

**APPLICATION OF LABORATORY AND COOPERATIVE FORMS OF
PEDAGOGY IN REDUCING STUDENTS' DIFFICULTIES IN TRIGONOMETRY**

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ABSTRACT

This is a quasi experimental research designed to determine the application of laboratory and cooperative forms of pedagogy in reducing students' difficulties in trigonometry in Imo State, Nigeria. The population was made up of 355 SSS2 students in government secondary schools in Ideato South Local Government Area of Imo State, Nigeria. The sample consisted of 57 respondents purposively determined using Diagnostic Mathematic Test (DMT) into Experimental (E), and Control (C) groups which had 27 and 30 students respectively. Respondents in the experimental group were taught Trigonometry using the Laboratory instructional strategy, while those in the control group (C) were taught using Cooperative Learning method. The treatment lasted for 6 weeks. Mathematics Achievement Test (MAT) was administered on the respondents at the end of treatment. Both the DMT and MAT were validated by experts and their reliability assessment using the Pearson Product Moment Correlation Coefficient Formula of $r = 0.79$ and 0.82 respectively were obtained. Data collected were analyzed using Mean, Standard deviation (SD), t-test, and analysis of covariance (ANCOVA). Results obtained after data analysis showed that there was a significant effect of the Laboratory and Cooperative instructional strategies in reducing students learning difficulties in trigonometry with Laboratory method as a better instructional strategy. Based on these results, it was recommended among others the adoption of Laboratory instructional strategy in teaching trigonometry to improved mathematics achievement among secondary school students.

INTRODUCTION

It has been the concern of educators, curriculum planners and teachers to explore teaching methods and strategies so as to find out the ones that will be combined to be suitable in teaching specific mathematical concepts in other to take care of students' errors and difficulties in mathematics (Olaogun, 2009). Mathematics as a core subject in both primary and secondary schools occupy a central place in the school curriculum; this is because of its

usefulness in national prosperity. This may suggest why Awofala (2010) posits that mathematics as a creation of human mind is seen as indispensable catalyst to the understanding of the national problem. Mathematics is the queen of all sciences; it plays a prominent role in the advancement of science and technology. It is a pattern of thought. Therefore, Lassa (2012) stated that mathematics is a way of thinking. Plato; a Greek Philosopher in Lassa (2012) stated that a person who is ignorant of geometry in mathematics is not worth talking to. Hence, mathematics is concerned with finding solutions to questions and problems that arise in everyday life. Mathematics involves thinking for one's self, sorting information, making use of a store of knowledge concerning shapes, numbers and measures seeing and using relationships, et cetera. Mathematical concepts are used to solve problems in other fields. It is used to calculate the quantity of materials needed for building, sewing, electrical work, et cetera. For example, geometry in mathematics gives shape to the world, names to objects, use to earn a living (Oladayo & Ekwueme, 2012). Mathematics should therefore be taught in such a way that it should provide the understanding of the relationship between mathematics and real life situations. This can better be achieved if students' errors and difficulties in the subject are identified and taken care of using appropriate instructional methods

However, the knowledge of this wealth of importance of mathematics has not prevented mathematics students from performing poorly in the subject. Alamina & Oladayo (2009) identified that both teachers and students have been finding it difficult to teach and learn mathematics. Students also find it difficult to solve mathematical problems accurately; they commit a number of errors while solving problems in mathematics. Aminu (2008) confirmed that students' perception and attitude towards mathematics is negative.

Furthermore, mathematics education is aimed at ensuring success for all students, yet it is seen that a few prosper in the subject, greater number find mathematics difficult, and commit errors in it. There are students who struggle and who will need appropriate help to be able to pursue mathematics further (David and Mohammed, 1993). Hence, mathematics need of such students is worth taking care of irrespective of whatever thing that might have been the cause of their difficulties and errors in mathematics. Most often, teachers use the same method of teaching to teach most of the concepts in mathematics. Therefore, secondary school students should be made to have varieties and pleasure in learning mathematics, this calls for the need to use different methods in teaching suitable specific topics in mathematics to provide understanding of the interaction between mathematics and real life (Lassa, 2012).

Opinions vary on the possible causes of the students' poor performance in mathematics, some say it is due to some factors such as students' unserious, low Intelligent Quotient, lack of interest and motivation in the subject. Others said it is as a result of the nature of mathematics, some others said it is due to the teaching methods and strategies that the teachers use while teaching mathematics (Olaogun, 2001). Okereke (2006) said among other things that lack of mathematics laboratory have contributed to the poor performance of students in mathematics.

However, students' poor performance in mathematics may be due to the difficulties they encounter while solving mathematical problems or due to the common errors they commit while solving problems in mathematics. It may as well be due to inability of the teachers to diagnose and identify these errors in students, it may be the use of inappropriate methods or even strategies used to teach specific mathematical concepts. This may suggest why Ogunkunle & Oladayo (2012) stated that teachers' inability to diagnose errors and learning difficulties among other factors may have contributed to students' poor performance in mathematics. In another study, Ekwueme (2006) found that the process errors and difficulties committed by students may have contributed to their poor performance in mathematics.

Poor performance and achievement of students in both external and internal examinations in mathematics has been on the increase in recent times (Okigbo, and Osuafor, 2008). Students find it difficult to comprehend many concepts in mathematics; as a result, they have difficulties in mathematics which result into committing errors. How to improve students' performance by reducing their errors and difficulties has always been one of the problems confronting mathematicians, mathematics teachers, educators, parents and guardians (Galadima, and Okogbenin, 2012).

These students' errors and difficulties which may have contributed to students' poor performance have not been properly attended to. Many new teaching methods have been developed by researchers and educators and used in the bid to improve the teaching and learning of mathematics. Moreover, the effectiveness of such teaching methods and strategies to remedy instruction to take care of students' errors and difficulties in trigonometry has not been ascertained, since students still find it difficult to solve problems in trigonometry. One is also yet to determine whether Laboratory method and cooperative strategies would be good enough to take care of students' errors and difficulties while learning and solving problems in trigonometry. This necessitated the conduct of the study.

Purpose of the Study

The main purpose of the study is to determine the application of laboratory and cooperative pedagogical strategies in reduction of students' difficulties in learning Trigonometry in senior secondary schools. The specific objectives of the study are to:

1. Ascertain the effects of laboratory method and cooperative learning in the reduction of learning difficulties in trigonometry among the experimental groups as measured by the pretest and post test.
2. To determine the difference in learning difficulty reduction in trigonometry among the experimental group and those in the control group.
3. To determine the effect of laboratory method of instruction on learning difficulties reduction among male and female students.

Research Questions

The following research questions guided the work.

1. What are the effects of laboratory method and cooperative learning in the reduction of learning difficulties in trigonometry as measured by the pretest and post test scores?
2. What is the difference in the reduction of learning difficulties in trigonometry in experimental and control groups as measured by their post test scores?
3. What is the influence of the effects of male and female games method in the reduction of learning difficulties in trigonometry as measured by their post test scores?

Hypotheses

Three null hypotheses were tested at .05 alpha level.

1. There is no significant difference in the pretest and post test effect on laboratory method and cooperative learning in the reduction of learning difficulties in trigonometry.
2. There is no significant difference in learning difficulty reduction among students taught using experimental and control group as measured by their post test scores.
3. There is no significant influence of effects of male and female of laboratory method on reduction of learning difficulties in trigonometry as measured by their post test scores.

Method

The study adopted the quasi-experimental research design to determine application of laboratory and cooperative forms of pedagogy in reducing students' difficulties in trigonometry in Imo State. The population of the study consisted of one hundred and seventy-

eight (355) Senior Secondary School Two (SSS2) students in Ideato South Local Government Areas of Imo State, Nigeria. The sample consisted of 57 students had 27 and 30 students respectively, was drawn using Diagnostic Mathematics Test (DMT) to determine students' learning difficulties in trigonometry. The treatment lasted for 6 weeks. Mathematics Achievement Test (MAT) was administered on the respondents at the end of treatment. Both the DMT and MAT were validated by experts and their reliability assessment using the Pearson Product Moment Correlation Coefficient Formula. The co-efficients of $r = 0.79$ and 0.82 respectively were obtained. Data collected were analyzed using Mean (\bar{x}), Standard deviation (SD), t-test, and analysis of covariance (ANCOVA) at .05 alpha level.

Results

The analyzed data and result of the study were presented below:

Research Question 1: What are the effects of laboratory and cooperative method in the reduction of learning difficulties in trigonometry as measured by the pretest and post test scores?

Table 1: Mean(\bar{x}) and Standard Deviation (SD) of the effects of laboratory and cooperative learning on trigonometry

Instructional Strategy	Pre-Test			Post-Test			
	N	\bar{x}	Sd	N	\bar{x}	Sd	Mean gain
Laboratory	27	42.70	3.70	27	71.59	2.71	28.89
Cooperative	30	38.77	5.92	30	57.90	3.09	19.13

Data in Table 1 indicated that the pre test and post test mean (\bar{x}) scores of effects of laboratory method in the reduction of learning difficulties in trigonometry were 42.70 and 71.59 respectively, while the mean gain is 28.89. Also, for cooperative method, their pre test and post test mean (\bar{x}) scores were 38.77 and 57.90 respectively while the mean gain is 19.13. This implied that respondents in laboratory and cooperative method were effective in reduction of learning difficulties in trigonometry. However, laboratory method was found to be better than cooperative method in the reduction of learning difficulties in trigonometry.

Research Question 2: What is the difference in the reduction of learning difficulties in trigonometry in experimental and control groups as measured by their post test scores?

Table 2: Mean (\bar{x}) and Standard Deviation showing difference in reduction of learning difficulties in trigonometry.

Instructional Strategies	N	\bar{x}	SD
Laboratory(Experimental)	27	71.59	2.71
Cooperative (Control)	30	57.90	3.09

Data in Table 2 showed that respondents in the experimental group obtained higher mean scores than their counterparts in control group. This means that greater reduction in learning difficulties in trigonometry was achieved among subjects in experimental group than those in the control group.

Research Question 3: What are the effects of Laboratory method of instruction on the reduction of learning difficulties in trigonometry among male and female students as measured by their post test scores?

Table 4.5: Mean (\bar{x}) and Standard Deviation (SD) showing influence of male and female

Instructional Strategy	Gender	N	\bar{x}	SD
Laboratory	Male	13	73.85	1.57
	Female	14	69.50	1.61

Table 3 showed that male and female respondents taught with laboratory method obtained mean (\bar{x}) scores 73.85 and 69.50 in reduction of learning difficulties in trigonometry respectively. The males in laboratory method scored higher than their female counterparts.

Hypothesis 1: There is no significant difference in the pretest and post test effect on laboratory method and cooperative learning in the reduction of learning difficulties in trigonometry.

Table 4: Analysis of Covariance (ANCOVA) of the effects of laboratory and cooperative method in trigonometry

Sources of Variation	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	2701.807 ^a	2	135.904	169.766	.000	S
Intercept	4166.983	1	4166.983	523.659	.000	S
PreLabCoop	37.517	1	37.517	4.715	0.034	S
VARLabCoop	2519.392	1	2519.392	316.608	.000	S
Error	429.702	54	7.957			
Total	239428.000	57				
Corrected Total	3131.509	56				

a. R Squared = .863 (Adjusted R Squared = .858)

The results shown in table 4 indicated that the group source VARLabCoop on the SPSS output) evaluates the null hypothesis that the population adjusted means are not equal. The results of the analysis indicate that this hypothesis should be rejected $F(1, 56) = 316.608$, $p < 0.05$. The test assesses the difference among the adjusted means (\bar{X}) for the two groups. The null hypothesis one was therefore rejected. This implied that there is a significant effect of laboratory and cooperative method on reduction of learning difficulties in trigonometry respondents in favour of those taught with laboratory method.

Hypothesis 2: There is no significant difference in learning difficulty reduction among students taught using experimental and control group as measured by their post test scores.

Table 5 t-test analysis of difference in Mathematics achievement of students in experimental and control groups

Instructional Method	N	\bar{X}	SD	Df	Cal. t	Crit. t	Remark
Laboratory	27	71.59	2.71				
Cooperative	30	57.90	3.09	55	17.71	2.04	S

Table 5 indicated that all calculated t-value 17.71 showing extent of difference in reduction of learning difficulties in trigonometry of respondents in experimental and control groups are respectively greater than the t-critical value of 2.04, at .05 alpha level and df of 55. The null hypothesis 2 was therefore rejected. This implied that significant difference in reduction of learning difficulties in trigonometry in experimental and control groups, in favour of those in experimental groups.

Hypothesis 3: There is no significant influence of effects of male and female of laboratory method on reduction of learning difficulties in trigonometry as measured by their post test scores.

Table 6: t-test analysis of influence of male and female of laboratory method on reduction of learning difficulties in trigonometry

Instructional Method	Gender	N	\bar{X}	SD	Df	Cal. t	Crit. t	Remark
Laboratory	Male	13	73.85	1.57				
	Female	14	69.50	1.61	25	7.10	2.31	S

In Table 10, the calculated t-value of 7.10 at .05 alpha level and df of 25 was greater than critical t-value of 2.31. The null hypothesis 3 was therefore rejected. This implied that there was significant effect of laboratory method on reduction of learning difficulties in trigonometry of respondents in favour of males.

Discussion

Application of laboratory and cooperative forms of pedagogy in reducing learning difficulties in trigonometry was investigated in this study. Findings indicated that students taught using laboratory method achieved

(\bar{X} = 42.70) at pre-test to (\bar{X} = 71.59) at post-test while cooperative method obtained (\bar{X} = 38.77) at pre-test to (\bar{X} = 57.90) at post test. This showed that subjects taught using laboratory method performed better than subjects taught with cooperative method.

Statistically the findings revealed that there was significant difference in the post-test scores of students taught using laboratory method of instruction and cooperative learning strategy with $F(1,56) = 316.61$ $p < 0.05$ in favour of Laboratory method group (Olatunde, 2010). This result implies that Laboratory method was more effective in reducing students' difficulty in trigonometry from the techniques applied. This finding is in line with Okigbo and Osuafor (2008) and Donnipad (2009). They found that laboratory method improved students' academic achievement. Furthermore, the use of mathematics laboratory enhanced achievement in mathematics (Pasha, Rao and Veerababu, 2012).

Moreover, the difference in learning difficulty reduction among students in Experimental and control groups is not significant as measured by their post test scores. Experimental groups achieved (\bar{X} = 71.59) at post-test, while

Control group had (\bar{X} = 57.90) in their post test score. This showed that the Experimental groups performed better than the control group. Statistical analysis displayed that there was significant difference in the post test scores of students in the experimental and control groups with t-critical value of 2.04, at 0.05 alpha level and dfs of 55 in favour of experimental group. This result is in agreement with the finding of Okigbo and Osuafor (2008) and Donnipad (2009); found that laboratory method improved students' academic achievement. Also, result of effect of laboratory method of instruction in reducing learning difficulties in trigonometry due to gender showed that male achieved

(\bar{X} = 73.85), while females achieved (\bar{X} = 69.50). This result is an indication that males performed better than females. Statistical analysis showed the calculated t-value of

7.10 at 0.05 alpha level and df of 25 was greater than critical t-value of 2.31. This implied that there was significant effect of laboratory method on reduction of learning difficulties in trigonometry of respondents in favour of males. This result means that males learning difficulties in trigonometry using Laboratory Method was reduced more than that of females. This result is in agreement with the findings of Adeyemi and Ajibade (2011), who observed that girls tend to perform better than boys in reading and verbal skills, while the reverse is the case in manipulative and physical productive tasks.

Conclusion

From the findings of this study, it was concluded that:

- All the instructional methods manipulated were effective in reduction of learning difficulties in trigonometry.
- The difference in reduction of learning difficulties in trigonometry in the experimental groups were found to be statistically significant; in favour of those taught using laboratory method.
- Respondents in the experimental group obtained higher trigonometry mean scores than their counterparts in the control group.
- The difference in Mathematics achievement between respondents in the experimental and control groups was found to be statistically significant; in favour of those in the experimental group.
- Significant difference existed in the reduction of learning difficulties of trigonometry of male and female respondents taught with laboratory method; in favour of the males.

Recommendations

Based on the results the following recommendations were made:

1. Laboratory and cooperative instructional strategies should be considered for teaching of trigonometry in secondary schools.
2. Mathematics and Science teachers should vary/differentiate instructional strategies in consideration to the topic, content, nature, interest, academic trait and the environment of learners in order to determine which one will be most suitable to reducing students' difficulties in trigonometry and in other science related subjects.
3. In-service training of teachers, seminars and workshop should be sponsored by the school/government to encourage and ensure effectiveness of teachers at improving

students' academic performance and raising the standard of education most especially in Mathematics.

4. Better remuneration and allowances should be given to Mathematics and science teachers because of the nature of their subjects to motivate them to work hard and be effective in lesson delivery.

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