended learning is no longer an option for classrooms, it is a necessity. The combination of face-to-face instruction and digital learning opportunities allows for individualization, flexibility and greater chance for students' academic success. The 21st-century learning has changed from traditional method to digital pedagogy. Learning styles which refer to students' approaches to learning, problem solving and processing information are also changing. The way students learn is very important in any teaching-learning situation because if students are to learn content knowledge to facilitate remembering, understanding, applying, analyzing, evaluating and creating, then educators can be assured that teachers are scaffolding learning by building on a basis of knowledge recall and comprehension to desired outcomes and consequences, which would enhance creativity and innovation. Impressively, teaching and learning with the aid of technology in this 21st century have become very prominent amongst the most basic and much-talked-about subjects in present-day education conversation, which is as a result of the fact that the advantages associated with the utilization of technology in aiding teaching and learning glaringly supersede its disadvantages. As such when technological tools are appropriately utilized, there is a high prospect that the outcome of the conversation will be tremendous as compared to when it is not utilized or inappropriately utilized for the same purpose. However, it can be stated that the utilization of technological software in educating learners has had a huge impact on both teachers and learners by way of proving a medium for instructors and learners who collaboratively interact in course of the teaching and learning process. The teaching of Mathematics is not left out in the use of digital pedagogy. Mathematics is defined as the science that deals with the logic of shape, quality and arrangement. Mathematics is seen today as the mother of all subjects. It is an important subject that is applicable to all facets of life. Everyone in the society makes use of Mathematics on daily basis including market men and women. As a result of this, the role played by Mathematics in all areas of development in live cannot be under-estimated. Mathematics serves as a backbone to all technological advancement in the world. There can be no meaningful development in this modern world of technological era without adequate and sufficient knowledge of Mathematics. The study of Mathematics enhances one's understanding of the world through the use of symbols and abstract representation of phenomena. It is a subject that is very important for the academic excellence of people irrespective of the programme of study. Knowledge of Mathematics is applied in every school subject. In Nigeria, Mathematics is one of the core subjects in the curricula of basic schools, senior secondary schools and colleges of education. Mathematics is all about logical analysis, deduction, calculation within its pattern and structures. Mathematics is also seen as a science that investigates geometric figures, compute numbers, and study

abstract topics such as quantity (numbers), structures, space and change. Mathematics is also seen as the science that deals with the logic of shape, quality and arrangement. Mathematics is all around us, in all we do. It is the building block for all our daily activities including mobile devices, architecture (ancient and modern) art, money, engineering, and even sports. Although, Mathematics has no generally accepted definition, but it can also be described as the study of different topics such as quantity, structure, space and change. Though, through the use of abstraction and logic, Mathematics developed from counting, calculation, measurement and the systematic study of the shapes and motions of physical objects. It is very difficult to imagine a world without Mathematics. Mathematics is featured as one of the most prerequisite for entry into higher institutions. In addition, many Universities having realized the importance of mathematical knowledge and have embedded some mathematical courses in various courses to be studied in the non-Mathematics programme. For instance, students that are supposed to undertake a research work as part of their programmes can only be successful when they have acquired basic knowledge in statistic, a branch of mathematical knowledge. The importance of Mathematics as a school subject cannot be over-emphasized. Its role as foundation for nation building, utility base for daily living, agent for development of critical and disciplined mindsets in individuals and support-service to other disciplines has been highlighted by many writers (Fitzmaurice, O'Meara, & Johnson, 2021). The United Nations Educational, Scientific and Cultural Organization (UNESCO), in pursuance of its global education for all program recognizes the importance of Mathematics to the educational growth of the child, promotes Mathematics education globally especially in developing countries. Hence it supports activities that address the lack of interest by students in Mathematics and those that aim at enriching teachers on both their knowledge of new developments in mathematics as well as its significance to society. The Mathematics curriculum at the secondary school level is aimed at preparing students to acquire ability to apply scientific knowledge to everyday life and to take a decision for further study at the University level. In order to achieve these objectives, teachers must adopt learner centered instructional strategies that will combine the power of teachers with the power of technology in the classroom like the use of Geoboard application in the teaching of Mathematics in secondary schools. A Geoboard is defined as a mathematical manipulative which can be used to explore basic concepts in plane Geometry such as perimeter properties, area and the characteristics of triangle and other polygons. It consists of a physical board with a certain number of nails driven in, around which are wrapped geo-bands that are made of rubber. Mathematics can be taught in a more meaningfully and better ways by using manipulatives. The use of manipulatives in the teaching of Mathematics has important roles to play. Most Mathematics teachers today make the learning of Mathematics difficult for students because all what they do in the class is the traditional way of teaching where the teacher is

seen as an island and the students are seen as the listeners. The teacher is the only active one in the class and the students are passive. The students concur to whatever the teacher says whether it is understood or not. Students in Mathematics class should be active and be able to explore the environment. A Mathematics class should be a constructive class where students relate and interact with one another and the environment, but the reverse is the case these days. Mathematics class is so abstract and learning takes place under a tensed environment. Base on this, one of the strategies in this study is the use of Geoboard in teaching Mathematics in secondary school. Gender is an important extraneous variable which sometimes affects the academic performance of secondary school students. This is probably because most students at the secondary school level are between the ages of 14 to 19 years, which is the age bracket when most of them are used as service givers both in school and at home. It is also the age most students drop out of school due to poverty and distractions. There is therefore the need to use teaching strategies that encourage gender equality, positive interdependence and group work so as to motivate the students for higher academic performance. This is in line with one of the United Nation's Millennium Development objectives which states that "women and men should be given equal rights, responsibilities and opportunities. Gender equality is the main objective a teacher achieves using Geoboard application because of their characteristic feature. These strategies encourage active participation of male and female students in the classroom setting. Both male and female students have equal opportunities and there is no gender discrimination in the instructional strategies as both males and females can play any of the collaborative roles during instruction. The concept in Mathematics that is widely used in our everyday discourse is Geometry. People often use the word Geometry without the understanding of its mathematical implications. There is no doubt that Geometry concepts are very important in a variety of mathematical concepts. Learning of Geometry depends on proper teaching method. The wrong use of teaching method in secondary school Mathematics has been a serious issue to investigate. Despite how important Mathematics is in our society, its importance and unique position in the school curriculum, it is also disappointing and discouraging to note that students still perform poorly in the subject. Cullen, Hertel and Nickels (2020) researched on the effect of GeoGebra software on the performance of learners in Mathematics and also the effect of gender on the performance of learners taught Mathematics with the use of GeoGebra package. The study adopted the nonequivalent pre-test post-test control group design. The population of the study comprised secondary Mathematics students in Ogbomoso North Local Government Area of Oyo State. The senior secondary school two (SSII) Mathematics students from two intact classes from each of the two purposively selected schools in the area constitute the sample (54 students for experimental group and 51 students for control group). Availability of functional computer system served as basis for selecting the schools. The

Research Article

classes were assigned into two groups (experimental and control) using simple random sampling technique. The experimental group was taught using GeoGebra, while the control group was taught using conventional method. In experimental group, the students interacted with different kinds of GeoGebra tools to solve problems in geometry, algebra, introductory calculus, among others. The control group was exposed to conventional method and taught the same topics. The experiment lasted for the period of six weeks. Two instruments were used for data collection, namely; Student Achievement Test in Mathematics (SATM) and Mathematics Attitudinal Scale (MAS). The two groups were pre and pos-tested using SATM, after which MAS was administered to them. Data collected were analyzed using t-test statistics. The findings showed that there was no significant difference in the sampled students based on Gender, since $t\text{-cal}$ was 0.66 while the critical value t_{tab} was 2.01 ($t\text{-cal} < t_{\text{tab}}$). This implies that both male and female had the same level of achievement. This further mean that both male and female produced the same scientific knowledge and interest as the male provided that sufficient rigor in undertaken in scientific enquiry. However, the use of GeoGebra can attenuate the gender in performance of the secondary school students in geometry. Eze (2020) investigated the effect of Geoboard on Junior Secondary School students' achievement in geometry. The study employed a pre-test post-test quasi experimental design. The study was conducted in four secondary schools. In each school two intact classes of JSSII were drawn and randomly assigned to treatment and control groups. The treatment group was taught geometry using the Geoboard while the control group was taught geometry using the conventional approach. Data were collected from both the treatment and control groups using a Geometry Achievement Test (GAT). Data were analysed using mean, standard deviation and the Analysis of Co-variance (ANCOVA). The results reveal that use of Geoboard is superior to the conventional approach in facilitating students' achievement in geometry. In addition, the Geoboard approach has no significant differential effect on the mean achievement of male and females in geometry. In the same vein also, there was no interaction between gender and instructional approach on students' achievement in geometry. Nneji (2019) conducted a study on the effect of Geoboard on senior secondary school students' achievement and retention in geometry. Quasi-experimental design was adopted in this study. Pre-test post-test, non-equivalent control group was used. Eight intact classes, four of which were randomly assigned to experimental and the other four to control groups are used for the study. Sample of the study consisted of 220 SSII students from Ishielu Local Government Area of Ebonyi State. Four research questions and four hypotheses guided the study. Geometry Achievement Test (GAT) was used for data collection. GAT was constructed by the researcher and validated by three research experts. Mean and standard deviation were used to answer the research questions while the hypotheses were tested at .05 level of significance using Analysis of Covariance (ANCOVA).

Research Article

Experimental groups were taught using Geoboard while control groups were taught the same topics using expository method. Major findings of the study revealed that students taught Geometry with Geoboard achieved higher and retained more than those taught with expository method. There was no significant difference between the mean achievement and retention scores of male and female students in the study. It was recommended that Mathematics teachers should adopt Geoboard in teaching Geometry. Mudaly and Sibiya (2019) investigated the effects of the Geoboard on learners' understanding of geometric theorems. The study employed a qualitative research design. The study was conducted in two secondary schools. Twenty-five (25) participants were selected randomly from each of two conveniently selected secondary schools. Four focus groups were eventually established, two from each school. All 50 participants were taught geometric theorems using the Geoboard for two weeks. The data were analysed using thematic analysis. The results revealed that Geoboards improved learners' understanding of geometric theorems, especially understanding the geometric terminology and reasoning. Ikechukwu (2022) examined the effects of the use of instructional materials (Geoboard and Geographical Globe) on students' performance in mathematics in Sabon Gari Local Government Area of Kaduna State. Three hundred and fifty students were randomly selected from four secondary schools and used as sample for the study. The sample was divided into two groups experimental and control. The study was quasi experimental design. A pretest was first given to both groups to ensure that they were homogeneous. Then the experimental group was taught mathematics using instructional materials like Geoboard, and Geographical Globe for six weeks while the control group was taught same topic with experimental group for same period but without the use of instructional materials. Both groups were post tested. A Mathematics Achievement Test (MAT) with a reliability coefficient of 0.78 calculated using split half methods served as the instrument of the study. Two research questions were asked and two hypotheses were formulated to guide the study. Some of the findings of the study include: Significant difference existed between the experimental and the control group with $p=0.02$; it was also discovered that there was no significance difference between the performance of male and female when taught mathematics with the use of Geoboard and Geographical Globe. Finally, it was recommended that mathematics teachers should use such as Geoboard, and Geographical Globe in their teaching. Anaechie and Ezeamaenyi (2022) studied the effect of using geo-board game in teaching and learning of some selected topics in Mathematics in junior secondary schools in Ideato North L.G.A., Imo State. The study adopted a post-test randomized quasi-experimental research design. The population of the study consisted of 1,496 JSS2 students in the public secondary school within the area of the study. A sample of 240 students (125 males and 115 females) were drawn using a simple random sampling technique. Three research questions and three research hypotheses

were formulated to guide the study. A Mathematics achievement test (MAT) was administered to the control and experimental groups of students after the experimental treatment. The instrument was validated by appropriate experts and the reliability coefficient was calculated using Spearman's reliability coefficient. The instrument had a reliability coefficient of 0.85 and as such, adjudged to have a high reliability index. The hypotheses were tested using t-test statistic. Among the findings were that use of geoboard game increases the students' achievement in identifying and differentiating polygons and in describing and locating coordinate points. Again, it was found out that gender has no significant effect on the achievement of students when taught with geo-board. Following the findings, the following recommendations were made: that Mathematics teachers should incorporate geoboard game in teaching various concepts in Mathematics; federal and state ministries of Education, professional bodies, such as the Mathematical Association of Nigeria (MAN) etc., should organize in-service training and/or workshop on regular basis for the teachers to upgrade their knowledge on the modern trends in teaching process, especially on the use of geo-board game. Finally, teachers should be encouraged, by relevant authorities, to use geo-board game. This can be done by providing them with necessary materials, including creating more time on the timetable for Mathematics. Mandlenkosi (2019) investigated the effects of using a Geoboard on learners' motivation for learning geometry theorems. The study was a qualitative research project, which included twenty ($n = 20$) participants from two secondary schools in King Cetshwayo District in KwaZulu-Natal Province (selected by means of convenience sampling). Eight ($n = 8$) of the top learners, four ($n = 4$) of the middle learners, and eight ($n = 8$) of the bottom learners were randomly selected from the mark list for the test on geometry theorems to form four focus groups. Each focus group comprised five ($n = 5$) participants. All twenty ($n = 20$) participants were taught geometry theorems using a Geoboard for two weeks. The data collected from the four focus groups were analysed using the Attention, Relevance, Confidence, Satisfaction (ARCS) theory of motivation, following an interview schedule. The results revealed that learners became motivated to learn geometry theorems after being taught these theorems using a Geoboard. The study further revealed that only the Attention, Relevance, and Confidence aspects of the ARCS theory increased learners' motivation, and not the Satisfaction aspect. Further findings of the study were that participants became more confident and showed interest in learning geometry theorems, especially in writing geometry theorems reasons correctly as corresponding with ARCS theory. It is recommended that external awards such as incentives must be used, along with Geoboards to teach geometry theorems which can subsequently increase extrinsic motivation and learners' satisfaction. It is against this background that the study will investigate effect of Geoboard for enhancement of Mathematics students' performance and retention in Ogbia LGA, Bayelsa State.

Research Article

Research Questions

The following research questions guided the study

1. What is the effect of Geoboard on students' mean performance score in Mathematics?
2. What is the effect of Geoboard on students' mean retention score in Mathematics?

3. Methodology

The study adopted pre-test, post-test quasi-experimental design. This is because the study on Geoboard on secondary students' mathematics performance and retention in Ogbia local government area, Bayelsa state made use of students as respondents. The Students were not randomized. Thus, intact classes were used. The population of the study consisted of four hundred and fifty (450) senior secondary two (SS2) Mathematics students. One hundred and sixty-three (163) SS1I students (92 males and 71 females) constituted the sample of the study. Purposive sampling technique was used to select three (3) public senior secondary schools while random sampling was used to assigned classes to experimental and control groups. Instrument titled Geometry Performance Test (GPT) was developed and used for data collection by the researcher. The GPT comprised 15 multiple choice objective questions drawn from the content area of study. The test questions were drawn from West African Senior Secondary Certificate Examination past question papers and Mathematics text books for senior secondary school based on the content of the study. The reliability of the instrument was done by test-re-test method. 20 SS2 Mathematics students from a senior secondary school in a neighboring community outside the study sample were used. The test was administered to the students twice over a period of two weeks. The initial and re-test scores were analyzed using Kuder Richardson (KR-20) formula which yielded reliability coefficient of 0.85. The data obtained in this study were analyzed using mean and standard deviation to answer the research questions.

Data analysis and Presentation**Table 1: mean and standard deviation on performance of students in Mathematics using Geoboard**

Group	Pre-test		Post-test		Mean Gain	Effect Size
	n	SD	SD			
Geoboard	55	56.53	13.57	80.33	17.20	33.8
	27.66					

Research Article

LM 51 53.06 14.52 59.20 15.60 16.14

From the Table 1, it can be observed that the pre-test mean score of experimental group taught using Geoboard was 56.53 while the post-test mean score was 80.33. For the control group taught using the lecture method, students had a pre-test mean score of 53.06 and a post-test mean score of 59.20. Considering the values, it can be seen that the mean gain for the pre-test and post-test mean scores of experimental groups and the control group were 33.8 and 16.14 respectively. While the effect size was 27.66. This result indicated that Geoboard has a greater effect in the academic performance of students in Mathematics than the lecture method. Research Question two: What is the effect of Geoboard on students' mean retention score in Mathematics?

Table 2: post-test and retention mean level of students in Mathematics using Geoboard and lecture method

Group	n	Post-test	Post	Post test	Mean Gain	Effect Size
Geoboard	55	80.33	84.90	14.57		
					11.24	
LM	51	59.20	62.53	13.33		

According to the results in Table 2, it can be seen that students in experimental group taught using Geoboard had a post-test mean score and retention mean score of 80.33 and 84.90 respectively, students in the control group taught using lecture method had post-test mean score of 59.20 and a retention mean score of 62.53. These values showed that the mean gain for the experimental group was 14.57, the control group was 13.33, while the effect size was 11.24. This result also showed that Geoboard has a positive effect on the retention level of students in Mathematics than the lecture method.

Discussion of Findings

Results in Table 1 and 2 indicate that Geoboard has a greater effect in the mean performance and retention of students in Mathematic than lecture method. This finding agrees with Okoye and Onyeka (2022). Who investigated the application of geotrigmetric set and geoboard on students' academic achievement and retention in mathematics in Rivers State, the findings established that the use of Geotrigmetric set and Geoboard respectively enhanced academic achievement and retention in mathematics than deductive teaching method.

Conclusion

Research Article

The study revealed that Geoboard strategies enhances students' performance scores in Mathematics (Geometry) than the lecture method. However, Geoboard learning strategies improve students' retention in Mathematics. It was further revealed that the instructional strategies (Geoboard) is effective in enhancing students' academic performance in Mathematics.

Recommendations

Based on the findings and the conclusion of the study, the following recommendations were made:

1. Mathematics teachers should be encouraged to adopt Geoboard learning strategies to help students develop intellectual capacity that will help in improving their performance.
2. Mathematics teachers should ensure regular usage of hands-on learning strategies such as Geoboard that enhances students' retention in Mathematics.
3. Regular organizing of seminars and workshops for training and retraining of teachers on Geoboard strategies should be encourage.

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Research Article

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