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APPLICATION OF GEOTRIGMETRIC SET AND GEOBOARD ON STUDENTS` RETENTION IN MATHEMATICS IN RIVERS STATE NIGERIA.

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ABSTRACT
The study investigated the application of geotrigmetric set and geoboard on students` retention in mathematics in Rivers State. The research design adopted for the study was quasi-experimental. Intact classes of (144) JSS1 students formed the sample of the study. Simple random sampling technique was used to select the sample of the study. Three research objectives, questions and null hypotheses guided the study. The research instrument used for the study was Mathematics retention Test. The reliability of the research instrument was computed using Kuder Richardson formula (KR -21) which yielded the reliability coefficient of 0.84. The instrument was administered and the data obtained were analyzed using Analysis of Covariance to test the hypotheses while mean and standard deviation were used to answered research questions. The findings established that the use of Geotrigmetric set and Geoboard respectively enhanced the retention of students in mathematics than deductive teaching method. However, the use of geoboard was found to be most effective than the use of geotrigmetric set. The study among others recommended that Mathematics teachers should use Geotrigmetric set and Geoboard in teaching Mathematics to help solve the problem of students` poor retention in Mathematics

Key words: Geotrigmetric set, Geoboard and Retention.

Introduction

Mathematics is an indispensable tool for development. It resolves truths uncovers errors. It makes our work more credible. Many professions such as engineering, medicine, physics, nurses, computer science, actuarial science require Mathematics proficiency. Virtually all fields benefit from the analytical and problem-solving skills students learn in Mathematics (Mamman & Isa, 2018). Yet, Mathematics is often perceived by majority of students as a difficult subject. In view of this, Mathematics teachers around the world are facing difficult times in trying to reverse this trend. Imparting the desired Mathematical knowledge to students in classrooms has been quite challenging. Expectations of students nowadays goes beyond what was required in the past. It is therefore worthy to note that teachers are facing enormous challenges in familiarizing themselves with the use of hands-on methods of teaching mathematics.

Mathematics is an activity subject. Hence, the way it is being thought is

important in aiding the students acquire basic mathematical knowledge, skills and attitude that will improve their retention of mathematical concept in other to solve different problems in life **(**Ehiwario, Aghamie & Azagbaekwue, 2018). Retention of mathematical knowledge and skill means acquiring the knowledge and skills which will be used later. Retention of mathematical knowledge is very important because it aids the students to continue to process the learnt knowledge which will be used later by transfer. Retention takes place when information is stored in the long-term memory for retrieval. It therefore, follows that, Mathematics education can be enhanced if abstract teaching is discouraged. When students are involved in various activities in the class as part of the mathematics lesson, the effect of the lesson is greater than the one found in rote learning. White (2012) asserted that making Mathematics relevant is a significant practice that allows students to develop connection with content. Using teaching methods that concentrate on hands-on and demonstration of facts and formulas rather than the memorization can help students make connection, improve in the retention of Mathematics concept learnt, since they understand the concepts better. However, the use of deductive teaching methods in teaching mathematics, characterized mostly by teacher-led instruction and negligible student investigation, lacks the element of students` discovery and self-sufficiency. For students to improve in the retention of mathematical content learnt, the use of geotrigmetric set and Geoboard to support learning and activities that involve students experimenting and discovering findings is required, therefore making students to be more involved and engaged in their learning. In contrast, in deductive method of teaching of Mathematics, students take more of an inactive role in the teaching and learning process, as the teacher typically imparts information to the students, while students then use memorization and repetition to master skills and concepts. Much of the exercise is rote and calls for little abstract thinking on the part of the student.

The geotrigmetric set can be used to teach practical activities on concepts such as trigonometric ratios, sine rule, cosine rule, Pythagoras theorem, angles, drawing and verification of properties of polygons, parts of a circle, verification of circle theorems and bearing (Uchebo, 2012). The activities are carried out by either observing the geotrigmetric set or suspending one or two of the pointers to form the desired polygon or concept. The geotrigmetric set is made up of the following components: Geotrigmetric template or stencil, a protractor, 2 pointers, 45^0 set square, 30^0 set square, thread lace, pair of compass, 15cm rule, instruction leaflet, pairs of cut polygon cards labeled a_1, $b_2$and c_3, pencils, eraser and sharpener. All the components aid in the teaching of the aforementioned Mathematics concepts.

The Geoboard on its own does not make any impression with respect to the teaching of Mathematics concepts except when rubber bands are wrapped around the pegs or nails to explore a variety of mathematical concepts. Students stretch rubber bands from peg to peg to form

geometrical shapes. The Geoboards are available in a variety of shapes, sizes, designs and colour (Inyang 2017). The platform or board of the Geoboard can be designed with plywood or plastic using brass nails or pegs. The shape of the board ranges from square, rectangle, circle, triangle or heart. The sizes can be in 3X3 pin board, 4X4 pin board,15X15 pin board and so on.

The Geoboard is capable of been used to teach a good number of topics in Mathematics. The basic geometrical concepts which can be explored using the Geoboard are properties of 2-dimensional objects, areas and perimeters of 2-dimensional shapes, translation, rotation, reflection. Chalker (2016) carried out a study on relative effectiveness of using manipulative to explore Mathematics concepts and found out that Geoboards can be used to teach Mathematics concepts such as coordination, patterns, scaling, positions, similarities, counting, congruence and classification. In addition, Odili (2006) pointed out that geoboard could be used to estimate the area of irregular and regular plane shapes, identify different plane shapes, to draw plane shapes and also to present data in pictorial form. Students have to practically manipulate the geoboard in order to explore the required mathematical concepts.

The saying that change is permanent perhaps expresses the dynamism of society but underscores its coefficient. Society is changing so rapidly that benchmarks and standards are eroded sooner or later. The dynamism of society cuts across all spheres of life including education. Teachers, educational planners and administrators are faced with the challenges of keeping abreast with the demands of a rapidly changing society and are constantly searching for new and innovative ways of making teaching effective. The mathematics teacher who is the classroom implementer of the mathematics curriculum is faced with the challenge of selecting the appropriate teaching method that will yield high performance, retention and meaningful learning in the students. The study therefore sought to find out if the use of Geotrigmetric set and Geoboard which students manipulate during classroom instruction could enhance the retention of students in mathematics.

Statement of the problem

The imperative of Mathematics cannot be over underlined, this is why, the learning of mathematics is unavoidable in the school curriculum from primary to tertiary level of education. Imperative of mathematics notwithstanding the performance of the subject is constantly poor. Mathematics is a subject whose nature encompasses abstraction which requires demystification. Observation showed that Mathematics teachers who are expected to employ appropriate hands-on teaching method in carry out classroom instruction for content elucidation, do not do so. Could this be one of the reasons for the observered students' poor academic performance in Mathematics examination (internal and external), which has continuously been poor at the junior secondary school level? It is also, evident that this poor performance has an upsurge in the

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senior secondary school as can be seen in the West African Examination Council (WAEC) Chief Examiners` reports of 2013-2018 as cited by (Usman & Musa, 2019). In order to solve the problem of poor acadenmic performance in Mathematics which might be attributed to poor retention, the methods and approaches of delivering mathematics lessons need to be investigated and improved upon. This observed students' poor academic performance in Mathematics examination (internal and external) over the years of my teaching Mathematics prompted the investigation of this study on effects of geotrigmetric set and geoboard on students' academic performance and retention in Mathematics. Therefore, the gap of this study is how to provide empirical evidence on the efficacy of the use of geotrigmetric set and Geoboard in solving the problem of poor students` retention in Mathematics in Rivers state.

Research Questions

The following research questions guided this study.

1: What is the difference in the mean retention scores of students taught mathematics with Geotrigmetric set and those taught using deductive teaching method?

2. What is the difference in the mean retention scores of students taught mathematics with Geobaord and those taught using deductive teaching method?

3: What is the difference in the mean retention scores of students taught mathematics with Geotrigmetric set and Geobaord and those taught using deductive teaching method?

Hypotheses:

The following null hypotheses were formulated and tested at 0.05 significant level.,

H_{01}: There is no significant difference in the mean retention of students taught mathematics with Geotrigmetric set and those taught using deductive teaching method

H_{02}: There is no significant difference in the mean retention of students taught mathematics with Geobaord and those taught using deductive teaching method.

H_{03}: There is no significance difference in the mean retention scores of students taught mathematics with Geotrigmetric set and Geobaord and those taught using deductive teaching method.

Research Method

This study is quasi-experimental research, structured as pretest-posttest non-randomized design. Intact classes were used. The pretest-posttest control group design was used to investigate application of Geotrigmetric set and Geoboard on Students` Retention in Mathematics in Oyigbo Local Government Area of Rivers State. The study was carried out in Oyigbo Local Government Area in Rivers State. The population of this study consisted of all the JSS1 students in the seven mixed government junior secondary schools in Oyigbo Local Government Area of

Rivers State. As at the time of the study (2021/2022 academic session) there were three thousand four hundred and fifty-one (3451) students made up of one thousand seven hundred and seventy-seven females (1777) and one thousand six hundred and seventy-four males (1,674), (Source, Zonal Post-primary School Board, Oyigbo Education Zone). Intact classes comprising of a total of one hundred and forty-four (144) Jss1 students formed the sample of the study. Simple random sampling technique was used to select three junior secondary schools in Oyigbo Education Zone of Rivers State; in which one school was used as experimental group 1, the second school as experimental group 2 and the third school as control group. Simple random sampling technique was also used to select one arm of Jss1 classes in each school. The experimental groups consisted of ninety-two (92) students made up of forty-five (45) females and forty-seven (47) males. The control group was made of fifty-two (52) students made up of thirty-one (31) females and twenty-one (21) males. The researchers developed instrument titled "Mathematics retention Test (MRT) which was used to collect data. (MRT) was made up of twenty-five multiple choice test items with options A to D. Each test item was allotted 4marks to give a total of 100% for the 25 items. The content of the test items was derived from the topics that were taught. The instrument contained 2 sections. Section A elicited information on the students' personal data. Section B contained 25 test items which measured students' retention in mathematics. The instrument was used for pre-test, post-test and post post-test. The items of the instrument were re-shuffled before the administration of posttest and post post-test to reduce memory effect. The students were required to answer all the questions from each section. To establish whether the test items in (MRT) addressed the topic of the research, the instrument was presented to one research expert in department of Curriculum Studies and Educational Technology and two research experts in measurement and evaluation in University of Port Harcourt to vet the content and errors in grammar, spellings, eliminate ambiguity and ascertain proper coverage of the instrument. The inputs were corrected at the final construction of the instrument. The reliability of (MRT) was established by carrying out a trial testing on a sample of 20 students who were not part of the sample for this study. The students were administered MRT once without any form of teaching with regards to the study. The answer scripts were retrieved, marked and graded in percentage. Reliability was computed using Kuder Richardson formula (KR - 21) which yielded a reliability coefficient of 0.84. This reliability index showed that MRT was reliable for the conduct of the investigation. The instrument was used to generate data on three different times during the study, namely pretest, posttest and post post-test. Participants of the experimental groups and the control group were given pretest before treatment, posttest after treatment and post post-test after two weeks of writing post-test respectively. The results of the test formed part of the data of this study. The researchers employed the intact classes Mathematics teachers as assistant researchers to deliver the lessons.

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These teachers were trained for two days by the researcher on the modality of the instruction. The students in the three different groups were first given a pretest of (MRT) without any form of prior teaching. After the pretest, the research assistants taught their respective group with the assigned lesson plans. The students in the experimental groups were taught with Geotrigmetric set and Geoboard respectively, while the control group was taught with deductive method. A posttest of (MRT) was given to the three groups after the teaching which lasted for a period of six consecutive weeks. The posttest was administered to the same students but this time, the test items was reshuffled starting with even number item from the bottom. Post post-test was also given to the students two weeks after the post-test but the test items was reshuffled starting with odd number item from the bottom. The scripts for both pretest, posttest and postpost-test were collated, marked and graded in percentage. The research questions were answered using mean and standard deviation, while Analysis of Covariance (ANCOVA) was used for the testing of the hypotheses. This was used to take care of the initial differences in the groups and to control selection bias. $P \leq 0.05$ level of significance was set for rejecting or accepting the null hypotheses

Presentation of Results

The results of the study were presented based on the research questions and hypotheses

Research Question 1: What is the difference in the mean retention of junior secondary school one students taught mathematics with Geotrigmetric set and those taught using deductive teaching method?

Table 1: Mean retention of students in experimental group and control group.

Groups	Methods		Post_test	Retention Test	Mean Gain	% mean Gain
Experimental Grp	GTS	Mean	69.23	69.54		
		N	26	26	0.31	0.45
		SD	11.64	9.80		
Control Grp	DM	Mean	33.15	29.29		
		N	52	52	-3.86	-13.20
		SD	9.28	11.86		

Table 1, shows that students taught mathematics with Geotrigmetric set had a mean gain of 0.31 and percentage mean gain of 0.45, while those taught using the deductive method had a mean gain of -3.86 and percentage mean gain of (-13.20), when the posttest and posi post-test test were compared. It was empirically established that students taught with Geotrigmetric set had higher retention than their counterparts taught with the deductive method.

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Research Question 2: What is the difference in the mean retention scores of Mathematics students taught with Geoboard and those taught using deductive teaching method?

Table 2: Descriptive statistics on mean retention scores of Mathematics students based on the use of Geoboard and Deductive method.

Methods		Post_test	Retention_test	Mean difference	Mean difference %
GB	Mean	69.30	72.30	3.00	4.15
	N	66	66		
	SD	11.81	11.43		
DM	Mean	33.15	29.29	-3.87	-13.20
	N	52	52		
	SD	9.28	11.86		

Table 2, shows that students taught mathematics with Geoboard had a mean difference of 3.00, while those taught using the deductive method had a mean difference of -3.87 when the posttest and post post-test test were compared. The percentage mean difference also indicated 4.15 for the students taught with Geoboard while students taught with deductive method had a percentage mean difference of (-13.20). This indicated a difference in favour of the use of Geoboard.

Research Question 3: What is the difference in the mean retention score of students taught geometry with Geotrigmetric set and Geobaord (experimental group1 and 2) and those taught using deductive teaching method (control group)?

Table 3: Mean and standard deviation on mean retention scores of the three groups (experimental group1 (GTS), experimental group 2 (GB) and control group (DM)).

		Post-test		Post Posttest		Retention	
Group	**N**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**SD**
GTS	26	69.23	11.64	69.54	9.80	0.31	10.67
GB	66	69.30	11.81	72.30	11.43	3.00	10.16
DM	52	33.15	9.28	29.29	9.28	-3.86	10.91

Key: GTS= Geotrigmetric Set, GB= Geoboard and DM= Deductive Method

Table 3, shows that the mean retention of students taught mathematics geometry with Geotrigmetric Set in experimental group 1 was 0.31, SD = 10.67 and students taught with Geoboard in experimental group 2 had a mean retention of 3.00, SD = 10.16 while those taught using the deductive method (control group) had a mean retention of -3.86, SD = 10.91.Based on

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the analyzed data in table 3, students that were taught mathematics with Geotrigmetric Set in experimental group 1and students taught mathematics with Geoboard in experimental group 2 had higher retention than those taught with the deductive method. The data in table 3 also revealed that students taught with Geoboard in experimental group 2 retained higher than students taught with Geotrigmetric Set in experimental group 1. Fig 1, displayed the graphical plot of the difference in the mean retention score of students taught geometry with Geotrigmetric set and Geobaord (experimental group1 and 2) and those taught using deductive teaching method (control group).

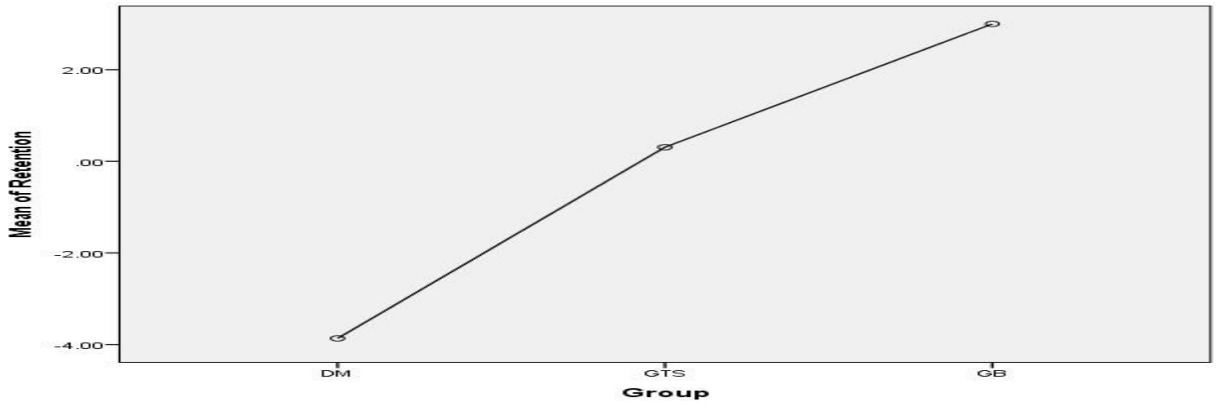


Fig 3: Mean plot on the difference in the mean retention scores of the three groups (experimental group1 (GTS), experimental group 2 (GB) and control group (DM)).

The graphical plot of the difference in the mean retention of students shows that the students taught using Geotrigmetric set had the value of 0.50, while those taught using Geoboard had the value of 2.00 and those taught using deductive teaching method had the value of -4.00. This shows that the students taught using Geoboard had higher retention than those taught using Geotrigmetric set and both mathematical manipulative had higher retention than those taught using deductive teaching method.

Test of Hypotheses

Hypothesis H_{O1}: There is no significant difference in the mean retention scores of junior secondary school one students taught mathematics with Geotrigmetric set and those taught using deductive teaching method.

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Table 4: Summary of ANCOVA of retention of students in experimental group and control group.

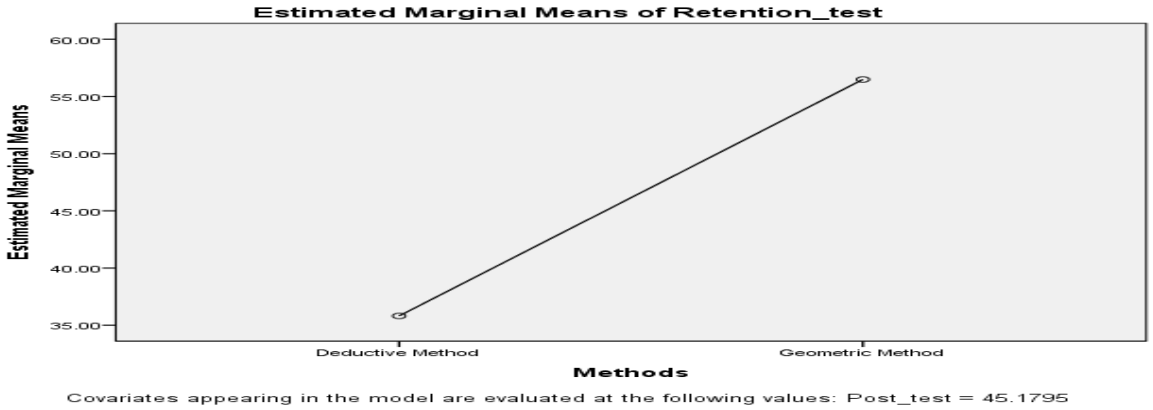
Tests of Between-Subjects Effects

Dependent Variable: Retention_test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	30371.84[a]	2	15185.92	156.23	.00	.806
Intercept	1332.31	1	1332.31	13.71	.00	.155
Post_test	2290.76	1	2290.76	23.57	.00	.239
Methods	**1899.43**	**1**	**1899.43**	**19.54**	**.00**	**.207**
Error	7290.37	75	97.21			
Total	179913.00	78				
Corrected Total	37662.22	77				

*Significant at P< 0.05

Table 4 revealed summary of Analysis of Covariance of students' retention based on the two methods, using post-test scores as a covariate, $F_{1,75}$ = 19.54 at (75) degree of freedom and probability level of 0.05 with p = 0.00, P < 0.05. The null hypothesis is rejected and the alternative hypothesis is retained. This indicated that there is significant difference between the mean retention scores of students taught with Geotrigmetric set and those taught using deductive teaching method in favour of Geotrigmetric set. Partial Eta Squared value is 0.207. The effect size is 20.7%. This means that 20.7% of all variance in retention is attributed to the methods. Hence geotrigmetric set had low effect on the mean retention of students. Fig 2 displayed the graphical plot of the difference in the mean retention scores of students taught with Geotrigmetric set and those taught using deductive teaching method in favour of Geotrigmetric set.



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The graphical plot of the difference in the mean retention of students shows that the students taught using Geotrigmetric had the value of 55.50 set and those taught using deductive teaching method had the value of 35.00. This shows that the students taught using Geotrigmetric set had higher retention than those taught using deductive teaching method.

H_{02}: There is no significant difference in the mean retention scores of students taught mathematics with Geoboard and those taught using deductive teaching method.

Table 5: Summary of ANCOVA of retention of Mathematics students base on the use of Geoboard and Deductive method.

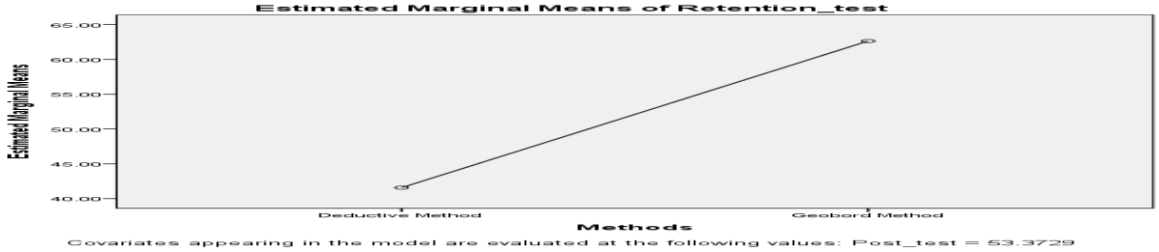
Tests of Between-Subjects Effects

Dependent Variable: Retention test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	58778.35[a]	2	29389.17	315.74	.00	P < 0.05
Intercept	1901.58	1	1901.58	20.43	.00	P < 0.05
Posttest	4964.20	1	4964.20	53.33	.00	P < 0.05
Methods	**3371.67**	**1**	**3371.67**	**36.22**	**.00**	**P < 0.05**
Error	10704.41	12	93.08			
Total	405305.00	118				
Corrected Total	69482.75	117				

*Significant at P< 0.05

Table 5, shows that using post-test scores as a covariate, $F_{1,115} = 36.22$ at (115) degree of freedom and probability level of 0.05 with p = 0. 00 which is P < 0.05. The null hypothesis is rejected and the alternative hypothesis is retained. This indicated a significant difference in favour of experimental group 2. Fig 3 displayed the graphical plot of the difference in the mean retention scores of students taught with Geoboard and those taught using deductive teaching method in favour of Geoboard.



The graphical plot of the difference in the mean retention of students shows that the students taught using Geoboard had the value of 65.50 set and those taught using deductive teaching method had the value of 45.00. This shows that the students taught using

Geoboard set had higher retention than those taught using deductive teaching method.

H_{03}: There is no significance difference in the mean retention scores of students taught mathematics with Geotrigmetric set and Geobaord (experimental group1 and 2) and those taught using deductive teaching method (control group).

Table 6: Summary of ANCOVA on the difference in the retention mean scores of on the three groups (experimental group1 (GTS), experimental group 2 (GB) and control group (DM)

Dependent Variable: PostPostTest

Source	Type III Sum of Squares	df	Mean Square	F	p-value	Partial Eta Squared
Corrected Model	64921.86[a]	3	21640.62	241.44	.00	.84
Intercept	2907.46	1	2907.46	32.44	.00	.19
PostTest	5522.50	1	5522.50	61.61	.00	.31
Group	**4447.95**	**2**	**2223.98**	**24.81**	**.00**	**.26**
Error	12548.57	140	89.63			
Total	533433.00	144				
Corrected Total	77470.44	143				

a. R Squared = .838 (Adjusted R Squared = .835)

Table 6 showed the Summary of ANCOVA on the difference in the mean retention scores of Mathematics students taught geometry based on the three groups (experimental group1 (GTS), experimental group 2 (GB) and control group (DM)). The result showed that there is a significant difference in the retention of students taught geometry with Geotrigmetric set and Geobaord (experimental group1 and 2) and those taught using deductive teaching method in control group. ($F_{2, 140}=24.81$, $p < 0.05$). The null hypothesis three, H_{O3} was rejected at significant level of 0.05since p value is less than 0.05. Partial Eta Squared value is 0.26. The effect size is 0.26 which is medium effect. This means that 0.26 of all variance in retention were attributed

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to the methods. Hence geotrigmetric set and Geoboard had medium effect on the mean retention of students.

Table 6a: Summary of Post Hoc Test on the mean retention scores of the three groups (experimental group1 (GTS), experimental group 2 (GB) and control group (DM)).

Dependent Variable: Post Posttest
Scheffe: Multiple Comparisons

(I) Methods	(J) Methods	Mean Difference (I-J)	Std. Error	Sig.	95 % Confidence Interval Lower Bound	Upper Bound
DM	GS	40.25*	2.72	.00	46.98	33.52
	GB	43.02*	2.10	.00	48.21	37.82
GS	**DM**	**40.25***	**2.72**	**.00**	33.52	46.98
	GB	2.76	2.62	.58	9.25	3.72
GB	**DM**	**43.01***	**2.10**	**.00**	37.82	48.21
	GS	**2.76**	**2.62**	**.58**	3.72	9.25

* The mean difference is significant at the 0.05 level.

Table 6a showed the summary of Post hoc test on the difference in the mean retention scores of Mathematics students based on the three groups (experimental group1 (GTS), experimental group 2 (GB) and control group (DM)).Table 6a indicated that the test between GTS and DM was statistically significant (DM = 40.25, p <.05) and in favour of GTS, that between GB and DM was also statistically significant (43.01, p <.05) and in favour of GB, however, that between GS and GB was statistically not significant (DM = 2.76, p > .05) though in favour of GB.

Discussion

The analysis of the results of the students' academic retention tested in Table 1 and Table 4 showed that the students taught with Geotrigmetric set had higher mean retention scores in post post-test than the students taught with deductive teaching method. The analysis of covariance presented in Table 4 confirmed that there is a significant difference between the mean retention of students taught with Geotrigmetric set and students taught with deductive teaching method. This significant difference is attributed to the treatment in the experimental group. This revealed that application of Geotrigmetric has positively influence students` retention ability in mathematics.

This finding is in consonance with the research work of Apondi (2015) and White (2012) which revealed that the experimental group who utilized hands-on learning and manipulative during their Mathematics lesson retained better than control group. The results of Chikwere and Ayama (2015) and Malakai (2015) agrees with this finding which revealed that there is a significant difference in the retention of students taught mathematics concepts with manipulatives than those who were taught without manipulatives. But the result of Kazim (2018) are contrary with this finding since the result revealed there was no significant difference in both group with respect to retention.

The analysis of the results of the students' retention tested in Table 2 and Table 5 showed that the students taught with Geoboard had higher mean retention scores in post post-test than the students taught with deductive teaching method. This significant difference is attributed to the treatment in the experimental group. This revealed that application of Geoboard has positively influence students` retention ability in mathematics. This finding supports the research work of Ehiwario, Aghamie and Azagbaekwue (2018) and Albert (2018). The result in table 3 revealed that the students who were taught in experimental group 1 with GTS and those in experimental group 2 who were taught with GB had a higher retention than the students who were taught with using the deductive method in control group. The result in table 6 further revealed that the students in experimental group 2 who were taught with GB had a higher retention than those in the experimental group 1 who were taught with GTS. When subjected to statistical analysis, the result in table 6 showed that there is a significant difference in the retention of students taught with Geotrigmetric set and Geoboard and those taught with Deductive Method ($F_{2, 140}=24.81$, $p<.05$). This led to the rejection of H_{O3} at significant level of 0.05 since p value is less than 0.05. The scheffe post hoc test of multiple comparison in table 6a revealed that the use of GB was most effective. This result agrees with the findings of White (2012) which showed that students who were taught using hands-on learning and manipulatives gained a higher ability to transfer from the use of concrete manipulative to paper-and-pencil problem solving than the students who were taught with the traditional teaching method in the control group and that there was a significant difference between the two groups with respect to retention. This finding also agrees with the findings of Juomu, Khalid and Ogbuji (2014) whose result showed that students who were taught area of 2-dimensional shapes using geoboard demonstration and manipulation had a higher retention of the taught concept than the students in the control group who were taught same topic using the conventional teaching method in which no geoboard was used for demonstration and manipulation. When the hypothesis was subjected to statistical test, the result revealed that there was a significant difference between the retention of students in the experimental group and those in the control group. The research finding of Yale, Ugwu and Baleta (2015) is in line with this

very finding as it showed that students in the experimental group who were taught with geoboard had a higher retention than their control group counterpart and there was a significant difference between the two groups with respect to retention. The result of Agbarakwe (2017) and Kazim (2018) are in agreement with this finding since their results revealed that students that were taught trigonometric concept with geotrigmetric set had a higher retention than those who were taught without the geotrigmetric set, though there was significant difference in both group with respect to retention. The findings of Evweherhoro (2013), Chikwere and Ayama (2015) and Malakai (2015) agreed with this finding that there is a significant difference in the retention of students taught mathematics concepts with manipulatives than those who were taught without manipulatives.

Conclusion

The findings of this study, showed empirical evidence and established that using geotrigmetric set enhanced the retention of students in mathematics than the deductive method. It was also found that there was significant difference on retention with respect to use of geoboard and deductive method which is in favour of the use of geoboard. The findings further established and empirically proven that the use of Geotrigmetric set and Geoboard respectively enhanced the retention of students in mathematics than deductive teaching method. However, the use of geoboard was found to be most effective than the use of geotrigmetric set.

Recommendations

Based on the findings and conclusions of the study, the following recommendations were made by the researchers:

1. Mathematics teachers should ensure the active hands-on participation of students during mathematics classroom instruction.
2. Mathematics teachers should use Geotrigmetric set, Geoboard and other Mathematics manipulative materials in teaching Mathematics, since they improve retention
3. Mathematics curriculum designers should prescribe the use of Geotrigmetric set and Geoboard in teaching and learning of Mathematics.
4. Seminars, workshops and symposia should be organized by the Ministries of Education and professional bodies such as Mathematical Association of Nigeria (MAN), Science Teachers Association (STAN), Curriculum Organization of Nigeria (CON) and National Mathematical Centre (NMC) on how to integrate Geotrigmetric set and Geoboard in the teaching of Mathematics.

References

Mamman. M. A & Isa. S. G (2018) Effectiveness of geogebra software on performance and attitude in mathematics among senior secondary school students in municipal zonal education area of Kano State, Nigeria. ABACUS (Mathematics Education Series) 43(1), 138 – 147

Albert L. N (2018) Effect of Triangle Solver Game on Senior Secondary School Students' Achievement in Trigonometry. *Journal of the Mathematical Association of Nigeria (Mathematics Education Series)* 43 (1) 228 – 235.

Apondi, J. A. (2015) Impact of instructional materials on academic achievement in Mathematics in public primary schools in Siaya County, Kenya Retrieved on April 4, 2018 from *http://erepository.uonbi.ac.ke/bitstream/handlecfaf*

Chikwere, P. & Ayama, K. (2015) Teaching of geometric construction in Junior High School: *Intervention Journal of Elementary Education*, 26(1), 139-146

Agbarakwe G.G. (2017). Impact of geotrigmetric set on the performance and retention of students in geometry in Aguata Local Government Area of Anambra State. *Journal of Computer Science and Statistics Education*, 6(4), 18-25.

Chalker, S. (2016). Developing measures of teachers' Mathematics knowledge for teaching. *Advanced Elementary School Journal*, 74(1), 41-53.

Ehiwario, J.C, Aghamie, S.O & Azagbaekwue, A (2018). The effect of demonstration method on the teaching and learning of Mathematics in secondary schools in Ika South Local government. *Journal of the Mathematical Association of Nigeria (Mathematics Education Series)* 43 (1) 189 – 201.

Evweherhoro, A.G. (2013). Effect of the use of constructivist teaching approach on junior secondary school student's retention in Mathematics. *Journal of Readings in Mathematics Education*, 2 (1), 89-102.

Inyang, M. (2017). Teacher knowledge and teaching: Viewing a complex relationship from three Mathematical perspectives. *Journal of Research and Innovation*, 2, 49-68.

Juomo, C.A., Khalid, U.H. & Ogbuji, F. (2014). Effect of geoboard on the academic performance of public junior secondary students in area of 2-dimensional shapes. Journal of Mathematics Association of Cannaan City,7, 216- 230.

Kazim, R. (2018). Effect of geotrigmetric set on junior secondary school students' retention in trigonometry. *International Journal of Research and Innovative Learning*, 3(5), 13-21.

Malakai, E.A. (2015). *Research findings in mathematical Sciences and Mathematics education: Implications and way forward*. Beryl Printing Press.

Odili, G.A. (2006). *Mathematics in nigeria secondary schools: A teaching perspective.* Rex Charles & Patric Ltd.

Uchebo, R. M. (.2012) *The goetrigmeteric set*: Raybometer ventures Nigeria Ltd.

Usman, M. A. & Musa, D.C. (2019). Concept mapping instructional strategies and senior secondary school students` performance and interest in Algebra

in Bauchi State. *Journal of the Mathematical Association of Nigeria (Mathematics Education Series)* 44 (1) 236-241

West African Examination Council. (2013-2018). Chief Examiner's Report West African Examination Council. Lagos.

White, K. M. (2012) The effect of an instructional model utilizing hands-on learning and manipulatives on Mathematics achievement of middle school students in Georgia Retrieved on June 7, 2018 from *http://erepository.uonbi.ac.ke/bitstream/handleCFAf*

Yale, M.T., Ugwu, F. & Baleta, B. A. (2015). Effects of geoboard on students' retention in Mathematics in Sekondi. *Journal of Educational Assessment and Research Method*, 3, (*7*),57-63.