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EFFECT OF ACTIVITY-BASED LEARNING METHOD OF TEACHING TRIGONOMETRIC RATIOS USING GEOTRIGMETRIC SETS, ON JUNIOR SECONDARY SCHOOL STUDENTS ACHIEVEMENT IN MATHEMATICS

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Abstract: This study investigated the effect of the use of Activity-Based Learning (ABL) method on junior secondary school students' achievement in mathematics when they were taught trigonometric ratios using geotrigmetric sets. The population size was 3,835 while the sample size was 100 in a quasi experimental research design. The instrument used for data collection was a researcher-made mathematics achievement test with r = 0.87. Analysis of covariance (ANCOVA) was used for data analysis. Results showed among others that the activities which were generated by the use of geotrigmetric sets brought about a significant effect on achievement of the experimental group of students compared to students in the control group.

Based on the results of the study, it was recommended that teachers should adopt the use of the geotrigmetric sets to generate enough and sufficient activities for students while introducing them to trigonometric ratios at the junior secondary school level.

Keywords: Geotrigmetric set; Activity–Based Method; Lecture Method; Trigonometric Ratios; Students' Achievement.

INTRODUCTON/BACKGROUND

Mathematics is a core course for primary and secondary school learners in Nigeria. It is made a core course in the National Policy of Education (NPE). The NPE specifically stated that "specialist teachers shall be provided for particular subjects such as: mathematics…" (FGN, 2013:8). It is similarly stated that "the curriculum for Junior Secondary Education shall be as follows: English Studies, One Nigerian Language, Mathematics… FGN, 2013:8). This is to emphasize the importance which the government of Nigeria attached to Mathematics Learning in schools.

The foregoing policy of government to boost the learning of mathematics in schools notwithstanding, the achievement of Junior Secondary School (JSS) students is still not good enough. There are indications that certain mathematics topics such as trigonometric ratios are not adequately learnt by students before they are exposed to the Junior School Certificate Examinations (JSCE). The chief examiners report for JSCE had in the past years pointed out certain topics where a little more is expected from both teachers and students before the students are exposed to external examinations in mathematics, particularly the geometry and trigonometry component of the curriculum (WAEC, 2020). Experience has also shown that the problems which students have with geometry at the Senior School Certificate level started from their Junior School Certificate level. Trigonometry is an important section of school mathematics.

Trigonometry simply means calculations with triangles (that is where the tri comes from). It is a study of relationships in mathematics involving lengths, heights and angles of different triangles. Trigonometry is used to set directions such as the north south east and west. It tells you what direction to take with the compass to get on a straight direction. It is used in navigation in order to

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pinpoint a location. It is used to find the distance of the shore from a point in the sea. Furthermore, its application includes: finding the height of building or mountains; video games; construction- roof inclination, roof slopes, ground surfaces; flight engineering; physics; marine biology and engineering; and navigation (Real life application of trigonometry, 2017). This is to emphasize the usefulness of trigonometry to humanity.

Awodeyi and Udoh (2017) had attributed the poor performance of students in mathematics in schools to teachers' inadequate selection of method of teaching as well as poor choice of appropriate instructional materials. However, research continues into ways of ameliorating the situation. The present study is one of such ways. The adoption of Activity-Based Learning (ABL) method of teaching and also, the selection of the Geotrigmetric Sets could simplify the learning of trigonometric ratios. This precisely, is the focus of the present study.

The Geotrigmetric set has both the teachers copy- for teachers demonstration and students' copies- for students demonstration. They are useful for practical teaching and learning of different concepts in geometry and trigonometry (Uchebo, 2011). The set is an invention which is patterned after the protractor in the students' mathematical set. It is boarded by four fixed and two movable rulers. The sole purpose of Geotrigmetric set in the classroom is to provide students with ways to experience and interact with ideas and information about real world practical problems and increase student's engagement. It is also to enable students learn science process skills which includes: observing; communicating; classifying; inferring; measuring and predicting; using space/time relations; and defining operationally (Smith and Welliver, 1990; AAAS, 2001). The Geotrigmetric set is to generate sufficient activities for classroom learning among students (Azuka, 2013; Oribhabor, 2020). This is in line with Activity-Based Learning (ABL) method of teaching. The ABL is a method adopted by teachers to bring about lifelong learning through rigorous participation of students in class activities in an absolute child-centre teaching process (Activity-Based Teaching Method, 2012).

The ABL method of teaching "focuses on the use of sense organs and learning is based on doing some hands-on experiments and activities. The idea of ABL is rooted in the common notion that children are active learners rather than passive recipients of information" (Thiyagu, 2018).

There are certain secondary independent variables which may be useful in educational research. One is the students' level of attainment prior to treatment, as discussed in details under instrument for data collection. The other is gender, male or female, which is a nominal variable. The essence of gender as used in this study is to determine whether treatment would have similar effect on both sexes. It would have been unnecessary to recommend a treatment that will heal one but worsen the case of the other.

The problem of the study:

The problem of the present study however is that the way and manner in which students learn trigonometric ratios should involve active participation in class activities with the Geotrigmetric sets. Students should talk, think, reason, construct and reconstruct ideas. This is achievable with the use of instructional materials. Unfortunately, learners (in different categories of ability levels and gender) appeared oriented towards the memorization of rules whose concepts they hardly decipher. Perhaps the problem could be ameliorated by teachers if they adopt the Activity-Based Learning (ABL) method of learning.

Purpose of the Study:

The purpose of this study is to investigate the effects of activity-based learning method of teaching trigonometric ratios using the 'Geotrigmetric sets' on Student Achievement in mathematics in Uyo, Nigeria. Specifically, the study is designed to:

(i) Compare the achievement of students when taught trigonometric ratios using activity-based learning method and lecture method of teaching.

(ii) Compare the achievement of male and female students when taught trigonometric ratios using Geotrigmetric sets in activity-based learning method.

(iii) Compare the achievement of students by ability levels when taught trigonometric ratios with Geotrigmetric set using activity-based learning method.

Research Questions:

In order to achieve the above objectives, the following research questions provide focus:

(i) What is the difference between the mean achievement scores of students when taught trigonometric

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ratios using activity-based learning method and lecture method?;

(ii) What is the difference between the mean achievement scores of male and female students when taught trigonometric ratios with Geotrigmetric set using activity-based learning method?; and

(iii) What is the difference between the mean achievement scores of students by ability levels when taught trigonometric ratios with Geotrigmetric set using activity-based learning method?.

Hypotheses:

Based on the research question, three null hypotheses were formulated to guide the study:

(i) There is no significant difference ($p \leq .05$) between the mean achievements scores of students when taught trigonometric ratios using activity-based learning and lecture methods;

(ii) There is no significant difference ($p \leq .05$) between the mean achievement scores of male and female students when taught trigonometric ratios using activity-based learning method; and

(iii) There is no significant difference ($p \leq .05$) among the mean achievement scores of students by ability levels when taught trigonometric ratios using activity-based method.

Procedures of the Study:

This section is concerned with the procedures adopted in carrying out the study. The study lasted three weeks. In other words, the first week was for introduction, the determination of level of mathematics attainment by learners prior to the commencement of experiment, and the pre-test. Two weeks was sufficient for treatment and post test.

Sample and Sampling Technique:

The area of study was Uyo, the capital of Akwa Ibom state, Nigeria. The population size of the study was 3,835 during the 2019/2020 academic session while the sample size was 100. This was drawn from two intact classes of 50 students each, in one Junior Secondary School. The school was sampled from among 12 co-educational secondary schools by Simple Random Sampling. The design of the study was quasi experimental and this made the sample size of 100 adequate.

Instrument for Data Collection:

A researcher made Mathematics Achievement Test (MAT) r=.086 containing 30 items was prepared using the geometry and trigonometric content of the mathematics curriculum for Junior Secondary Three (JSS 3).

The level of mathematics attainment by learners prior to the experiment is an important secondary variable in the present study. The researchers appreciated the fact that there are specific abilities among learners such as reasoning, mental and cognitive abilities (Cognitive abilities, 2007; Three types of learning abilities, 2020). However, it makes sense to use the level of knowledge attainment in a study, especially in mathematics.

The procedure for determining the level of mathematics attainment includes the collection of cumulative scores of students in their mathematics tests from the previous year's up to the time researchers were about to introduce treatment. Students' ability in this wise is the procession of skills and proficiency to do mathematic. The attendant benefit of the cumulative scores, which is determined on ex-post facto basis, is that the average scores are used to rate learners' ability on a 3-scale, and hence determine who among the learners may be classified or rated as low, average or high achievers prior to treatment.

The essence of the ratings is to enable the researchers check for 'level up' of achievement between initial gaps or disparity at the end of the study. Students whose cumulative scores are around the 'mean' are classified as 'average' ability level; those who are one standard deviation above the 'mean' as classified as high; while those who are one standard deviation below the 'mean' are classified as low ability level of students.

Method of Data Analysis:

The data obtained from the study were analyzed using mean, standard deviation and analysis of covariance (ANCOVA). The mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The choice of ANCOVA was informed by the use of pre-test as covariate to control for the effects of students initial individual difference other than ability level.

Results

Research Question One:

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What is the difference between the mean achievement scores of students when taught trigonometric ratios using activity-based learning method and lecture method?

Research question one is answered from Table 4.1. The mean posttest scores on the table are derived from using pretest scores as covariate with posttest scores.

Table 4.1: Descriptive of mean achievement scores of all students by methods

Methods	N	$\bar{X}$	S.D	Observed Difference
Experimental	50	17.808[a]	.419	6.413
Control	50	11.395[a]	.428	

a. Covariates appearing in the model are evaluated at pretest scores of mean 8.18.

On Table 4.1, the mean score of 50 students taught trigonometric ratios through the use of Activity Based Method is 17.808[a] with a corresponding standard deviation of 0.419, while the 50 students taught trigonometric ratios through the use of lecture method had a mean score of 11.395[a] with a corresponding standard deviation of 0.428. This shows that students taught trigonometric ratios using Activity Based Method performed higher than those taught using Lecture Method with the mean difference of 6.413. Also, the standard deviations 0.419 (experimental) and o.428 (control group) are very close indicating that the intact groups are homogeneous and similarly compact within the groups.

Research Question Two

What is the difference between the mean achievement scores of male and female students when taught trigonometric ratios with Geotrigmetric sets using activity-based learning method?

Table 4.2: Mean and standard deviation of students' posttest scores among experimental group by gender.

Gender	**N**	$\overline{X}$	**S.D**	**Observed Difference**
Male	23	14.128[a]	.468	0.946
Female	27	15.074[a]	.394	

a. Covariates appearing in the model are evaluated at pretest scores of mean 8.18.

As shown in Table 4.2, the mean achievement score of 23 male students taught trigonometric ratios using activity based method is 14.128[a] with corresponding standard deviation of 0.468 while that of the 27 female students is 15.074[a] with a standard deviation of 0.394. This indicates that the difference in mean scores between male and female students is 0.946. The two groups are identically sparse, i.e. 0.468 and 0.394 are the measures of dispersion among gender groups. The groups are about the same in homogeneity.

Research Question Three:

What is the difference among the mean achievement score of students by ability level when taught trigonometric ratios with Geotrigmetric set using activity-based learning method?

Table 4.3: Description of Mean Scores and Standard Deviation among Students in Experimental Group, by Ability Levels

Ability Level	**N**	$\overline{X}$	**S.D**	**Observed Difference**		
				|A-B|	|A-C|	|B-C|
A. High	12	14.348[a]	.588	.400		
B. Average	18	14.748[a]	.492		0.359	
C. Low	20	14.707[a]	.465			0.041

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a. Covariates appearing in the model are evaluated at pretest scores of mean 8.18.

As shown on Table 4.3, the mean achievement scores of students with high, average and low mathematics initial ability levels, taught trigonometric ratios using activity based method are 14.348[a], 14.748[a], and 14.707[a] respectively. The corresponding standard deviation are .588, .492 and .465 respectively. The difference between the mean score of High and Average Ability level students is 0.400, that between High and Low is 0.359 and between Average and Low is 0.041.

Testing of the Null Hypotheses:

The hypotheses were tested using Analysis of Covariance (ANCOVA).

Table 4.4: ANCOVA of Achievement Scores by Group, Gender and Ability Levels

Source	Type III sum of squares	df	Mean square	F	Sig. p≤.05
Corrected Model	2442.206[a]	12	203.517	25.180	.000
Intercept	671.633	1	671.633	83.096	.000
Pretest (as covariate)	777.337	1	777.337	96.174	.000
Method	922.883	1	922.883	114.182	.000
Gender	18.510	1	18.510	2.290	.134
Ability	2.559	2	1.279	0.158	.854
Error	703.184	87	8,083		
Total	24725.000	100			
Corrected Total	3145.390	99			

a. R squared=.776 (Adjusted R. square=.746); b. Covariates appearing in the model are evaluated at pretest scores of mean= 8.18.

Table 4.4 refers to the tests of hypotheses one, two and three.

Hypothesis One

There is no significant difference between the mean achievements score of students when taught trigonometric ratios using activity-based learning method and lecture method.

On Table 4.4, the calculated F-value for method is 114.182 and the corresponding p-value is 0.000. The result shows that, the computed p-value is less than the alpha value (p≤.05). Therefore, the null hypothesis which stated that there is no significant difference between the mean achievements score of students when taught trigonometric ratios using activity-based learning method and lecture method cannot be upheld and is subsequently rejected. This can only be attributed to the effect of the Geotrigmetric sets.

Hypothesis Two

There is no significant difference between the mean achievement score of male and female students when taught trigonometric ratios with Geotrigmetric sets using activity-based learning method.

On Table 4.4, the calculated F-value for gender is 2.290 and the corresponding p-value is 0.134. The computed p-value is greater than the alpha value (i.e. p>.05). Therefore, the null hypothesis which stated that there is no significant difference between the mean achievement score of male and female students when taught trigonometric ratios with Geotrigmetric set using activity-based learning method cannot be rejected, and is therefore retained at 0.05 level of significance. The Geotrigmetric sets enhanced the achievement of both boys and girls.

Hypothesis Three:

There is no significant difference between the mean achievement score of students by ability levels when taught trigonometric ratios with Geotrigmetric set using activity-based method.

As shown on Table 4.4, the calculated F-value for ability levels is 0.158 and the corresponding p-value is 0.854. The computed p-value 0.854 is greater than the alpha value (i.e. p>.05). Therefore, the null hypothesis which stated that there is no significant difference between the mean achievement score of students by ability level cannot be

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rejected at the 0.05 level of significance. In other words, there is no significant difference among the mean achievement scores of high, average and low ability students when taught trigonometric ratios using Activity Based Method. This can only be attributed to the choice of activity-based learning method and the use of the Geotrigmetric sets.

Summary of Findings:

1. There is a significant difference between the mean achievement scores of the group who were taught trigonometric ratios using Activity-Based method of learning with the geotrimetric sets.

2. There is no significant difference between the mean achievement scores of male and female students when taught using ABL method of learning with the geometric sets. In other words, the ABL method and the instructional material enhanced the achievement of male and female students.

3. There is no significant difference between the mean achievement scores of students by ability levels when taught trigonometry using ABL method with the geotrigmetric sets.

The initial gaps between the levels had to be bridged. This can only be attributed to the choice of method and instructional material.

Discussion of Findings:

Effect of Activity-Based Learning Method on Students' Achievement by Method Groups

The study showed that there is a significant difference between the achievement scores of students taught trigonometric ratios using Activity-Based Learning Method and those taught with Lecture Method. The observed effects of Activity-Based Learning Method on students' achievement in the concept of trigonometric ratios can only be attributed to the facts that the Activity-Based Learning Method stimulated, and encouraged the students to take active part in the learning process. This finding agrees with the findings of Smith and Welliver, 1990; and Uchebo (2011) that Activity-Based Method of Teaching enhances students' achievement and aids retention of knowledge. It also agrees with Celik (2018) who reported an enhanced Achievement and Attitudes of sixth Grade students towards Mathematics when taught using Activity-Based Learning Method.

Effect of Activity-Based Learning Method on Students' Achievement by Gender

The study showed that there was no significant difference between the mean achievement scores of male and female students taught trigonometric ratios using activity based method. The non significance difference between the achievement scores of male and female students could only attributed to the use of hands-on activities which the instructional material (i.e. the Geotrigmetric) offered both male and female students. Female students usually excel with hand-on activities, and the study has indicated that the Activity-Based Learning Method had good effects on females. This also agrees with the findings of Popoola (2014) that gender is not a significant determinant of students' performance in mathematics.

Effect of Activity-Based Learning Method on Students' Achievement by their Ability Levels

This study showed that there is no significant difference between the achievement scores of high, average and low ability level students when taught trigonometric ratios using activity-based learning method. The results of this study corroborates Awodeyi and Udoh (2017); and Thiyagu (2018) that appropriate choice of methods of teaching and instructional materials had more and far reaching effect on students ability levels. For example, students who were initially categorized as low ability level in mathematics learning were able to find themselves at the same levil with their counterparts who were initially categorized as high ability level students. In other words, the initial gaps between students groups were effectively bridged. This is a feat that can only be attributed to the hands-on resource material and the Activity- Based Learning (ABL) method.

Conclusion

Based on the findings, it was concluded that the Geotrigmetric set which was used to generate learning activities for the lesson is effective in facilitating students' academic achievement in trigonometric ratios. The Geotrigmetric sets also enhanced student's achievement by gender. It also bridges the initial gaps between students of different academic ability levels.

5.4 Recommendations

Based on the findings of the study, the following recommendations were made:

i. Students will acquire the required knowledge and skills of mathematics, as stated in lesson objectives, when a topic like trigonometric ratios and also geometry are taught using Activity- Based Learning (ABL) method, and with the choice of good instructional material like the Geotrigmetric sets.

ii. Mathematics teachers should use Activity-Based Learning Methods in teaching the concept of trigonometric ratios and other related concepts in geometry. The teachers should select appropriate instructional materials like the Geotrigmetric sets to generate classroom activities.

iii. Government and school proprietors should see the need to provide schools with adequate instructional material like the Geotrigmetric sets in their mathematics laboratotries for use by students. They should also organize workshops for teachers of mathematics, where activity-based learning methods will be introduced to teachers for their implementation in schools.

iv. Curriculum planners should emphasize activity-based learning when reviewing mathematics curriculum for schools. Text book writers should apply the use of activity based learning method in designing and structuring their text books

v. The society will benefit whenever mathematics is adequately taught and student's knowledge of mathematics is enhanced. Therefore, the time to improve on the quality of mathematics teaching in schools is now.

REFERENCES

Activity-Based Teaching Method (2012). Retrieved on 17th November, 2021 at *iveportfolio.blogspot.com*

American Association for the Advancement of Science (AAAS, 2001). Retrieved on 15th November, 2021 from: http://hrmars.com.

Awodeyi, A. F. and Udoh, R. J. (2017). Method combination therapy as instructional strategy for teaching secondary school Geometry and effects on students' achievement and retention in mathematics. *Mathematical Theory and Modeling*, 7(2), 33-50.

Azuka, B. F. (2013). Activity-Based Learning Strategies in the mathematics classroom. *Journal of Education and practice. Retrieved 18th November, 2021 from semanticscholar.org*

Cognitive Abilities, (2007). Merriam-Webster, Incorporated. Retrieved at wordcentral.com on 9th July, 2020.

Federal Government of Nigeria (FGN, 2013). National Policy on Education (NPE). National Education Research and Development Council (NERDCl: Lagos-Nigeria) https://sphero.com, on 8th December, 2020.

Oribhabor, C. B. (2020). Evaluating the effect of activity-based method of teaching Mathematics on Nigerian Secondary School Students Achievement and Retention in Mathematics. *Journal of Puissant: A Multidisciplinary Journal*,(1), pp. 77 – 87.

Real life application of trigonometry (2017). Retrieved July 2021 at https://www.mathnasium.com

Smith, K. A. & Wellive, P. W. (1990). The Development of a Science Process assessment for fourth-grade students. Retrieved on 9th July, 2020 from https://doi.org/10.1002.

Thiyagu, K. (2018). Activity-Based approach of learning mathematics. Retried on 17th November, 2021 from *slideshare.net* Three types of learning abilities, 2020. Three types of learning abilities. Retrieved at

Uchebo, R. M. (2011). The Geotrigmetric set: An innovation for practical teaching and learning of basic geometry and trigonometry (manual and workbook). African First Publishers Plc, Onitsha, Nigeria.

West African Examinations Council (WAEC), (2020). WAEC Nigeria Chief Examiner's Reports Checker [2008-2018] on Mathematics. Retrieved from https://www.lasu-info.com in July 2021.