



Effect of Mathematics Laboratory Method on Senior Secondary School Students' Performance in Plane Shapes in Bassa Local Government Area of Kogi State, Nigeria

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ABSTRACT

This research work investigated the Effect of Mathematics Laboratory Method on Senior Secondary School Students' Performance in plane shapes in Bassa Local Government Area of Kogi State, Nigeria. A simple random sampling was used to select two schools in Bassa LGA, and 80 students from two intact classes were selected. The quasi-experimental research design was adopted which Involved pre-test and post-test control group. The instrument used the collection of data was the Mathematics Performance Test (MPT), which consisted of 20 objective questions. The instrument for data collection was validated by three experts, one from Foundation of Education (measurement and evaluation) and two from Science Education. The reliability of the instrument was 0.86 with the use of Kuder-Richardson's formula 20(K-R20). The research questions raised were answered with the aid of mean and standard deviation, while the analysis of covariance (ANCOVA) was used to test the two null hypotheses at 0.05 level of significance. The findings revealed that the use of Mathematics Laboratory Method to teach Perimeter and Area of Plane Shapes enhanced students' Performance than the Conventional Method. Perimeter and Area of Plane Shapes using the Mathematics Laboratory Method. It was recommended that Mathematics student teachers should be trained on the use of mathematics laboratory. Mathematics teachers should use mathematics laboratory in teaching mathematics in senior secondary schools.

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INTRODUCTION

Education is the totality of life experiences that people acquire, which enables them to cope with and derive satisfaction from living in the world. It is on this premise that it is believed that the quality of a nation's education is proportional to the level of its prosperity (Achimugu, etal, 2023) Today it is a reality to say that the standard of living of a nation is dependent on the level or science and technology of that nation. While science is the bedrock of technology, Mathematics is the gate and key to sciences (Salami, 2022). Mathematics plays a key and fundamental role in the development and growth of any nation. This is true because the

knowledge of Mathematics is needed for scientific discoveries and technological breakthrough which are the true indicators of developed economy in any nation (Anigbo, 2016).

Research evidences have shown that Mathematics is an essential tool for scientific and technological breakthrough that has led many nations to achieved sustainable economy (Gambari, Shittu, Daramola, & Jimoh, 2016) Science and technology are two distinct concepts that work together and Mathematics is an instrument for any performance in them. This explains the reason why Mathematics is regarded as language and queen of science and technology. Mathematics is regarded as the

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queen of science and technology right from the ancient time.

The ancient educators who were the first to link Mathematics to science are Friedrich Gauss and Benjamin Peirce. Friedrich Gauss defined Mathematics as the queen of science while Benjamin Peirce described it as science for the drawing of necessary conclusions about nature. This shows the relevance of the knowledge of Mathematics to science and technology as well as its application for successful economic development that has been the expectation of under developed nations.

It means that any under developed nation like Nigeria has to improve its science and technology as well as its economy through the effective teaching and learning of Mathematics. It was in an attempt to achieve this sustainable economy that Nigeria as a nation repose implicit confidence in the power of science and technology to deliver her from poverty, ignorance and diseases, which are the three indices of under developed economy in any nation (Gimba & Agwagah, 2018).

Consequently, it was in the same attempt that the Federal Republic of Nigeria prescribed Mathematics as a core and compulsory subject for all students in both primary and secondary schools. This is also the reason why, every student seeking admission into tertiary institutions in Nigeria is expected to be competent in Mathematics and must also pass it at credit level. Mathematics has always been a core subject in the junior and senior secondary school curriculum right from the Colonial and post-colonial curriculum development in Nigeria due to its importance. The importance and contribution of Mathematics to achieve economic development of nations through science and technology cannot be over emphasized.

Despite the position of Mathematics in the national policy on education in Nigeria, West Africa Examination Certificate Chief Examiners' report for the period of (2010 – 2016) examinations have shown a consistent poor academic performance in secondary school general examination in Nigeria. An extraction of WAEC Chief Examiner's report according to Eze

(2014). The West African Examination Council (WAEC) also shows their statistics based on geopolitical zones in Nigeria for 2014/2015 examination with poor performance of candidates in Mathematics in the North-Central geopolitical zone excluding FCT. It was also observed by other researchers such as Olagunju and Jimoh (2017) that students' performance in Mathematics generally has been poor over the years. This poor performance of students in Mathematics has been alarming and disturbing and if the situation is not controlled, it may reduce, hinder or prevent some students' access to admission opportunities in tertiary institutions. The effect of this situation will affect not only Mathematics education but it will also affect other disciplines.

However, the poor performance of students in Nigeria has been linked and attributed to many factors. Some of these factors include; teachers' predominant use of traditional method of instruction which is basically chalks and talks method with textbooks. Other factors that could have led to poor students' performance include phobia, students' lack of interest in mathematics, low and poor retention, gender related issues, lack of teachers, teachers impatience and unpreparedness, students' negative attitude towards mathematics, abstractness nature of mathematics, use of inappropriate teaching methods, poor students' background in mathematics, lack of Mathematics laboratories in Nigerian secondary schools among others (Akanmu, Sunday & Ayila, 2016).

A Mathematics laboratory is a special place where students or investigators can experiment, explore and verify facts and ideas (Sunday, et al 2023b). It is a place where opportunities are given to learners to relate facts to reality through the use of manipulatives and pedagogical resource materials. Manipulatives such as a collection of games, puzzles, and other teaching and learning materials are used in a Mathematics laboratory to drive home ideas and to promote a better understanding of concepts. The use of the mathematics laboratory has been revealed to be better than the traditional method of solving problems in Mathematics (Sunday, Akanmu & Fajemidagba, 2017).



The use of the Mathematics Laboratory Method will not only promote a better understanding and stimulate creative thinking in the mind of the learners but it will make learning more interesting, retentive, refreshing and rewarding. This method also helps to eliminate the issue of boredom in learning the subject (Sunday, etal, 2016). Sunday, etal (2023) had earlier advocated the use of a laboratory in teaching Mathematics. According to him, it will lead students to formation of concepts out of experiences with discrete objects. Mathematics laboratory is the brain of child numeracy development. It is a place where students can learn and explore concepts and verify facts and theorems a variety of activities using different materials. These activities may be carried out by the teacher or the students to explore, to learn, to stimulate interest and develop favourable attitude towards Mathematics.

The essence of using the laboratory method is to bridge the gap between abstract and reality and to promote understanding of ideas. The abstractness with which certain teachers teach Mathematics scares some students who are regarded the best in the discipline. According to Samuel and Sunday (2023), using instructional materials or teaching aids, as well as enjoyable activities that learners like, is the only way to make teaching and learning effective, relevant, and engaging. The present status of learning and education is woefully inadequate. Learning entails complete attention, it also requires active participation of the students in the class, and actively participating in is the most effective way to learn Mathematics. Lessons should not be run by teachers' only students' needs to be in participation also.

Teachers employ tried-and-true methods in the classroom, such as the lecture technique (talk and chalk). As a result, pupils' capacity to absorb, acquire, and recall material is impaired, and children are less interested in studying Mathematics. As a consequence, the traditional method of teaching Mathematics have failed to develop skills such as formulating, modeling, and problem-solving. It's possible that students won't always remember and retain what

they've studied before. Simple geometrical shapes, such as cubes, cuboids, cylinders, and cones, among others are covered in the classroom so that students do not see the real materials. To get rid of the abstractness of Mathematics, demonstrations and practical ways should be employed. To increase skills provide practical experiences with concepts such as assumptions, assertions, and rules, a strategy is necessary. The problem of ineffective instruction, may be solved by employing the laboratory in a planned and logical manner.

The influence of gender on students' performance in Mathematics has remained a controversial and topical issue amongst educationist and psychologists. Sunday, etal (2023a) suggested that the difference in Mathematics performance of male and female students has bearing and indeed account for the difference observed between the personalities of men and women. Ajai and Imoko(2015) investigated the extent to which prior social skills and academic performance as well as the teachers' gender and the gender ratio of classes explained boys' and girls' teacher-assessed academic performance in Norwegian mathematics. The study found that previous academic performance at the classroom level explained variance in boys' and girls' individual academic achievements in mathematics. Maria, Silvia and Dalit (2016) investigated the influence of gender stereotype as a predictor of secondary school students' academic performance and it was found that gender stereotype has significant influence on students' academic performance in favor of the male students.

Ajai and Imoko (2015) assessed gender differences in Mathematics performance and retention by using Problem-Based Learning (PBL). The study revealed that male and female students taught algebra using PBL did not significantly differ in performance and retention scores, thereby revealing that male and female students are capable of competing and collaborating in Mathematics. The finding showed that performance is a function of orientation, not gender. Ebele and Abigail (2016) investigated the effect of using mathematics laboratory in teaching



on students' performance in Junior Secondary School Mathematics, from their findings, it was observed that the use of mathematics laboratory enhanced performance in mathematics. The results also showed that no significant difference exists in the performance of male and female mathematics students taught with mathematics laboratory.

In the quest for a teaching method that can address the cognitive, affective, and psychomotor aspects of learning, this research work is interested in discovering whether the laboratory method of teaching may improve senior secondary school students' performance in mathematics and also the difference in the performance of male and female students in Mathematics when taught using Mathematics Laboratory. Because Mathematics is a subject that must be studied via doing rather than reading, it needs the employment of a method and a location that are both appropriate. The correct solution might be to employ a Mathematics laboratory and a Mathematics laboratory technique. This activity type helps students understand concepts.

It is based on the concepts of observational learning and moving from the concrete to the abstract. In the laboratory, students may study and explore a wide range of subjects, as well as verify a wide range of facts and ideas using a number of activities and tools. The use of a Mathematics laboratory in teaching and learning assists in the integration of theory and practice. According to Ogunkunle (2019), the advantages of having a Mathematics laboratory include: displaying knowledge; providing an avenue for experimentation through practical work; providing a pool of resources for quick access; and removing abstractness and improving effective teaching/learning.

STATEMENT OF THE PROBLEM

Many subjects in the senior secondary school cannot be taught effectively and efficiently without the use of a well-equipped laboratory, subjects such as Chemistry, Physics, Biology and Mathematics requires the use of Laboratory for effective teaching and learning. Mathematics is a

subject feared and hated by students and it is made compulsory for every school child and even in many professions and careers (Samuel & Sunday, 2024). Evidence of poor performance in Mathematics by senior secondary school students pointed to the fact that the most desired technological, scientific and business application of Mathematics is not being sustained. This makes it paramount to seek for a strategy for teaching that aim at improving its understanding and performance by students. The lack of Mathematics laboratory and its facilities and non-use of Mathematics laboratory techniques in teaching Mathematics in senior secondary schools is one of the major factors that contribute to poor performance in Mathematics by secondary school students, hence this study.

Research Questions

The following research questions were asked to guide this Study

1. What is the difference in the performance of students when taught Mathematics using the mathematics laboratory method and those taught Mathematics using the conventional method?
2. What is the difference in the performance of male and female students in Mathematics when taught Mathematics using the Mathematics Laboratory method?

Research Hypotheses

The following research hypothesis were formulated to guide this study

H₀₁: There is no significant difference in the performance of senior secondary school students when taught Perimeter and Area of Plane Shapes using Mathematics laboratory method and those taught Perimeter and Area of plane shapes using the conventional method.

H₀₂: There is no significant difference in the performance of male and female students when taught Perimeter and Area of Plane Shapes using the Mathematics Laboratory method.



METHODOLOGY

This study adopted a quasi-experimental research design in which pre-test and post-test was administered to the students. The study involved two groups; the experimental and control group. The population of this study comprised all the senior secondary school (SSS 2) students in Bassa Local Government Area of Kogi State. The sample for this study comprised of Eighty (80) SSS 2 students. Forty (40) was in the experimental group and forty (40) was in the control group. A simple random sampling technique was adopted to choose the sample size, which consists of two (2) intact classes from the five (5) public senior secondary schools in Bassa LGA. This research work used an instrument titled "Mathematics performance Test (MPT)" which was used for data collection. The MPT was used to conduct the pre-test and post-test to find out the performance of students in Mathematics.

The test item was derived from the Perimeter and Area of Plane Shapes for which lesson plans was also prepared. The test was made up of twenty (20) items of multiple-choice questions with four options (lettered A – D) each, of which only one option is the correct answer. The lesson plans for teaching the two (2) groups (experimental and control group) was prepared considering the lesson topic, age, and class of the students, class size, gender, lesson duration of 40 minutes per teaching session, students' previous knowledge, specific objectives of the lesson, instructional materials, reference materials, and instructional approach.

The researcher prepared the lesson plans and Mathematics performance Test (MPT) for the study and it was given to three experts for validation. One expert from measurement and evaluation (foundation of education) and two other experts from Science Education who used their intellectual knowledge to critically, analytically and logically examine the instruments relevance to the contents and statements, and then made the instrument valid for the study. To determine the reliability of the instrument (MPT), a re-test approach was performed using the same simple random sampling technique for fifteen (15) SSS 2 students. This group of students had not

previously been taught the topics before the administration of the instrument (MPT). The students were asked to try all the twenty (20) items in the MPT. The same instrument was administered to the same sample after the two (2) week period with a change in the series of questions. The initial and reassessment results of the sample was Calculated with Kuder-Richardsons formula 20 (k-R20) and the Coefficient of confidence of the reliability attained was 0.87. As attached in the appendix

A pre-test of the mathematics performance Test (MPT) was administered to the students before the treatment started. After which the teaching sessions of the mathematics concepts for two weeks of four periods each commenced. Each group (control and experimental group) was taught Perimeter and Area of Plane Shapes, for the duration of time under similar environmental conditions using the lesson plans for each group. The different scores obtained during pre-test and post-test was used for data analysis. Group A ($n = 40$) was taught Perimeter and Area of Plane Shapes using Mathematics Laboratory method, while group B ($n = 40$) was taught the same topics without the use of Mathematics laboratory method but with lecture method using ordinary lesson plan.

The teaching which was for two weeks was done by the researcher. This was done for both groups. The students were taught, examined using the Mathematics performance Test (MPT) and their scripts was marked and results was compiled by the researcher in both groups. The mean and standard deviation was used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

RESULTS

The purpose of this study was to to investigate the effects of Mathematics laboratory method on senior secondary school students' performance in mathematics. This chapter is concerned with the presentation and analysis of data gathered through the use of Mathematics performance test (MPT) given to the testees in the process of data collection.



Table 1:

Pre and Post-test Mean Scores and Standard Deviation of the Experimental and Control Groups

Group	N	Pre-test mean	SD	Post-test mean	SD	Mean gain
Experimental	40	34.73	4.35	78.33	8.06	43.60
Control	40	38.53	4.76	72.37	7.57	33.84

Research question 1:

What is the difference in the performance of students when taught Mathematics using the Mathematics laboratory method and those taught Mathematics using the conventional method?

Table 1 shows the pre-test mean score of 34.73 with standard deviation of 4.35 for the experimental group. It also shows a post-test mean score of 78.33 with standard deviation of 8.06 for experimental group. Table 1 also shows a pre-test mean score of 38.53 with standard deviation of 4.76 and post-test mean score of 72.37 with a standard deviation of 7.57 for the control group. Table 1 also shows a mean gain of 43.60 for the experimental group against the mean gain of 33.84 for the control group. The difference in the mean gain shows that the experimental

group differed from the control group in the mean gain by a difference score of 9.76. This indicated that, the students in the experimental group showed higher performance in the Mathematics performance Test more than the control group. This result, therefore, shows that students taught Perimeter and Area of plane shapes using the Mathematics laboratory method performed higher than those taught Perimeter and Area of plane shapes using the conventional method.

Research Question Two

What is the difference in the performance of male and female students in Mathematics when taught Mathematics using the Mathematics Laboratory method?

Table 2: *Pre and Post Test Mean Scores and Standard Deviation of Male and Female Students*

Gender	N	Pre-test mean	SD	Post-test mean	SD	Mean gain
Male	22	37.16	3.58	76.81	8.46	39.65
Female	18	36.23	3.35	75.84	8.31	39.61

Table .2, shows the mean score of male students in the pre-test as 37.16 with standard deviation 3.58, while the mean score of female students in the pre-test was 36.23 with a standard deviation of 3.35. Whereas the post-test mean score of male students was 76.81 with standard deviation of 8.46, while that of the female students was 75.84 with standard deviation of 8.31. Table 4.2, also shows the mean gain of 39.65 for male students and 39.61 for the female counterparts. There is a slight difference in the mean gain of

female and male student in the Mathematics performance Test, if going by mere observation by 0.04 against female. This shows that the male students had higher scores in the Mathematics performance Test than their female counterparts as it appear by the superior mean gain scores of the male students. The standard deviation of male and female students of 8.46 and 8.31 respectively shows that individual scores of female students were more clustered to the group mean than that of the male students



Table 3: *Summary of Analysis of Covariance (ANCOVA) of Students' performance in Perimeter and Area of plane shapes based on teaching method and Gender*

Source of variation	Type III sum of squares	F-values	df-mean	Squares at p<0.05	Sig.	Decision
			2045.23			
Corrected model	7646.003a	4	4	12.003	0	S
Intercept	26547.24	1	24783	183.784	0	S
Pre-test scores	476.974	1	423.345	2.814	0.118	NS
			7416.28			
Group	7282.874	1	3	42.121	0	S
Gender	35.976	1	41.832	0.202	0.654	NS
Group * gender	401	1	246.21	2.131	0.145	NS
Error	16708.6	91	170			
Total	375920	96				
Corrected total	25891.65	95				

Hypotheses 1:

There is no significant difference in the performance of senior secondary school students when taught Perimeter and Area of Plane Shapes using Mathematics laboratory method and those taught Perimeter and Area of plane shapes using the conventional method.

Results presented on Table 4.3 shows that $F(1, 91) = 42.121$, $P < 0.05$. This means that students who are taught Mathematics using Mathematics laboratory method (experimental group) had greater performance in Perimeter and Area of plane shapes more than the the students who are taught Mathematics using the conventional method (control group). This shows that the use of Mathematics laboratory method in teaching Mathematics improved students' performance in Mathematics. Therefore, the null hypothesis that states that there is no significant difference in the performance of senior secondary school students when taught Perimeter and Are of Plane Shapes using Mathematics laboratory method and those taught Perimeter and Area of plane shapes using the conventional method is rejected.

Hypothesis 2:

There is no significant difference in the performance of male and female students when

taught Perimeter and Area of Plane Shapes using the Mathematics Laboratory method.

Results shown on Table 3 shows that $F(1, 91) = 0.202$, $P > 0.05$, this means not significant. This implies that significant difference did not exist in the mean scores of male and female students in Perimeter and Area of plane shapes. Both male and female students had almost the same scores in Perimeter and Area of plane shapes. Therefore, the null hypothesis which proposes that there is no significant difference in the performance of male and female students when taught Perimeter and Area of Plane Shapes using the Mathematics Laboratory method is retained.

FINDINGS OF THE STUDY

1. From table 1, it was observed that students taught Perimeter and Area of plane shapes using the Mathematics laboratory method performed higher than those students taught Perimeter and Area of plane shapes using the conventional method. This shows that the use of Mathematics laboratory method in teaching Mathematics improved students' performance in Mathematics.
2. From table 2, it was also observed that there was a slight difference in the mean



gain of female and male student in the mathematics performance Test, if going by mere observation by 0.04 against female. This shows that both the male and female students had almost the same scores in Perimeter and Area of plane shapes

DISCUSSION OF THE FINDINGS

Effect of Mathematics Laboratory Method on senior secondary school students' Performance in Mathematics in Bassa LGA. It was discovered in this study that Mathematics Laboratory Method has significant effect on students' performance in Mathematics. This was empirically shown from the higher post-test mean of the experimental group that was taught Perimeter and Area of Plane Shapes using Mathematics Laboratory Method. The post-test mean of the experimental group was greater than their counterparts in the control group that was taught Perimeter and Area of Plane Shapes using the conventional method. The higher mean score recorded from the experimental group could be as result of the active participation of the students in the teaching and learning process which the learners used some of their sense organs during the learning process.

This finding is the same with some earlier studies such as Nasirudeen, Kennedy, Debo and Gafar (2021), who discovered that the use of mathematics laboratory method to teach Number and Numeration enhanced students' performance unlike the conventional method. This finding of the current study also agreed with Okigbo and Osuafor (2018), who discovered that the use of mathematics laboratory enhanced students' performance in mathematics. This prompted them to explain further that mathematics laboratory is a model of learning in which students learn not by receiving a message but interpreting it. This implies that students must take some responsibility for their learning. This is because they are actively involved in teaching and learning process.

Influence of Gender on Students' performance in Perimeter and Area of Plane Shapes. The finding in this study based on the

mean gain scores shows that male students had more performance in Perimeter and Area of Plane Shapes than their female counterparts with a slightest difference going by a mere comparison of the mean gain of the two groups (male and female). The tested hypothesis to determine the difference in the mean interest scores of male and female students in the study further shows that the difference in the mean interest rating scores of male and female students in perimeter and Area of Plane Shapes was not significant. This means that gender did not influence senior secondary school students' performance in Perimeter and Area of Plane Shapes in the study.

Both male and female students taught Perimeter and Area of Plane Shapes using mathematics laboratory method have approximately the same performance in Perimeter and Area of Plane Shapes. This finding is in perfect agreement with the findings of Ebele and Abigail (2016), in a similar study in plane geometry using Mathematics laboratory method, reported that no significant difference exists in the performance of male and female mathematics students taught using mathematics laboratory method. The finding also agreed with some researches such as Nasirudeen, Kennedy, Debo and Gafar (2021), who reported that there is no significant effect of gender on the performance of students taught number and numeration using mathematics laboratory approach.

CONCLUSIONS

Based on the findings of this research work, the following conclusions were made from the study; the use of Mathematics laboratory method has significant effect on senior secondary school students' performance in Mathematics. Students taught Perimeter and Area of plane shapes using Mathematics laboratory method had higher score in Perimeter and Area of plane shapes than those taught using the conventional method. This means that the use of Mathematics laboratory method proved to be more effective in improving students' performance in Mathematics than the use of conventional method. Gender had no significant influence on students' performance in Perimeter and Area of plane shapes. It was



discovered that both male and female students in the study maintained almost the same level of performance in Perimeter and Area of plane shapes.

RECOMMENDATIONS

The following recommendations were made from this study based on the findings of the study:

1. Mathematics teachers should use mathematics laboratory method to teach mathematics in senior secondary schools.
2. Seminars/workshops should be organized for mathematics teachers in senior secondary school on the use of mathematics laboratory method.

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