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GRAPH BOARD UTILIZATION AND JUNIOR SECONDARY STUDENTS' PERFORMANCE IN GRAPHICAL SOLUTION OF LINEAR EQUATIONS IN RIVERS STATE NIGERIA

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Abstract

This study investigated graph board utilization and junior secondary students' performance in graphical solution of linear equations. The study had three objectives. Quasi experimental design which presented two experimental groups and one control group was used. Purposive sampling technique was used to draw a sample of 163 students from a population of 5,452 Junior Secondary two (JS 2) students in public junior secondary schools in Obio Akpor Local Government Area of Rivers State Nigeria. Instrument used to collect data was Linear Graph Achievement Test which was of the multiple-choice type. The 25-item LGAT was validated by experts and had a reliability index of 0.82. Analysis of data was done using mean, standard deviation and Analysis of Covariance statistical tool at 0.05 significant level. The result showed that the use of graph board combined with the use of graph paper was more effective for the teaching of graphing concepts related to linear equation than the use of graph board only or use of graph paper only. The result also showed that there was a significant difference between students' performance in graphical solution of linear equation when taught with graph board combined with the use of graph paper and when taught with either graph board only or graph paper only. Based on the findings it was recommended that mathematics teachers should teach students graphing concepts with a combination of graph board and graph paper.

Keywords: Linear Equation, Graph Board, Graph Paper, Performance, Students.

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Introduction

Education in Nigeria and every other country place great importance in the teaching and learning of Mathematics due to its utilitarian nature. Kenba (2022) opined that Mathematics is the pivot which many other subjects revolve. It is also the subject that is primarily concerned with the processes, skills, creativity, logic and reasoning which lead to the solution of individual and societal problems. Lawan and Bolaji (2019) posited that Mathematics is a necessary and sufficient tool for the achievement of the developmental goals of any society. This is because the development of any nation depends on her scientific and technological advancements. Bouden (2015) summarized it all by stating that there can be no science and technology without Mathematics. Thus, Mathematics is important in the education of every child due to the fact that it is a subject that is applied to everyday activities of an individual. Mathematics education therefore is an indispensable tool to both individual and national development.

There is no one acceptable definition of Mathematics. The various definitions of Mathematics implies that it does not exclusively deal with number work or computations alone, but also deals with observations, generalization, analysis, relationships, development of logical and creative reasoning of whosoever that embraces it (George & Charles-Ogan, 2023). This may suggest why the subject is made compulsory in primary and secondary schools. It is also a tool that is used to unravel scientific phenomena. Mathematics also aids in resolving most real-life situations in the society.

There are so many events that are related in one way or the other. It is very important that the relationship between the variables be studied in order to observe patterns for generalizations and decision taking. The concept of relationship in Mathematics refers to the association of two or more variables, events, objects with respect to some properties they possess. In Mathematics, a relation is an association or connection between sets of values. Mathematical relation is between the x-values and y-values of ordered pairs. The relationship can either be none, positive or negative. The relationship can also form a pattern (repeated or non-repeated). Relationships in Mathematics can be computed using algorithms or plotted using graphs. The use of algorithms requires formula or mathematical rules to establish the relationship. Adjapong et al. (2021) posited that the use of algorithm does not expose students to the pictorial representation of data sets. Thus, mathematical relationships can be presented as tables, mappings or graphs.

The crucial need of representing information in an abridged form has paved way for the inclusion of graph work in the Mathematics curriculum. Mathematics teachers from time to time find themselves teaching Mathematics contents that are encapsulated in graphing. This is because the concept of graphing stretches its tentacles to all walks of life (Williams, 2013). Graphs are used to show the mathematical relationship between sets of data. Mathematics topics that deal with graphing include line graphs, bar graphs, pictographs and Cartesian graphs.

The nature and structure of Mathematics entails that effective and relevant instructional materials be utilized to teach mathematical concepts so as to demystify the abstraction and at the same time improve students' performance. The nature and structure of Mathematics also demands that the contents be taught with adequate and relevant instructional materials to enhance students' performance in the subject. Odogwu (2015) opined that the nature of Mathematics as a school subject is characterized with abstraction, estimation, computation

and symbolism. It therefore implies that a careful selection and use of instructional materials to deliver Mathematics contents is inevitable.

Remillard and Heck (2014) defined instructional material as any device a teacher utilizes to support instruction in order to unknot and make clearer instructional concepts to the learners. A key feature of effective instructional material is the selection and utilization of instructional materials that meet the needs of learners and fit the constraints of the teaching and learning environment. The careful selection of instructional material to teach graphing in Mathematics should consider the class size, age of students, and relevance of the selected instructional material, durability, portability, visibility and availability.

In the teaching of graphing in Mathematics, the teacher needs to employ the demonstration instructional strategy with the help of grids. The grids that can be employed to teach graphing in Mathematics are either the graph paper or the graph board. Amidst the dearth of instructional materials for the teaching of Mathematics in general and the graph board for the teaching of graphical solutions of equations in particular, the Mathematics teacher is faced with the challenge of the type of grid to utilize to deliver topics that are graph related. The junior secondary two (JS2) class is the first outing that students experience in graphing and the graph of linear equations is the first type of algebraic graph that students are expected to plot. It is therefore very important for teachers to utilize relevant instructional material that will be effective at this stage. This is because a poor grasp of this foundational teaching and learning of graphing will impede on students' performance in higher graph works such as graphical solution of quadratic equations, simultaneous equations, inequalities and trigonometric functions.

The abstract nature of Mathematics demands that its teaching and learning should be carried out to successfully enhance students understanding of mathematical concepts, ideas, skills and processes. This calls for use of learning materials that can enhance such understanding. Abstraction in Mathematics cannot be handled without such learning materials. Learning materials are also used interchangeably with instructional materials, educational materials or teaching aids.

The graph board is a two-dimensional maxi frame grid board that is used to demonstrate the plotting of graphs of relationships. The large size of the graph board makes it possible for a large group of learners to comfortably view the demonstration of the plots. The graph board comes in different sizes. It is characterized by grid lines with blocks that are one centimeter square which allow for precise measurements. The graph board also features as products of chalk graph board, white graph board or electronic graph board. There are also lines marking the vertical and horizontal half way on the graph board which are bolder. These bolder lines can serve as a built in X-Y axis.

Maraizu et al. (2020) opined that the shortage of instructional materials for the teaching and learning of Mathematics is on the increase due to non-supplies from the government to schools. ThankGod and George (2021) in their study titled availability, utilization and improvisation of instructional materials for effective Mathematics teaching and learning in junior secondary schools in Rivers State Nigeria found that Mathematics teachers have a non-challant attitude towards improvisation of instructional materials for classroom instruction. Given that the graphical solution of linear equation can be demonstrated and taught with a relevant and appropriate instructional material called graph board, why then do Mathematics teachers only utilize a relevant but non appropriate instructional material called graph papers to demonstrate and teach this topic? Maraizu et al.

(2020) carried out a study and found out that most Mathematics teachers utilize only graph papers to demonstrate and teach large class size the concept of Cartesian coordinates and graphing. It is against this backdrop that this study sought to investigate the effect of graph board utilization on academic performance of junior secondary students in the graphical solution of linear equations.

Review of Related Literature

Graphing is a very important concept in Mathematics and the Sciences. Martenalleh (2018) posited that the knowledge and use of graph has permeated and found itself useful in almost every area of man's endeavour. Graphs are visuals that are commonly used to represent information with data set or the relationship that exist between variables. When information becomes big and complicated to be represented in text form, the best option is to represent such information in graphical form. Thus, graphs bring out one of the aesthetic beauty of Mathematics. Therefore, the concept is included in the Mathematics curriculum and taught in schools.

Though the concept of graphing is applied in Mathematics and other school subjects, it is in the Mathematics curriculum that the concept is included and taught. This makes it imperative that it is the responsibility of the Mathematics teachers to introduce and teach the concept of graphing to students for use in Mathematics, other school subjects and their daily activities. The concept of graph is introduced and taught in Mathematics, thus it is expected that the mastery of graph concept be done in the Mathematics class. Every other use of graph in other school subjects is based on the assumption that students have learnt it in their Mathematics lesson.

Anyim (2020) defined graph as a diagram that represents two dimensional relationships that exist between two variables. The graph is visualized as horizontal and vertical grid lines. Thus, it comes in any form of graph board or graph paper. Booth (1981) pointed out that there is a fair commitment on the part of the teachers to the teaching and use of graphs to convey information to readers, summarize information or demonstrate relationships between variables.

A prerequisite to the understanding of graph is a conceptual knowledge of the number line and the Cartesian plane coordinate. This implies that the Mathematics teacher who wants to teach students graph should diagnose and remediate any challenges students have in the pre requisite concepts before teaching the new topic. A student who lacks mastery of number line, Cartesian plane and coordinate cannot plot the graph of a linear equation. This is because in Mathematics the success of graphing linear equation is built on the knowledge of foundation concepts of graphing. Yem (2015) carried out a study to investigate the common errors students commit in graphing and found out that the errors they commit include the following.

1. Duplication of information in the text in graphs
2. Duplication of information in graphs in tables
3. Graphs lack proper legends
4. Use of wrong type of graph to represent the data
5. Graphs are not plotted to scale
6. Non labeling of data

Ugwumadu (2012) opined that every topic learnt in the Mathematics classroom has its everyday usage. The usage of these topics in our day-to-day activities can be director indirect. Linear equation is generally applied in our environment in a situation where one or more than one variable is dependent on the other. The concept of linear equation can be applied in our day-to-day activities also. It is noteworthy to know that any situation where there is an unknown quantity, such information can be represented on linear graph to explore such quantity by representing the unknown quantity with numeric values. For instance, if someone wants to figure out income over time, compute distant time rates, or to predict the profit of a business or forecast weather, linear graphs are very welcome to the occasion.

Linear equation is a mathematical tool that can used to verify the cost of variables. A variable cost is the comparison of the cost of a commodity or services in relation to any other commodity or services in other to determine the best bet so as to maximize cost. Determination of rates and proportions is very useful in every aspect of human endeavour. No wonder, mathematicians say that Mathematics is a veritable tool for societal development and advocated that everybody should use it.

Linear equation is basically used for prediction. No one lives in this world without predicting one variable or the other. When past and present data set are recorded and graphed, the resulting linear graph can be employed to forecast the future happening or event with respect to that variable. For instance, it can be used in the church to know the attendance of church members to church programmes or the amount of offering realized from each Sunday service. It can also be used by meteorologists to forecast the weather. It is very helpful to apply linear equations in everyday activity to make predictions concerning the happenings of the future. This initial linear equation can be plotted on a graph and used to predict the cumulative approximated profits monthly.

Statement of the Problem

It is the responsibility of the teacher to ascertain the type of instructional material that will be relevant and effective for usage during Mathematics classroom lesson delivery. Given that instructional materials are vehicles that the teacher uses to convey information to students during teaching and learning, help demystify difficult concepts, increase students interest and retention, teachers still do not know how and when to use certain instructional materials in Mathematics. The use of relevant but not appropriate instructional materials in the teaching of Mathematics can cause adverse effect on students' performance, interest and retention in Mathematics. The researchers have observed that the recommended teacher-student ratio is not feasible in the Nigerian public junior secondary schools, thus we talk about the large class size.

Graphing is a vital content in Mathematics because it is utilized in Mathematics and every other human endeavour. Graphing in Mathematics starts with the location of points on the Cartesian coordinates then moves to graphing of linear equation and then the graphing of other functions such as quadratic, simultaneous linear equation and trigonometry. The researchers have observed that Mathematics teachers actually use grids (graph paper) to teach the graphing of linear equations during classroom teaching, but the question that one asks is, what kind of grid do they use? Are the grids used relevant and effective for the teaching of graphing generally or linear equation to be specific? Given that an instructional material can be relevant for a particular topic but not effective calls for this investigation since there are some grids known as graph boards which can also be employed to teach the graphing of linear equations to a large class size. This study therefore investigated the possible effects

that graph board utilization may have on junior secondary students' performance in graphical solution of linear equations**.**

Aim and Objectives of the Study

The aim of this study was to find out the effectiveness of graph board utilization on students' academic performance and retention in the graphical solution of linear equations in junior secondary school. Specifically, the objectives of the study were to:

1. Determine whether any difference exist in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board + graph paper and those taught using mathematical graph paper only.
2. Find out whether there is any difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board + graph paper and those taught using mathematical graph board only.
3. Find out whether there is any difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board only and those taught using mathematical graph paper only.

Research Questions

The following three research questions were answered.

1. What is the difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board + graph paper and those taught using mathematical graph paper only?
2. What is the difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board + graph paper and those taught using mathematical graph board only?
3. What is the difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board only and those taught using mathematical graph paper only?

Hypotheses

The null hypotheses formulated below were tested at 0.05 significant level.

H_{O1}: There is no significant difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board + graph paper and those taught using mathematical graph paper only.

H_{O2}: There is no significant difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board + graph paper and those taught using mathematical graph board only.

H_{O3}: There is no significant difference in the academic performance mean scores of students taught graphical solution of linear equation using mathematical graph board only and those taught using mathematical graph paper only.

Research Design

A design which employed the pretest-posttest non equivalent and non randomized intact class quasi-experimental parameter was used. The design had three groups (two experimental and one control group).

Population of the Study

The population for the study comprised of all five thousand four hundred and fifty two (5,452) Junior Secondary two (JS 2) students in the fourteen public junior secondary schools in Obio Akpor Local Government Area of Rivers State Nigeria.

Sample and Sampling Technique

Purposive sampling technique was used to draw a sample of one hundred and sixty three (163) JS2 students from the population. Only schools that have mathematical graph boards were sampled.

Instrument for Data Collection

The instrument that was used to collect data was titled "Linear Graph Achievement Test" (LGAT). This instrument was developed by the researchers. The test items of LGAT were emanated from the recommended reference materials, New General Mathematics for JS 2 and MAN Mathematics for JS 2. LGAT was made up of sections A and B. Section A contained the bio-data of the sample students while section B was made up of twenty five (25) multiple choice test items on the graphical solution of linear equations. Each multiple test item in LGAT had four options labeled A to D. The instrument demanded circling of only one correct answer for each item from the sample students. The total score for LGAT was 100%. A table of specification was prepared using Bloom's revised version of the educational cognitive taxonomy as shown in Table i. A marking guide was also prepared for the marking of LGAT.

Table i: Table of Specification for Linear Graph Achievement Test (LGAT)

S/N	Topic	Remembering(16%)	Understanding(28%)	Applying (20%)	Analysing (20%)	Evaluating(16%)	Total (100%)
1.	Construction of Table of Values (20%)	1	2	-	1	1	**5**
2.	Scaling of the Cartesian Plane (20%)	1	2	-	1	1	**5**
3.	Plotting of Points on the Cartesian Plane (20%)	-	-	2	2	1	**5**
4.	Drawing the Straight Line of the Graph (20%)	2	1	2	-	-	**5**
5.	Reading the Values from the Graph (20%)	-	1	1	1	2	**5**
	Total (100%)	**4**	**6**	**5**	**5**	**5**	**25**

Validity of the Instrument

LGAT was subjected to both face and content validation by two experts in Mathematics education. The reviews made by the experts were used to modify the instrument before administering to the sample.

Reliability of the Instrument

The test-retest method of determining reliability of an instrument was used to establish the reliability coefficient of LGAT. The instrument LGAT was administered to twenty (20) JS2 students who were not part of the study sample. To accomplish this, LGAT was first given to the twenty students without any teaching, after which same test items were re-shuffled and re-administered to same set of twenty students after a period of two weeks. The first and second test scores were then correlated using the Pearson Product Moment Correlation Coefficient (PPMCC) statistic. The reliability index obtained for LGAT was 0.82.

Method of Data Collection

Lesson plans for teaching the three (3) groups were prepared by the researchers. Three lesson plans on graphical solution of linear equations were prepared for each group. The topic was prepared for the experimental group 1 (students that were taught with mathematical graph board + graph paper demonstration instructional strategy), experimental group 2 (students that were taught with mathematical graph board only and control group (students that were taught with mathematical graph paper only).

The regular intact class Mathematics teachers were used as research assistants to carry out the teaching. These regular Mathematics teachers of the sample students were trained by the researchers on how to conduct the teaching. The teachers were monitored during the teaching session to make sure the teaching sessions were in accordance with the expected procedure.

A pretest of the LGAT was first administered to the three groups, and then followed by the teaching of the topics for two weeks. Each group was taught the same content, by same regular Mathematics teacher, for the same duration of time, under similar environmental conditions using the same lesson plans. The only difference was the use of Graph board + Graph paper for demonstration in the experimental group 1, use of Graph board only for demonstration in the experimental group 2 and use of Graph paper only for demonstration in the control group. After the experiment, a post-test of re-shuffled LGAT test items was given to the three groups. The students' scripts for both pretest and posttest were collated, marked, scored in percentages and statistically analyzed for meaningful interpretation and discussion.

Method of Data Analysis

The data was analyzed using the Statistical Package for Social Sciences (SPSS) software version 21.0. The research questions were answered using the mean and the standard deviation while the null hypotheses were tested using Analysis of Covariance at .05 alpha level.

Results

Table 1: Mean and standard deviation on performance mean score of students taught graphical solution of linear equation with GB+GP and GP only

		Pretest		Posttest		Performance	
Group	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
GB+GP	54	34.85	12.25	72.53	12.63	37.68	11.23
GP	51	35.47	14.61	46.96	11.21	11.49	10.58

Key: GB+GP= Graph Board combined with Graph Paper
GP= Graph Paper only

Table 1 showed the mean and standard deviation on the difference in the performance of students taught graphical solution of linear equation in the experimental group one using mathematical graph board combined with graph paper demonstration instructional strategy and those taught same topic in the control group using graph paper only. The data in table 1 showed that the students in the experimental group one that were taught using graph board combined with graph paper demonstration instructional strategy had a mean gain performance of 37.68, SD=11.23 while those in the control group that were taught using

Graph Paper only had a mean gain performance of 11.49, SD=10.58. The experimental group one had a higher mean gain than the students in the control group.

Table 2: Mean and standard deviation on performance mean score of students taught graphical solution of linear equation with GB+GP and GB only

		Pretest		Posttest		Performance	
Group	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
GB+GP	54	34.85	12.25	72.53	12.63	37.68	11.23
GB	58	37.61	13.37	53.16	13.24	15.55	9.04

Key: GB+GP= Graph Board combined with Graph Paper
GB= Graph Board only

Table 2 showed the mean and standard deviation on the difference in the performance of students taught graphical solution of linear equation in the experimental group one using graph board combined with graph paper demonstration instructional strategy and those taught same topic in experimental group two using Graph Board only. The table showed that the students in the experimental group one that were taught using graph board combined with graph paper demonstration instructional strategy had a mean gain performance of 37.68, SD=11.23 while those in experimental group two that were taught using Graph Board only had a mean gain performance of 15.55, SD=9.04. The experimental group one had a higher mean gain than the students in the experimental group two.

Table 3: Mean and standard deviation on performance mean score of students taught graphical solution of linear equation with GB only and GP only

		Pretest		Posttest		Performance	
Group	**N**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
GB	58	37.61	13.37	53.16	13.24	15.55	9.04
GP	51	35.47	14.61	46.96	11.21	11.49	10.58

Key: GB= Graph Board only
GP= Graph Paper only

Table 3 showed the mean and standard deviation on the difference in the performance of students taught graphical solution of linear equation in the experimental group two using Graph Board only and those taught same topic in the control group using Graph Paper only. The data in table 3 revealed that the students in the experimental group two that were taught using Graph Board only had a mean gain performance of 15.55, SD=9.04 while those in control group that were taught using Graph Paper only had a mean gain performance of 17.21, SD=9.04. The experimental group one had a higher mean gain than the students in the control group.

Table 4: Summary of ANCOVA on the difference in the performance of students taught graphical solution of linear equation using mathematical GB+GP and GP only

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4847.40[a]	2	2423.70	38.52	.00	.42
Intercept	6772.02	1	6772.02	107.63	.00	.25
Group	100.52	1	100.52	1.60	.03	.06
Pretest	4662.46	1	4662.46	74.10	.00	.40
Error	7613.38	102	62.92			
Total	461264.00	105				
Corrected Total	122460.77	104				

a.R Squared = .425 (Adjusted R Squared = .406)

Table 4 showed the presentation of the summary of analysis of covariance (ANCOVA) on the difference between the performance of students that were taught graphical solution of linear equation with mathematical Graph Board combined with Graph Paper demonstration instructional strategy and those taught same topic with Graph Paper only. It can be deduced from table 4 that a significant difference exists between the performance mean score of students who were taught with mathematical Graph Board combined with Graph Paper demonstration instructional strategy and those taught with Graph Paper only F1, 102=1.60, p = .03; p< .05, partial eta squared = .40. H_{O1} was rejected at a probability level of .05 since p-value was less than .05.

Table 5: Summary of ANCOVA on the difference in the performance of students taught graphical solution of linear equation using GB+GP and GB only

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2701.68[a]	2	693.53	41.610	.00	.46
Intercept	658.25	1	658.25	35.02	.00	.35
Group	130.07	1	130.07	8.01	.00	.04
Pretest	695.21	1	695.21	42.83	.00	.43
Error	1331.03	109	16.92			
Total	45821.00	112				
Corrected Total	4032.71	111				

a.R Squared = .580 (Adjusted R Squared = .682)

Table 5 showed the presentation of the summary of analysis of covariance (ANCOVA) on the difference between the performance of students that were taught graphical solution of linear equation with mathematical Graph Board combined with Graph Paper demonstration instructional strategy and those taught same topic with Graph Board only. It can be deduced from table 5 that a significant difference exists between the performance mean score of students who were taught with mathematical Graph Board combined with Graph Paper demonstration instructional strategy and those taught same topic with Graph Board only F1, 109=8.01, p = .00; p< .05, partial eta squared = .43. H_{O2} was rejected at a probability level of .05 since p-value was less than .05.

Table 6: Summary of ANCOVA on the difference in the performance of students taught graphical solution of linear equation using GB only and GP only

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5049.31[a]	2	693.53	41.610	.00	.46
Intercept	3203.64	1	658.25	35.02	.00	.35
Group	130.07	1	130.07	8.01	.00	.04
Pretest	695.21	1	695.21	42.83	.00	.43
Error	1331.03	106	16.92			
Total	45821.00	109				
Corrected Total	4032.71	108				

a.R Squared = .580 (Adjusted R Squared = .682)

Table 6 showed the presentation of the summary of analysis of covariance (ANCOVA) on the difference between the performance of students that were taught graphical solution of linear equation with mathematical Graph Board only and those taught same topic with Paper only. It can be deduced from table 6 that no significant difference exists between the performance mean score of students who were taught with mathematical Graph Board only and those taught same topic with Graph Paper only F1, 106=8.01, p = .00; p< .05, partial eta squared = .43. H_{O2} was rejected at a probability level of .05 since p-value was less than .05.

Discussion of Findings

The result revealed that students that were taught graphical solution of linear equation with mathematical Graph Board combined with graph Paper performed better than those that were taught same concept with Graph Paper only. This could be as a result of the dual instructional demonstration which the students received. The students that were taught with Graph paper only, did not have the opportunity of visualizing the demonstration using the mounted Graph Board. The use of Graph Paper only, may have hindered a broad visualization of the taught concept. When subjected to statistical test, it was revealed that there was a significant difference between the performance mean score of students who were taught with mathematical Graph Board combined with Graph Paper demonstration instructional strategy and those taught with Graph Paper only F1, 102=1.60, p = .03; p< .05, partial eta squared = .40 which led to the rejection of H_{O1} at a probability level of .05 since p-value was less than .05. This finding agrees with that of Ejakpovi and Uveruveh (2014) whose result showed that graph board utilization was more effective in students understanding of mathematical graphing than the use of Graph Paper only. Also in agreement with this result is the Igbojinwaekwu (2020) whose result revealed that use of graphed board enhanced students' graphical knowledge than ungraphed board. The results of Ejakpovi and Uveruveh (2014); Igbojinwaekwu (2020) showed that there was a significant difference in students' mathematical performance when taught with graph board and when taught otherwise.

The result of this study also showed that the use of graph board combined with graph paper also was more effective than the use of graph board only to teach students graphing concepts. This indicates that, in as much as graph board is an effective and relevant instructional material to teach graphing concept to students it should be combined with the graph paper. The use of Graph board only does not give students opportunity to personally practice the graphing concept which they have learnt. When subjected to statistical test it was revealed that there was a significant difference between the performance mean score of students who were taught with mathematical Graph Board combined with Graph Paper demonstration

instructional strategy and those taught same topic with Graph Board only F1, 109=8.01, p = .00; p< .05, partial eta squared = .43 which led to the rejection of H_{O2} at a probability level of .05 since p-value was less than .05. This is in consonance with Armah and Osafo-Apeanti (2012) whose result showed that use graphical software was more effective than the use of graph board only.

Table 6 showed the presentation of the summary of analysis of covariance (ANCOVA) on the difference between the performance of students that were taught graphical solution of linear equation with mathematical Graph Board only and those taught same topic with Paper only. It can be deduced from table 6 that no significant difference exists between the performance mean score of students who were taught with mathematical Graph Board only and those taught same topic with Graph Paper only F1, 106=8.01, p = .00; p< .05, partial eta squared = .43. H_{O2} was rejected at a probability level of .05 since p-value was less than .05. This indicated that use of graph board only or use of graph paper only was not effective to teach students graphing concepts in mathematics. This is in consonance with the finding of Akpalaugo (2021).

Conclusion

From the findings, it was concluded that students' performance are enhanced when taught graphical solution of linear equation with a combination of graph board and graph paper instructional resources than when taught with only graph board or only graph paper.

Recommendations

The following were recommended based on the results.

1. Students should be taught graphing concepts with a combination of graph board and graph paper.
2. Students should not be taught graphing concepts with graph board only as instructional material.
3. Students should not be taught graphing concepts with graph paper only as instructional material.

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