EFFECTS OF MATHEMATICS LABORATORY ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN MATHEMATICS IN MINNA METROPOLIS, NIGER STATE

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Abstract
The study examined the effect of mathematics laboratory on the achievement of Senior Secondary School Students' in Mathematics in Minna Metropolis, Niger State. Three research questions and hypotheses guided the study. The pre-test – post-test non-equivalent control group quasi-experimental design was adopted. The population of the study comprised of 120 year I (SSS 1) students in the science class. Mathematics Laboratory Achievement Test (MLAT) was use for data collection, and analyses were made using the Mean, Standard Deviation. Analysis of Covariance (ANCOVA) was used to test null hypotheses at 0.05 level of significance. The study found that those taught mathematics using laboratory had higher mean achievement scores in the MLAT than their counterparts taught without using mathematics laboratory, and no significant difference exists between the post-test mean and standard deviation achievement scores of students with respect to ability-level and gender. It was therefore recommended that mathematics laboratory should be introduced in all schools and laboratory method of teaching be adopted for the teaching of mathematics in schools.

Keywords: Mathematics, Laboratory, Achievement

Introduction
Mathematics involves thinking logically and reasonably so as to comprehend the process in which formulae are generated and their areas of applications. To enhance learner's with effective mastery learning of mathematics, it is essential to device ways of reducing the abstractness of mathematics through the uses of mathematics laboratory. Adenegan, (2010) afford evidence that when instructional material is well utilized in the teaching and learning, it can provide concrete bases for conceptual thinking, high degree of interest for students and make learning permanent. Mathematics may be described as the fundamental science. It is that branch of science that uses numbers and symbols. Numbers and symbols are arranged using systematic mathematical rules. It plays an important role in forming the basis of all other sciences which deal with the material substance of space and time. Mathematics has a number of very useful benefits to our mind if we go into its study. It develops our reasoning, helps us to have an analytical thinking, quickens our mind, generates practically and also its use can be applied in the day-to-day activities.

Mathematics laboratory is relatively new in the teaching and learning of mathematics. It is a practical oriented classroom or place where materials useful for the effective teaching and learning of mathematics are kept. It is the latest design to make mathematics real. The term "laboratory method" is commonly used today to refer to an approach to teaching and learning of mathematics which provides opportunity to the learners, to abstract mathematical ideas through their own experiences, that is to relate symbol to realities. It is uncommon in our schools today possibly as a result of lack of fund or the absence of any government policy on the provision of such laboratory facilities. In summary, its non-

existence in our schools is one of the major contributory factors to mass failure in mathematics.

According to Adenegan, (2010), the mathematics laboratory is a unique room or place, with relevant and up-to-date equipment known as Instructional materials, designated for the teaching and learning of mathematics and other scientific or research work, whereby a trained and professionally qualified person (mathematics teacher) readily interact with learners (students) on specified set of instructions. Agwagah, (2014) observed that the only way to make the teaching and learning of mathematics effective, meaningful and interesting is by the use of instructional materials and measurable activities the learners like to do. The present status of teaching and learning of mathematics is far from being satisfactory. Teachers engaged in using traditional method of teaching, such as lecture method (talk and chalk) in their classroom, and a result of these, the power of thinking understanding and retention are not developed among students in spite the importance of mathematics to has been point and all over the world that the subject has specific features, nature and structure that make many people scared and loose interest in it. Dogan, (2012) stated that mathematics laboratory provides an opportunity for the students to discover mathematics through practicing and proper utilization of mathematics laboratory.

Gender and mathematics achievement, usually gender is a variable believed to relate to achievement in mathematics. It is sometimes observed as a predictor of mathematics achievement, Mansor, (2013) there are lots of factors that affect girls mathematics achievement in different societies such as Nigeria, these factors can be parent's background, parent support, cultural issues, learners' socioeconomic condition and learners' self-confidence that may affect their future achievement in mathematics.

Ado and Nwosu (2016) conducted a study on the influence of laboratory method on students' mathematical creativity in Yenagoa Local Government Area of Bayelsa State. This study investigated the influence of laboratory method on student's mathematical creativity in Junior Secondary Schools in Yenagoa, Bayelsa State. The study was guided by three research questions and three hypotheses. The pre-test – post-test non-randomize control group design was adopted for the study. The data collected were analyzed using mean and standard deviation, and the Analysis of Covariance (ANCOVA). The result indicated that laboratory method of teaching significantly enhances students' creativity in mathematics.

Anyichie and Onyedike, (2012) who investigated the effects of self-instructional learning strategy on students' achievement in solving mathematical word problems and observed that the effect of gender on mathematical word problem achievement was found insignificant. However, a significant interaction effect was observed between gender and learning strategy. Thus, males in the experimental group significantly performed better than their female counterparts. Based on these findings, educational implications the study were raised which include among others that mathematics is seen by most female students as difficult subject which can only be handled by male students since attention is needed to really handle mathematics and as a result of house chores, female students give less time to mathematics.

Esan (2015) carried out at Ilessa in Osun State of Nigeria on a total of 240 students that were JSS classes. The study was on the effect of cooperative sitting strategy using problem solving on academic achievement of the students in mathematics. The design for the study was quasi-experimental. Experimental and control groups were the two groups used for the study where the experimental group was taught using cooperative problem-solving technique, the control group was taught using lecture method. Using t-test for the analysis

after data collection, it was shown that the attitude of the students became positives towards word problem and which in turn increase their academic performance in mathematics, meaning that cooperative learning strategy significantly increase students' academic achievement better than lecture method.

Statement of the Problem

The abstractness of mathematics is unbearable to our senior secondary schools today, mathematics is a subject hated by students and it is made compulsory for every school student and even in many professions and careers. Evidence of poor achievement in mathematics by secondary school students revealed that most desired technological, scientific and business application of mathematics is not being sustained. This makes it paramount to seek for a method for teaching mathematics that aim at improving its understanding and performance by students. The lack of laboratory techniques in teaching mathematics is one of the major factors that contribute to poor achievement in mathematics by secondary school students (Ogunkule, 2000). Therefore, this study is designed to find out the effect of mathematics laboratory on senior secondary school students' achievement in mathematics in Minna Metropolis, Niger State.

Purpose of the Study

The purpose of this study is to investigate the effect of mathematics laboratory on senior secondary school students' achievement in mathematics. Specifically, the study seek to achieve the following:

(i) To investigate the extent to which the use of mathematics laboratory will enhance the students achievement in mathematics.
(ii) To compare the achievement of male and female mathematics students taught with mathematics laboratory method.
(iii) Influence of students' ability levels on their achievement when they were exposed to mathematics laboratory method.

Research Questions

The study attempted to find answers to the following research questions:

(i) What effect does mathematics laboratory have on achievement of students in mathematics?
(ii) Does gender of students influence their achievement in mathematics when taught mathematics laboratory?
(iii) Is there any difference in the achievement of high, medium and low ability students exposed to the mathematics laboratory?

Research Hypotheses

Based on the research questions above, the following null hypotheses were tested

Ho_1: There is no significant difference in the achievement of students' taught mathematics using mathematics laboratory and those taught with conventional method in mathematics.

Ho_2: There is no significant difference in the achievement of male and female students exposed to mathematics laboratory method.

Ho_3: There is no significant difference in the achievement of low, medium, and high ability students when taught mathematics using mathematics laboratory.

Methodology

The quasi-experimental design was adopted for this study. Specifically, the pre-test, post-test non-equivalent control group design was used. The study was conducted in Minna metropolis, Niger State where 120 senior secondary school students were used in the study

from three science colleges. No sample was taken, in order to obtain a more justifiable result. Hence the population of the study constituted the sample. A twenty-item multiple choice mathematics laboratory achievement test (MLAT) was administered on the control and experimental groups. All the items were drawn from the past questions on mathematics geometry in West African Examination council (WAEC) from 2014 to 2019. A pretest was conducted to ascert5ain intelligence status of the groups. Those who scored d < 50 and those who scored > 50 were classified as low ability, medium ability and high ability level students respectively. Thereafter, the experimental groups were taught using the mathematics laboratory achievement test (MLAT) while the control groups were taught using the lecture method.

Finally, a post-test was administered on the control, and experimental groups and the scores of both groups in pre-test and post-test were recorded and compared. The research questions were used to test the null hypothesis at 0.05 level of significance, using the statistical package for social sciences (SPSS). Where the p-value was greater than the 0.05 level of significance (P-values 0.05 level of significance) the null hypothesis was therefore accepted. But where reverse was the case (P-value < 0.05 level of significance); the null hypothesis was rejected.

Results

Table 1: Mean achievement scores and standard deviation of students exposed to mathematics laboratory and lecture method

Group	N	Pretest ($\bar{x}$)	SD	Posttest ($\bar{x}$)	SD	Mean Gain
Experimental	80	31.70	8.56	72.92	11.07	40.21
Control	40	26.53	9.51	54.57	7.88	26.09

The result presented in table 1 above, shows that the control group and the experimental group had the pre-test mean scores of 26.53 and 31.70 while the standard deviation of 9.51 and 8.56 respectively. However, the post-test means and standard deviation scores for the control group and the experimental group were 54.57 and 72.92 while S.D of 7.88 and 11.07 respectively. The difference in their mean and standard deviation post-test score of 18.35 and 3.19 indicated that the experimental group recorded higher achievement than their control group counterparts in mathematics laboratory achievement test (MLAT).

Table 2: The mean achievement scores and standard deviation of male and female students exposed to mathematics laboratory

Group	N	Pretest ($\bar{x}$)	SD	Posttest ($\bar{x}$)	SD	Mean Gain
Male	50	23.40	6.33	62.85	5.88	38.78
Female	30	22.00	6.21	62.74	7.77	31.68

The result presented in table 2 above, shows that 80 students comprising of 50 male and 30 female, were taught using mathematics laboratory achievement test in which the male students had mean achievement score of 62.85 while the female students had mean achievement score of 62.74 and standard deviation of male achievement score of 5.88 and female 7.77. The difference in their mean achievement score of 0.11 is not statistically significant hence indicating that both the male and female students performed equally when taught using mathematics laboratory achievement test.

Research Question Three

Is there any difference in the achievement of high, medium and low ability students exposed to mathematics laboratory?

Table 3: Mean achievement scores and standard deviation of students with high, medium and low ability in mathematics laboratory

Ability Level	N	Pretest ($\bar{x}$)	SD	Posttest ($\bar{x}$)	SD	Mean Gain
High Ability Level Students	45	30.57	6.52	60.45	5.15	36.87
Medium Ability Level Students	20	28.13	5.54	60.32	4.30	25.19
Low Ability Level Students	15	28.17	5.51	60.31	4.14	25.14

The result presented in Table3 shows that 80 students comprising of 45 high ability, 20 medium ability and 15 low ability level students were taught using mathematics laboratory achievement test in which, the low ability level students had a mean and standard deviation scores of 60.32 and 2.14 while the high ability level students had mean and standard deviation achievement score of 60.45 and 5.15. The difference in their mean achievement score of 0.13 is not statistically significant hence indicating that the low ability level students and high ability level students performed equal and even the medium ability level students when taught using mathematics laboratory.

Hypothesis One: There is no significant difference in the achievement of students' taught mathematics using mathematics laboratory and those taught with conventional method in mathematics.

Table 4: Analysis of Covariance (ANCOVA) on the Posttest Achievement Score of the Experimental and Control Groups

Source	Type III Sum Square	df	Mean Square	F	Sig
Corrected Model	4759.7936	2	2329.897	.22696	.000
Intercept	26724.388	1	26724.399	260.369	.000
Pretest (Covariate)	2085.781	1	2085.791	203.16	.000*
Treatment	1753/527	1	1753.527	.18066	.000
Error	10039.196	38	102.543		
Total	31034.000	78			
Corrected Total	13908.990	80			

Significant at 0.05

Table 4 shows the comparison of posttest mean scores of the experimental and control groups. The significance p-value of 0.00 <0.05. It indicates that there is significant difference, thus rejecting the null hypothesis one (HO_1). This implies that there is significant difference in the posttest mean achievement score of mathematics laboratory students in science colleges exposed to mathematics laboratory method and their counterparts expose to lecture method.

Hypothesis Two: There is no significant difference in the achievement of male and female students exposed to mathematics laboratory method.

This hypothesis was tested using ANCOVA statistic method, to compare the mean scores of students in experimental group (Stratified into Male and Female) with the pre-test score's serving as covariate. The result is shown below in table 5.

Table 5: Analysis of Covariance (ANCOVA) on past post-test mean score of male and female students in the experimental group

Source	Type III Sum Square	df	Mean Square	F	Sig
Corrected Model	15032.595[a]	1	806.297	7.761	.001
Intercept	12263.418	1	2263.418	132.350	.000
Pretest (Covariate)	1522.619	41	1522.619	16.415	.000
Treatment	152.190	40	152.190	1.641	.193
Error	4558.726	43	83.175		.193
Total	1866372.000	42			
Corrected Total	6191.321				

Significant at 0.05

Table 5 indicates that the calculated F-value of 1.641 is not significant because the significant value of .193 is greater than 0.05 alpha levels. This result implies that there was no significant difference between post-test mean score of male and female students. That is, male students score when both were taught using mathematics laboratory method. Therefore, the null hypothesis is accepted.

Hypothesis Theses: There is no significant difference in the achievement of low, medium and high ability students' when taught mathematics using mathematics laboratory.

Table 6: Analysis of covariance (ANCOVA) on the achievement of high, medium and low ability levels students in the experimental group

Source	Type III Sum Square	df	Mean Square	F	Sig
Corrected Model	3208.6059	3	1103.686	17.118	.000
Intercept	15359.700	1	15359.700	258.757	.000
Pretest (Covariate)	216.628	1	226.628	2.887	.054
Ability	1738.200	2	918.100	14.099	.000
Error	2882.716	40	60.772		
Total	185372.000	43			
Corrected Total	6281.421	42			

Significant at 0.05 alpha levels

Table 6 shows that the calculated F-value of 14.099 is significant because .000 significant levels is less than alpha levels. This shows that there is a significant difference in the post-test mean score of high, medium and low scorers. Therefore, the null hypothesis is rejected.

Discussion

The result from the findings of this research indicated that the students taught with the mathematics laboratory method performed better than those taught with lecture method. The students' gender has no significant influence on students achievement in mathematics laboratory when they were taught with the mathematics laboratory method. The findings also revealed that there is a significant difference in the post-test achievement of high. Medium and low scorers when the students were taught with the mathematics laboratory method. This finding is in line with Issa, (2014) who confirmed that graphical instructional package has the potential and functionality effect to enhance achievement when compare to lecture method.

Conclusion

Mathematics laboratory method could enhance the teaching and learning of mathematics. It improves students' achievement in 21st century mathematics. Mathematics teacher should be readily familiarized with the modern day techniques of teaching mathematics and based on the results of this study, it can be concluded that there was significant difference in the achievement of senior secondary school students on mathematics laboratory in Minna Metropolis, Niger State.

Recommendations

In the light of the findings of this study, the following recommendations were made:

(i) The use of mathematics laboratory should be encouraged in teaching mathematics concept.
(ii) Establishment of mathematics laboratory in our senior secondary schools is highly needed.
(iii) Seminars, workshops and in-service training should be organized for teachers to enable them acquire the necessary skills in the development of mathematics laboratory for classroom instruction.
(iv) Mathematics laboratory should be made an integral part of curriculum of mathematics.

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