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EFFECT OF MATHEMATICS LABORATORY INSTRUCTIONAL APPROACH ON THE PERFORMANCE OF JUNIOR SECONDARY STUDENTS IN PLANE GEOMETRY

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Abstract
This study determined the effect of the mathematics laboratory instructional approach on the performance of junior secondary students in plane geometry in Obio/Akpor Local Government Area of Rivers State. The study employed the pretest and posttest non-equivalent, non-randomized intact class quasi-experimental research design. A simple random sampling technique was used to choose two (2) schools out of fourteen (14) schools. The study population included 8,431 JSS2 students while the sample included ninety-six (96) students. Two research questions and two hypotheses guided the study. The Mathematics Performance Test (MPT) was used to collect the data, the instrument was validated and the reliability was determined to be 0.82. The mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at the 0.05 level. The result of the study revealed that there was a significant difference in the performance of students taught properties of plane shapes with mathematics laboratory instructional approach and those taught with the conventional approach. Also, no significant difference existed in the performance of students taught properties of plane shapes with mathematics laboratory instructional approach by gender. This study, therefore, recommended among others that all secondary schools should have a Mathematics laboratory.

Keywords: Mathematics performance, Mathematics laboratory instructional approach, Plane geometry, Gender.

Introduction

Everything about a man's life dwells on the level of knowledge he has acquired. This knowledge has a long way to help man succeed. It is believed that a nation's prosperity lies in the quality of its education. It is also a fact that a nation's standard of living depends on how far it has gone with science and technology. Science is the basis on which technology is invented while Mathematics is the key to sciences. However, Mathematics has become the most important subject of study for everybody and it has made an in-road into everyone's endeavour. Nigerian schools have recommended a minimum credit level in Mathematics WASSCE/NECO as a requirement for admission into most of the higher institutions of learning.

Mathematics is a subject that has been defined by various authorities. One of the main characteristics of Mathematics due to the different definitions is that it is a subject that is encapsulated in abstractions, and it is also a subject that many students experience because of the myths that surround it. The subject (Buckley, 2013, Taylor, 2010) cited by George and Amadi(2016). Glenda and Walshaw (2009) postulated that many students have difficulty with math and this leads to them doing very poorly at it. Mathematics lessons in schools today are dominated by textbooks that deal primarily with the manipulation of symbols and are often largely removed from the child's real world. Endless repetition, pointless memorization, and a lack of general interest are some of the reasons ascribing a negative attitude towards Mathematics.

Mathematics relies on logic and creativity. The study of Mathematics has pursued a variety of practical purposes and its intrinsic value. Mathematicians and other professionals study Mathematics because of its beauty and

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intellectual challenges. Albert quoted by Odogwu (2015), sees Mathematics as "security, certainty, truth, beauty, insight structure, and architecture … the part of human knowledge that she calls Mathematics as one thing, one great glorious thing". Odili (2019) defines Mathematics as the science of quantity and space. "It is a systematized, organized and exact branch of science". It is a creation of the human mind, concerned primarily with ideas and reasoning. According to Abakpa and Iji (2011). Mathematics is an intellectually stimulating subject that affects every talent of human activities such as politics, economics science and technology. Agwagah and Nwoye, (2012) observed that students lack interest in the study of Mathematics and perform poorly. In addition, inadequate qualified teachers, insufficient instructional materials, lack of Mathematics laboratory, poor use of instructional materials, and improper approach of teaching have contributed to making the teaching and learning of Mathematics ineffective.

One of the objectives of the new Mathematics curriculum in the country is to get rid of the dogmatic ways of teaching Mathematics. One such way is the use of the procreative approach in the Mathematics laboratory and the use of games. This is an era of media-driven innovation and Mathematics teachers must devise ways of teaching concepts in an interactive way that develops the interest of the students and their cognitive, psychomotor, and affective domains. The teacher of Mathematics has a difficult task making it fun and yet educative. Games provide an opportunity for building students' confidence and enthusiasm for Mathematics, problem-solving, and higher-level thinking. Mathematics games develop Mathematics communication by having students explain and justify their movements with one another.

Elaine (2013) defines Mathematics as a science that deals with the logic of form, quantity, and arrangement. Elaine went on to explain that Mathematics surrounds us everywhere, in everything we do; as it is the building block for everything in our daily life including mobile devices, architecture (old and modern), art, money, technology, and even sports. Implicitly, Mathematics is a logical way of thinking aimed at solving personal and social problems. Problems; and has improved our communication, accommodation, production, and leisure activities promptly. In the opinion of Paul (2015), the importance of Mathematics has never been more important than it is now and in the foreseeable future, given mathematical skills for a wide variety of analytical, technological, scientific, safety, and economic application. Paul further emphasized that Mathematics applies to all basic sciences such as biology, chemistry, and physics; the social sciences such as economics, psychology, and sociology; Engineering sciences such as civil, mechanical, and industrial engineering; technological areas such as computers, missiles, and communications. There are even uses of math in the arts like sculpture, drawing, and music.

The Mathematics process involves creativity and exploration which is the most important facet of the subject. It is, therefore, recommended that the teaching of Mathematics should focus on the process and not just on transferring knowledge into the students' notebooks. This can easily be achieved when students learn Mathematics with an instructional laboratory approach (Manjunath, 2018). According to Odili (2006), the math laboratory can also be defined as a resource centre for learning math, it consists of a specially equipped room in the building where math classes meet regularly, or in a corner of the regular classroom with tables and while math is none experimental science such as Physics or Chemistry, a Mathematics laboratory can make a great contribution to the practical learning of Mathematics concepts and skills. It leads to the development of abstract thinking and concept formation (Odogwu, 2015).

The word geometry comes from the Greek, geo means earth and material means correct perception and measurement. Lassa (2012), quoted by Odogwu (2015), defines geometry as the study of space and its subsets. Geometry could be a formal systematic definition of shape, volume, and spatial relationships between totally different points in space. It is additionally a sort of spatial thinking that students use all the time while not being responsive to it. Zeeman (2001), cited by Jones (2006), defines geometry as a branch of Mathematics that uses visualization to enable students to remember theorems, understand the evidence, suggest guesswork, perceive reality, and a global vision admits.

Okigbo and Osuafor (2008) explored the effect of using a Mathematics laboratory in teaching mathematics on the achievement of mathematics students. The purpose of this study was to see how using a mathematics laboratory in the classroom affected students' performance in Junior Secondary School Mathematics. The study enlisted the participation of 100 JS 3 Mathematics students. The research is a quasi-experimental study. The utilization of a mathematics laboratory was found to improve mathematical achievement. The findings also

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revealed that there is no significant difference in achievement between male and female mathematics students who are taught in a mathematics laboratory.

Statement of the Problem

There has been a negative attitude towards the learning of Mathematics for years. This is evident in their poor performance in the subject as revealed by Zalmon and Wonu (2017) who carried out a comparative analysis of students' Mathematics achievement in the West African Senior Secondary School Certificate Examination (WASSCE) in Nigeria. Nwabueze (2010) observed that most students see Mathematics as a very difficult subject such that they cannot scale through, especially when they begin to score low marks or even zero in the subject. Therefore, they lose interest in learning and get bored whenever they enter Mathematics class. Also, in a topic like geometry, teachers rather than making the students participate actively in constructing the shapes using cardboard papers, scissors, markers, etc will prefer to ask them to draw the shapes in their exercise books using just a ruler and pencil. This is because most secondary schools do not have Mathematics laboratories. Therefore, the study assessed the effect of the Mathematics laboratory on plane geometry. It also assessed the effect of this approach (Mathematics lab) on students understanding of this topic as was compared with those taught using the traditional approach or approach.

Purpose of the Study

Specifically, the purpose of this study is to examine the effect of the Mathematics laboratory instructional approach on the performance of junior secondary students in plane geometry. And the objectives of this study are to:

1. Determine if there is any difference in the academic performance of students who were taught the properties of plane shapes using the Mathematics laboratory instructional approach and those who were taught the same subject using the traditional instructional approach
2. Ascertain if there is any difference in the academic performance of the male and the female students taught properties of plane shapes with Mathematics laboratory instructional approach.

Research Questions

The study was guided by the following research questions:

1. What is the mean difference in academic performance between students who were taught the properties of plane shapes using the Mathematics laboratory instructional approach and those who were taught the same subject using the traditional instructional approach?
2. To what extent are the mean difference in the academic performance of the male and the female students who studied properties of plane shapes using a Mathematics laboratory instructional approach?

Hypotheses

The following null hypotheses were tested at 0.05 significant levels;

Ho_1: There is no significant difference in the performance mean score of students taught properties of plane shapes using Mathematics laboratory instructional approach and those taught the same topic using the conventional instructional approach.

Ho_2: No significant difference exists in the performance mean score among male and female students taught properties of plane shapes using the Mathematics laboratory approach.

Materials and Methods

Research Design

This study adopted a quasi-experimental research design in which pretest and posttest were administered to the students. The study involved two groups; the experimental and control groups.

Population of the Study

The population of the study comprised all the 8,431 Junior Secondary Two (JSS2) students in Obio/Akpor Local Government Area of Rivers State.

Sample and Sampling Technique
The sample for this study comprised of ninety-six (96) JSS2 students. Fifty (50) were in the experimental group and forty-six (46) 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 fourteen (14) public schools in the Obio/Akpor zone.

Instrument for Data Collection
The researcher developed an instrument titled 'Mathematics Performance Test (MPT)' which was used for data collection. The MPT was used to conduct the pretest and posttest to elicit the achievement of students in Mathematics. The test item was derived from the properties of plane shapes for which lesson plans were also prepared. The test was made up of twenty-five (25) 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) were prepared considering the lesson topic, age, and class of the students, class size, sex and qualification of the intact class teachers, lesson duration of 40 minutes per teaching session, students' previous knowledge, specific objectives of the lesson, instructional materials, reference materials, and instructional approach.

Validity of the Instrument
The face and content validity of the instruments was determined by an expert in the area of Mathematics education in the Department of Mathematics/Statistics who certified them fit for the study.

Reliability of the Instrument
To determine the reliability of the instrument (MPT), a retest approach was performed using the same simple random sampling technique for twenty (20) JSS2 students in a non-degree school. This group of students had not previously been taught the topics before the administration of the instrument (MPT). Students were asked to try all twenty-five (25) 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 were correlated with Pearson's product-moment correlation and the coefficient of confidence was 0.82, which was sufficient for the test.

Method of Data Collection
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 using the content by the researcher, for the duration of time under similar environmental conditions using the same lesson plans. The different scores obtained during pre-test and post-test were used for data analysis. Again, the MPT was administered to JSS2 students who were not included in the experiment.

Method of Data Analysis
The mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at a 0.05 significant level.

Results
Research Question1: What is the mean difference in academic performance between students who were taught the properties of plane shapes using the Mathematics laboratory instructional approach and those who were taught the same subject using the traditional instructional approach?

Table 1: Mean and standard deviation on the difference in the performance of students who were taught the properties of plane shapes using the Mathematics laboratory instructional approach and those who were taught the same subject using the traditional instructional approach

		Pretest		Posttest		Gain	
Group	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
MLS	50	33.76	11.67	49.84	8.65	16.08	10.20
CVM	46	36.83	12.34	42.26	10.38	5.43	13.20

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Table 1 showed the mean and standard deviation on the difference in the performance of students who were taught the properties of plane shapes using the Mathematics laboratory instructional approach and those who were taught the same subject using the traditional instructional approach. The table showed that the students taught properties of plane shapes with the Mathematics laboratory instructional approach had a mean gain performance of 16.08, SD=10.20 while those taught with the conventional approach had a mean gain performance of 5.43, SD=13.20. This implies that students who were taught properties of plane shapes with the Mathematics laboratory instructional approach had a higher mean gain than those taught using the conventional approach.

Research Question2: What is the difference in the academic performance of the male and the female students taught properties of plane shapes using Mathematics laboratory instructional approach?

Table 2: Mean and standard deviation on how the performance of the students in the experimental group taught properties of plane shapes with Mathematics laboratory instructional approach differ by gender

		Pretest		Posttest		Gain	
Gender	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Female	28	32.36	10.94	48.71	9.19	16.36	10.05
Male	22	35.55	12.57	51.27	7.87	15.73	10.61

Table 2 showed the mean and standard deviation on how the performance of the students in the experimental group taught properties of plane shapes with Mathematics laboratory instructional approach differs by gender. The table showed that the male students taught properties of plane shapes with Mathematics laboratory instructional approach had a mean gain performance of 15.73, SD=10.61 while the female students had a mean gain performance of 16.36, SD=10.05. This implies that the female students outperformed the male counterparts in the experimental group.

H_{01}: There is no significant difference in the performance of students taught properties of plane shapes with the Mathematics laboratory instructional approach and those taught with the conventional approach.

Table 3: Summary of ANCOVA on the difference in the performance of students taught properties of plane shapes with Mathematics laboratory instructional approach and those taught with the conventional approach.

Dependent Variable: Posttest

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	***p-value***
Corrected Model	2907.851[a]	2	1453.925	19.361	.000
Intercept	11395.168	1	11395.168	151.740	.000
Pretest	1531.607	1	1531.607	20.395	.000
Group	1747.298	1	1747.298	23.267	.000
Error	6983.983	93	75.097		
Total	214872.000	96			
Corrected Total	9891.833	95			

a. R Squared = .294 (Adjusted R Squared = .279)

Table 3 showed the summary of ANCOVA on the difference in the performance of students taught properties of plane shapes with Mathematics laboratory instructional approach and those taught with the conventional approach. The result showed that there is a significant difference in the performance of students taught properties of plane shapes with Mathematics laboratory instructional approach and those taught with the conventional approach ($F1, 93=23.267, p<.05$). The null hypothesis one was rejected at 0.05 alpha levels.

H_{02}: No significant difference exists in the performance of the students in the experimental group taught properties of plane shapes with Mathematics laboratory instructional approach by gender.

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Table 4: Summary of ANCOVA on the difference that exists in the performance of the students in the experimental group taught properties of plane shapes with Mathematics laboratory instructional approach by gender

Dependent Variable: Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	*p-value*
Corrected Model	1051.109[b]	2	525.555	9.458	.000
Intercept	6949.136	1	6949.136	125.061	.000
Pretest	970.467	1	970.467	17.465	.000
Gender	21.428	1	21.428	.386	.538
Error	2611.611	47	55.566		
Total	127864.000	50			
Corrected Total	3662.720	49			

a. Group = MLS

b. R Squared = .287 (Adjusted R Squared = .257)

Table 4 showed the summary of ANCOVA on the difference that exists in the performance of the students in the experimental group taught properties of plane shapes with Mathematics laboratory instructional approach by gender. The result showed that no significant difference exists in the performance of the students in the experimental group taught properties of plane shapes with Mathematics laboratory instructional approach by gender (F1, 47=.386, p>.05). The null hypothesis two was retained at 0.05 alpha levels.

Discussion of findings

Laboratory approach and students' performance

Research question one (1) and its hypothesis one (1) investigated the mean difference in the performance of students taught properties of plane shapes with the Mathematics laboratory instructional approach and those taught with the conventional approach. The findings revealed that students who were taught properties of plane shapes with Mathematics laboratory instructional approach performed higher (MG = 16.08, SD = 10.20) than those who were taught with conventional approach (MG = 5.43, SD = 13.20). Also, the hypothesis showed there was a significant difference in the academic performance of the students, therefore, the use of the Mathematics laboratory instructional approach significantly affected the academic performance of students taught properties of plane shapes. However, Okigbo and Osuafor (2008) established that the utilization of a mathematics laboratory was found to improve mathematical achievement.

Gender associated performance of students

Research question (2) and its corresponding hypothesis (2) on the mean difference in the academic performance of students in the experimental group taught properties of plane shapes with Mathematics laboratory instructional approach by gender. The findings showed that the female students who were taught properties of plane shapes with the use of the Mathematics laboratory instructional approach in the experimental group achieved more (MG = 16.36, SD = 10.05) than their counterparts in the same group (MG = 15.73, SD = 10.61). Also, the hypotheses showed that no significant difference exists in the performance of the students in the experimental group who were taught properties of plane shapes with the Mathematics laboratory instructional approach by gender. This result disagreed with Ganley et al., (2018) who revealed that girls tend to have less positive attitudes in Mathematics. From this study, it was discovered that boys have higher levels of Mathematics anxiety and lower levels of confidence in their Mathematics skills instead of girls against what was discovered by Ganley, et al. (2018). It is boys that are not too sure of themselves and not girls, even when they show similar performance in their levels to girls. Okigbo and Osuafor (2008) also revealed that there is no significant difference in achievement between male and female mathematics students who are taught in a mathematics laboratory.

Conclusion

This study revealed that students have mean score gains in their performances when taught plane geometry using the Mathematics laboratory approach than when taught with the conventional approach. There is a significant difference in the mean scores of students taught plane geometry with the Mathematics laboratory approach and those taught without Mathematics laboratory approach for better performance. The Mathematics

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laboratory approach is also not gender bias in advancing the learning outcome of the students. The findings imply that when students are taught in the Mathematics laboratory, they explore things themselves.

Recommendations

The researcher made the following recommendations based on the findings of this study;

1. Mathematics laboratory should be established in all the secondary schools to enable students to develop more interest in the learning of Mathematics and participate actively in the class.
2. Teachers should always use the conventional approach in teaching Mathematics, but should also allow the students of both sexes to experiment and explore patterns and ideas through Mathematics laboratory instructional approach, while they are guided.
3. Curriculum planners should include Mathematics laboratory instructional approach as a subject of its own and emphasize interactive activities.

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