



Effect of Mathematics Laboratory on Senior Secondary School Students' Academic Performance in Mathematics in Dekina Local Government Area

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ABSTRACT

Laboratory Method is an essential way teaching and learning mathematics. It provides a hands-on approach to learning mathematical concepts, making it easier for students to understand and apply them. The use of mathematics laboratory has become increasingly popular in recent years, as it has been proven to be an effective way of teaching mathematics. The study focused on the effect of the laboratory apparatus on junior secondary students' academic achievement in mathematics in Ankpa local government area in Kogi state. A total of 100 JSS 2 Mathematics students were involved in the study. A quasi-experimental pre-test, post-test control group design was adopted, involving 100 selected students. The participants were divided into experimental ($n = 50$) and control ($n = 50$) groups. The experimental group was taught mathematics concepts using the laboratory method, while the control group received instruction through the conventional method. Data were collected using the Mathematics Performance Test (MPT), validated by experts in the department. Results were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). Finding of this study revealed that the use of mathematics laboratory enhanced achievement in mathematics. The results also showed that no significant difference exists in the achievement of male and female mathematics students taught with mathematics laboratory. The study recommended that teachers should be encouraged to use mathematics laboratory in teaching fraction, geometry and set theory and mathematics student teachers should be trained on its use in their methodology class.

ARTICLE INFO

Article History

Received: March, 2026

Received in revised form: July, 2026

Accepted: August, 2026

Published online: September, 2026

KEYWORDS

Mathematics, Laboratory, performance, senior, schools

INTRODUCTION

Mathematics is a fundamental subject that plays a crucial role in the development of individuals and societies. It provides students with problem-solving skills, logical reasoning, and critical thinking abilities. However, the teaching and learning of mathematics in Nigeria, particularly in Kogi state, have been faced with numerous challenges. One of the key challenges is the lack of practical experiences and hands-on activities in the classroom. This has resulted in poor performance among junior secondary school students in mathematics. The place of mathematics in man's way of life and development cannot be over emphasized. Generally,

mathematics is a very desirable tool in virtually all spheres of human endeavor, be it science, engineering, industry, technology and even the arts (Gainsburg, 2015).

A mathematically minded man is usually more dependable than one who is otherwise disposed. That is why the study of some Mathematics is compulsory up to the secondary stage of all education systems, and its habit has to be sedulously fostered (Wikipedia, 2018). Devlin (2017), explores the idea that mathematics is a language that allows us to describe and understand the world around us. Mathematics is a key subject in the school curriculum and is considered a knowledge that is indispensable to

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the educated person. According to a report by the National Council of Teachers of Mathematics (NCTM, 2018), learning of mathematics promotes mathematical literacy, which is crucial for understanding and participating in the modern world. Mathematics is needed for analysis, organization and evaluation of the information needed in order to make new decisions.

Mathematics laboratory is a physical or virtual space where students can engage in hands-on activities and experiments to explore mathematical concepts and develop problem-solving skills (Sunday, etal 2017). The use of mathematics laboratory helps to integrate theory and practical work in mathematics. Mathematics laboratory is essential for teaching and learning mathematics. It provides a hands-on approach to learning mathematical concepts, making it easier for students to understand and apply them. The use of mathematics laboratory has become increasingly popular in recent years, as it has been proven to be an effective way of teaching mathematics (Wilson & Turner, 2022).

One of the most important benefits of mathematics laboratory is that it helps to make abstract concepts more concrete. Many mathematical concepts can be difficult to understand when presented in a purely theoretical manner. However, when students are able to see and manipulate physical objects, they are better able to understand the concepts being taught. This is particularly true for younger students who may struggle with abstract concepts. Another benefit of mathematics laboratory is that it allows students to explore mathematical concepts in a more interactive way. Rather than simply listening to a lecture or reading a textbook, students can actively engage with the material by using the apparatus. This can help to increase their interest in mathematics and make the subject more enjoyable.

There are many different types of tools found in mathematics laboratory, each designed to teach different mathematical concepts in the mathematics laboratory. Some of the most commonly used apparatus include geometric shapes, measuring tools, and graphing calculators. Geometric shapes, such as cubes and

spheres, can be used to teach concepts such as volume and surface area. Measuring tools, such as rulers and protractors, can be used to teach measurement and angles. Graphing calculators can be used to teach graphing and data analysis. By incorporating mathematics laboratory into teaching, educators can help to make mathematics more accessible and enjoyable for their students (Akanmu, etal 2016).

Mathematics in Nigeria Junior Secondary School has come a long way. In the traditional society, before the introduction of formal education, mathematics was used mainly in taking stock of daily farming and trading activities. Most traditional societies has their number systems which were either base five or twenty. These could be seen in their market days and counting systems. However, the coming of the missionaries introduced formal (or Western type) education to Nigeria. In this system of education, mathematics occupied a central position in the school curriculum. This has remained the position in the Nigerian education system today, even with the introduction of the 6-3-3-4 system of education.

In this system, mathematics is a core subject from the primary through the junior secondary to the senior secondary school levels of the educational system. The 6-3-3-4 system of education refers to six years of primary education, three years of junior secondary education, three years of senior secondary education, and four years of tertiary education. Mathematics is a core subject in the Nigerian educational system, and its importance cannot be overstated. It is a subject that provides the foundation for many other disciplines and is essential for technological and scientific advancements.

However, the status of mathematics education in Nigeria's Secondary School has faced several challenges. One of the major challenges is the shortage of qualified mathematics teachers. According to a report by the National Mathematical Centre (NMC) in 2017, there is a significant shortage of qualified mathematics teachers in Nigeria. This shortage has resulted in a lack of quality instruction and has negatively impacted students' achievement in



mathematics. Another challenge is the lack of adequate teaching and learning resources.

Many Secondary School in Nigeria lack basic teaching materials such as textbooks, calculators, and other instructional aids. This lack of resources hampers effective teaching and learning of mathematics and limits students' ability to grasp mathematical concepts. Furthermore, the curriculum for mathematics in Secondary School has been criticized for being too theoretical and not adequately preparing students for real-life applications of mathematics (Sunday, etal 2016). The curriculum needs to be revised to include more practical and problem-solving approaches to enhance students' understanding and application of mathematical concepts.

Despite these challenges, efforts have been made by the government to improve the status of mathematics education in Nigeria's Secondary School by initiating programs to make teaching and learning resources available in Secondary School. For example, the Universal Basic Education Commission (UBEC) has been providing grants to schools to improve infrastructure and purchase teaching materials, including mathematics textbooks and other instructional aids. Since mathematics is a subject which has to be learnt by doing rather than by reading the doing of mathematics gives rise to the need for a suitable method and a suitable place. Mathematics laboratory is the proper answer to it. This activity method leads the students to discover mathematical facts. It is based on the principles of learning by observation and proceeding from concrete to abstract.

Academic performance is an important aspect of a student's educational journey as it lays the foundation for future academic success. Several studies have been conducted to examine the factors that contribute to performance in mathematics in secondary school. One study conducted by Achimugu, etal (2023) investigated the impact of teachers' quality on academic performance of secondary school students in Nigeria. The study found that teachers' quality significantly influenced academic performance, with students taught by highly qualified teachers performing better academically. In addition, a

study by Sunday, etal (2023), examined the impact of school environment on performance of secondary school students in Nigeria. The study found that a conducive school environment positively influenced performance, with students in schools with better facilities and resources performing better academically. By understanding and addressing these factors, educators and policymakers can work towards improving students' mathematical performance and promoting overall academic success.

STATEMENT OF THE PROBLEM

The absence of mathematics laboratory in secondary schools has hindered students' ability to grasp mathematical concepts effectively. The lack of practical experiences and hands-on activities has limited students' understanding and application of mathematical principles. Consequently, this has led to low performance in mathematics in secondary school students in Dekina local government area in Kogi state, Nigeria. 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.

Evidence of poor performance in mathematics by secondary school students pointed to the fact that the most desired technological, scientific and business application of mathematics is not being sustained. The lack of mathematics laboratory and non-use of laboratory techniques in teaching mathematics is one of the major factors that contribute to poor performance in mathematics by secondary school students. In addition, Sunday etal (2016), investigated the effect of mathematics laboratory on senior secondary school students' academic achievement in mathematics mensuration. They recommend that mathematics teachers should adopt the use of mathematics laboratory in teaching mathematics in Ondo State secondary schools.

Sunday, etal (2014), investigated the influence of mathematics laboratory in teaching and learning of mathematics in senior secondary schools in Cross River State, Nigeria. A two groups, pre-test post- test quasi-experimental



design was adopted for the study. The study revealed that students taught in mathematics laboratory performed significantly better than those taught in the class room. He also recommended that mathematics teachers should adopt the use of mathematics laboratory in teaching mathematics in Cross River State secondary schools. Maruff and Amos (2011), investigated the effect of using improvised materials on academic achievement of senior secondary school mathematics students in Oyo State, Nigeria. The research design adopted was quasi-experimental using pre-test post -test non-randomized control group.

Purposive sampling was used to obtain a sample of three co-educational secondary schools. The researcher concluded that the utilization of improvised instructional materials promotes and enhance effective teaching-learning process, thus, mathematics teachers should be encouraged to use them in their lessons. Taken the above studies together, it is clear that literature indicates that majority of the studies conducted on effect of mathematics laboratory on secondary school students' performance in mathematics were limited to other states and local government secondary schools, showing lack of studies in Dekina local government area in Kogi state.

Therefore, since studies indicate lack of studies to be carried out on effect of mathematics laboratory on secondary school students' performance in mathematics in Dekina local government in Kogi state, the present study intends to contribute to the existing literature by investigating on effect of mathematics laboratory on secondary school students' performance in mathematics with specific focus on senior secondary schools in Dekina Local Government Area in Kogi State. Therefore, this study is designed to find out the effect of mathematics laboratory on secondary school students' performance in mathematics in Dekina Local Government Area in Kogi State.

Research Questions

This study answered the following questions;

1. What is the effect of mathematics laboratory on academic performance mean scores of students taught mathematics using mathematics laboratory and those taught using lecture method?
2. What is the effect of mathematics laboratory on the mean performance scores of male and female students in mathematics?

Research Hypotheses

The following hypotheses were formulated and tested.

H0₁: There is no significant difference between academic performances mean scores of students taught mathematics using mathematics laboratory and those taught using lecture method.

H0₂: There is no significant difference between academic performance mean scores of male and female students taught using mathematics laboratory.

METHODOLOGY

The study adopted a quasi-experimental research design in which pre-test and post-test were administered to the students to examine the effect of the mathematics laboratory on junior secondary school students in mathematics. The study involved two groups: the experimental and the control groups. Two public schools were purposively selected for the study. One arm of 50 JSS II students was randomly selected from each of the two selected schools. Fifty (50) students were in the experimental group and fifty (50) in the control group. One class (experimental group) was assigned to treatment group A, comprising 50 students (23 boys and 27 girls), and the other class was assigned to control group B, which also comprised 50 students (17 boys and 33 girls).

A total of one hundred (100) students were used for the study. The researcher used the Mathematics Performance Test (MPT) as the primary instrument. Laboratory apparatus and the lesson plan were also used as instructional tools for the study. MPT: This was a twenty-item achievement test constructed by the researcher based on the JSS II mathematics syllabus in the



area of fractions. The test was in essay form and covered areas of knowledge, comprehension, and application levels. The same MPT was used for the pre-test and post-test, but the color of the post-test paper was changed from white to yellow. The test consisted of twenty (20) multiple-choice items, each with four options (A–D), of which only one was the correct answer.

Lesson Plan:

The lesson plan was written in two forms:

1. A plan that used laboratory apparatus as teaching materials for the treatment group A.
2. An ordinary lesson plan used in the conventional classroom for group B.

The lesson plans for teaching the two groups (experimental and control) were prepared considering the lesson topic, age and class of the students, class size, gender, lesson duration (40 minutes per session), students' prior knowledge, specific objectives of the lesson, instructional

materials, reference materials, and instructional approach. A pre-test of the Mathematics Performance Test (MPT) was administered to students before the treatment began. Afterwards, the teaching of the mathematics concepts took place over two weeks, with four periods per week. Each group (experimental and control) was taught by the researcher using the same content and under similar environmental conditions, following the prepared lesson plans. The differences in scores obtained from the pre-test and post-test were used for data analysis. The data collected were analyzed using mean, standard deviation, and Analysis of Covariance (ANCOVA) (Thomas et al 2026)

RESULTS

Research Question One:

What is the effect of mathematics laboratory on academic performance mean scores of students taught mathematics using mathematics laboratory and those taught using lecture method?

Table 1. Mean Mathematics Performance Scores of Treatment and Control Groups.

Groups	Mean Pre-Test	Mean Post-Test	Mean Gain
Experimental (n=50)	22.6 ($\delta = 1.68$)	50.5 ($\delta = 1.79$)	27.9
Control (n =50)	19.9 ($\delta = 1.55$)	34.7 ($\delta = 1.29$)	14.8
Mean differences	2.7	15.8	13.1

The data on the effect of laboratory apparatus on the mean performance scores of students taught mathematics using laboratory apparatus and those taught using conventional method are presented in table 1 above. It revealed that students taught mathematics in the control group had a mean performance score of 19.9 in pre-test and 34.7 in post-test while student taught mathematics in experimental group had a mean performance score of 22.6 in pre-test and 50.5 in post-test. Students taught mathematics in control group had mean gain score of 14.8 while their counterpart taught in experimental group had gain

score of 27.9. Students in experimental perform more than those in control group Therefore laboratory apparatus had more effect on students taught mathematics using laboratory apparatus in experimental group than those taught using conventional method.

Research Question Two:

What is the effect of mathematics laboratory on the mean performance scores of male and female students in mathematics?



Table 2. Mean Mathematics Performance Scores of Male and Female Students in Experimental Group.

Groups	Mean Pre-Test	Mean Post-Test	Mean Gain
Male (n=23)	24.9 ($\delta = 1.11$)	51.7 ($\delta = 1.07$)	26.8
Female (n =27)	20.6 ($\delta = 1.04$)	49.5 ($\delta = 0.88$)	28.9
Mean differences	4.3	2.2	-2.1

In the above table 2. it is revealed that male students had mean performance score of 24.9 in pre-test and 51.7 in post-test, while the female students had a mean performance score of 20.6 in pre-test and 49.5 in post-test. Male students had a gain score of 26.8 while their female counterparts had a gain score of 28.9. Therefore, the female students had higher mean

performance core than their male counterparts with a mean difference of 2.1.

Research Hypotheses One (H_{01}):

There is no significant difference between academic performance mean scores of students taught mathematics using mathematics laboratory and those taught using lecture methods.

Table 3. ANCOVA statistics for testing H_{01} .

Source of Variance	Df	SS _x	SS _y	SS _{xy}	SS _{yx}	MSS _{yx}	Sd _{yx}
Between groups	1	188	6342	1105	3853	3853	
Within groups	98	11268	26993	4350	26885	274	16.6
Total	99	11456	33335	5455			

$F_{yx} = 14.04 = F\text{-cal and } F\text{-crit} = 3.94$

Data in table 3 showed that there is a significant difference in the mean performance score of students taught mathematics using laboratory apparatus and those taught using conventional method. The null hypothesis was therefore rejected. Hence, there was a significant difference in performance of mathematics

students taught with mathematics laboratory and those taught with lecture method.

Hypothesis Two (H_{02}):

There is no significant difference between academic performance mean scores of male and female students taught using mathematics laboratory.

Table 4. ANCOVA Statistics for Testing H_{02} .

Source of Variance	Df	SS _x	SS _y	SS _{xy}	SS _{yx}	MSS _{yx}	Sd _{yx}
Between groups	1	5.12	426	-46.7	447.7	447.7	
Within groups	48	6193	9672	2701	8494	177	13.3
Total	49	6198	10099	2654			

$F_{yx} = 2.53 = F\text{-cal} < F\text{-crit} = 4.04$

The null hypothesis was not rejected. Results from this hypothesis showed that there was no significant difference in performance of male and female mathematics students taught with mathematics laboratory.

Findings of the Study

From the above discussion, the following findings were made

1. Mathematics Students who were taught with laboratory apparatus achieved



- better than those students who were taught using conventional method.
2. There exists no significant difference in mean performance scores of male and female mathematics students taught with laboratory apparatus.
 3. Male and female students exposed to laboratory apparatus performed at the same level. Thus, mathematics laboratory apparatus is a good strategy for narrowing the gap in performance of male and female students.

DISCUSSION OF THE FINDINGS

Results of this study showed that students taught mathematics with laboratory apparatus achieved more than those taught without laboratory apparatus. This was tested in Hypothesis one which revealed that a significant difference exist between the performance of students taught mathematics with laboratory apparatus and those taught with conventional method. This was in favor of mathematics laboratory group. This finding is supported by Andrew (2018), Alex (2015) and Sunday,etal (2016) where they highlighted the advantages of using laboratory apparatus in teaching to include providing opportunity for student to understand and internalize the basic mathematical concepts. In this way the students achieved better than otherwise.

The outcome of this study revealed that from boys had a mean gain of 26.8 while girls had a mean gain of 28.9. This was tested in hypothesis two. Results from this hypothesis showed that there was no significant difference in the mean performance scores of male and female mathematics students taught with laboratory apparatus. This finding is in line with the findings of Gogetter (2017), who reported that students' gender has no significant effect on their performance when taught with tangram puzzle game. However, the finding disagrees with the findings of Tabith and Patience (2017). They reported gender as a significant factor in performance when mathematics is taught with certain strategies/techniques. Endy and Ann (2011) also reported gender as significant factor in

physics performance when taught physics with pictorial and written advance organizers.

CONCLUSION

Based on the findings of this study, it can be concluded that the use of laboratory apparatus in teaching mathematics to junior secondary schools in Dekina local government area in Kogi state has a significant positive effect on their students' academic performance. The results showed that students taught using laboratory apparatus had higher mean performance scores compared to those taught using conventional methods. Additionally, there was no significant difference in the mean performance scores of male and female students taught using laboratory apparatus, indicating that the use of this laboratory apparatus is beneficial for all students regardless of gender. Therefore, it is recommended that educators in Dekina local government area and beyond incorporate laboratory apparatus into their mathematics curriculum to enhance students' learning and academic performance.

RECOMMENDATIONS

The following recommendations were made based on the finding of the study:

1. Mathematics teachers should use laboratory apparatus in teaching mathematics.
2. Government should establish mathematics laboratory with enough apparatus in all schools like other science subject laboratories
3. Seminars/workshops should be organized for mathematics teachers in secondary school on the use of mathematics laboratory apparatus.

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