Edukasiana: Jurnal Inovasi Pendidikan
ISSN 2809-6770
Volume 3, Issue 2, 2024, pp. 244-256

Fostering Students' Academic Achievement in Physics through Graphic Organizer-Enhanced Learning Strategy

Theophilus N. Uzomah[1], Emmanuel E. Achor[2]*, Gladys U. Jack[3]
1. Department of Agric & Bio-environmental Engineering Technology, Federal Polytechnic, Bali, Taraba State, Nigeria
2. Department of Science and Mathematics Education, Benue State University, Makurdi, Nigeria
3. Department of Science Education, Taraba State University, Jalingo, Nigeria

*Corresponding Author: nuelachor@yahoo.com

Article History:
Received 2024-02-09
Accepted 2024-04-30

DOI:
10.56916/ejip.v3i2.706

ABSTRACT
This study focused on fostering academic achievement in physics using graphic organizer-enhanced learning strategy among secondary students, Taraba State Nigeria. Two research questions and two hypotheses guided the study. The study adopted a quasi-experimental, research design. The sample for the study was 172 students comprising 113 males and 112 females drawn from secondary schools offering physics in Jalingo education zone. Data for the study were generated using Physics Achievement Test (PAT). Kuder Richardson-20 (K-20) formula was used for the reliability of PAT with index of 0.85 obtained. Mean, standard deviation and Analysis of Covariance (ANCOVA) were used for data analysis. The following findings emerged: There was significant difference in the mean score academic achievement in Physics of students taught using graphic organizer-enhanced learning strategy and those thought using the conventional strategy. There was significant difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy. It was recommended that Physics teachers should employ graphic organizer-enhanced learning strategy in their interaction when teaching physics as the strategy has the capacity to enhance male and female students' academic achievement in physics. Physics teachers should regularly provide the structure and opportunity for students to employ graphic organizer-enhanced strategy in their learning process.

***Keywords**: physics; achievement; graphic organizer learning strategy; gender*

1. INTRODUCTION

Science education world over and in Nigeria is still far from achieving the goal of meaningful learning and robust learning outcomes including interest, performance and competence development leading to creative individuals. Efforts to more effectively engage students in science can be successfully achieved with the participation of all partners in education. Here the science teachers including Physics teachers become the focus.

Physics has many uses in the communication, transportation, information and health sectors. Knowledge and principles of physics are applied in the design of devices for monitoring, measuring, regulating, power generating as well as developing machines and equipment used in health, military, industrial and agricultural organizations. The focus of physics education has been to guide students develop critical thinking and by extension to the understanding of physics concepts which enhance good academic achievement.

Academic achievement on its own part, is performance outcome in intellectual domain taught at school. Criteria that indicate academic achievement includes grades, certificate or degrees which reflect the intellectual capacity of the holder (Steinmayr, Meibner, Weidinger & Wirthwein, 2014). Through the learning of physics students acquire conceptual and procedural knowledge relevant to their daily life experiences.

While physics has many potential benefits including scientific and technological advancements, there has been a growing concern in the academic community about the strategy teachers employ in teaching physics. Research has reported that teacher's in-adequate training in the use of appropriate instructional strategies results to students' poor achievement in physics and lack of critical thinking to apply knowledge in dealing with challenges (Achor, 2020; Brookfield, 2012; Browne & Keeley, 2010).

In bid to enhance learning, researchers are continuously searching for strategies for effective content delivery. Towards this direction government and other professional bodies such as science teachers Association of Nigeria (STAN) have been organizing training and retraining workshops for science teachers with the aim of enhancing their instructional delivery capability and by extension improve students' academic achievement in physics. However these efforts are still far from recording tangible improvement in students' achievement in physics (Samba, et al, 2020).

Despite these concerns, there is also evidence to suggest that strategy such as graphic organizer learning strategy can have positive effect on students' academic achievement in physics. For example, graphic organizer is an instructional strategy that organizes information in pictorial format. The graphical arrangement allows the students to identify the missing information or connecting link in their critical thinking. Effect of graphic organiser on improving learning outcome has been investigated and found useful in structuring students' critical thinking about a topic, linking materials students are learning with what they already know and in assisting students with organization and attention challenges (Osewalt, 2020). In addition, Students remember concepts and topics easily, if graphic organizer is used during lessons.

Characteristic features that make graphic organizer a unique tool that can facilitate learning, are the visual displaying of key information, organizing information for easy comprehension, showing how ideas are connected within a text or surrounding a concept, providing students with a structure for grasping abstract ideas. Other characteristics of graphic organizer include, allowing to put into practice different skills such as comparing data, ordering events and structuring the information, combining traditional note taking or outlining with the visuo-spatial benefits of diagram, helping students' to both physically see and conceptually understand relationships between their ideas. Benefits of the use of graphic organizer in the classroom is that it helps visualize or present information in a way that is easier to comprehend by breaking down larger or complex concepts into smaller and simpler parts. It provides students the opportunity to actively contribute and participate in the learning process. Graphic organizer helps to develop cognitive skills such as brainstorming, categorising and prioritizing of content. As a learning tool, graphic organizer may help in recalling prior knowledge about a subject and quickly connect it to new information. It provides self-learning: by using graphic organizer for note-taking, analysing, and in studying, students can familiarize themselves with a lesson far more easily.

Although the focus of the research was to investigate whether graphic organizer-enhanced learning strategy lead to different improvements in students' academic achievement in physics, however gender was considered a moderator variable, even though not of primary interest to the study, but as independent variable it might affect the dependent variable (academic achievement), since normal classes usually consist of male and female students. Gender refers to the socially determined ideas and practices of what it is to be male or female including attitudes and behaviour that depend upon the expectations from society.

Statement of the Problem

Students' achievement in physics over the years in external examination has not been encouraging. The trend is not different from secondary schools in the study area. A percentage table reflecting WASSCE results from 2011-2020 (Taraba State WASSCE Results, 2020) is evidence. During these years percentage passes did not exceed twenty, while failures were above fifty percent, indicating poor achievement.

Persistent under-achievement of students in physics external examinations in the study area is worrisome. Majority of students hardly can apply what they have learnt. A situation that had not only brought delayed, but equally denial of opportunity to students opting to study engineering, technology, medicine and other physics-based courses in higher schools. This ugly situation is not only frustrating to the students and parents, but equally negative on the society's advancement. Though investigations have been conducted on effectiveness of instructional strategies for improving students' academic achievement in physics, yet more need to done especially in the study area.

Purpose of the Study

The purpose of the study is to investigate if graphic organizer-enhanced learning strategy fosters students' academic achievement in physics better than the conventional teaching strategy. Specifically, it aims to achieve the following objectives.

1. To find out the effect of graphic organizer-enhanced learning strategy and the conventional strategy on students' academic achievement in physics.
2. To determine the effect of graphic organizer-enhanced learning strategy on male and female students' academic achievement in physics.

Research Questions

1. What is the difference in the mean score academic achievement in physics of students taught using graphic organizer-enhanced learning strategy and those taught using the conventional strategy?.
2. What is the difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy?

Statement of the Hypotheses

HO_1: There is no significant difference in the mean score academic achievement in Physics of students taught using graphic organizer-enhanced learning strategy and those taught using the conventional strategy.

HO_2: There is no significant difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy.

2. METHODS

Research Design

Quasi-experiment, specifically the pretest-posttest, non-equivalent control group design was adopted for the study. A quasi-experiment is the type of experimental design that does not have randomly assigned groups. The researcher collects participants in a group that cannot or should not be divided up, such as existing groups. Common attribute of quasi-experimental design is that it tries to identify the effect of a variable (independent variable) on another variable (dependent variable) in which an intervention is introduced to one group and the other is treated as control group.

The quasi-experimental design was adopted because it was not possible to have complete randomization of the participating students due to the avoidance of disrupting the already existing setting (streaming of classes) in the schools. In addition to the earlier stated reason for the choice of the design, is the fact that intact classes were used. To justify the choice for the use of intact classes for the study, studies (Nworgu, 2010; Emaikwu, 2013) suggest that intact class should be used when it is not possible to assign subjects to experimental and control groups. The students in their intact classes were assigned to three groups namely the experimental group (EG) and the control group (CG). In implementing the design, experimental group$_1$ and experimental group$_2$ were given a pre-test on linear momentum, then received treatment (GOLS & CBLS respectively) and after, given a post-test. At the same time the control group (CTS) was given a pre-test on linear momentum and did not receive treatment and then given a post-test.

Population, Sample and Sampling

The population of 2,105 SS2 students studying physics in Jalingo education zone in Taraba State comprising of 1,158 males and 947 females was the target for the study (Taraba State Post-Primary Education Management Board, 2022). Names of secondary schools offering physics within Jalingo education zone, the population of SS2 Students offering physics as well as the breakdown into male and female gender was presented in.

Sample size of 172 SS2 students drawn from secondary schools offering physics in jalingo education zone was used for the study. The sample was obtained using hat and draw simple random sampling technique and intact sampling technique also. The hat and draw method of simple random sampling technique involves putting names of schools in a hat and drawing two names out of the schools. While intact class sampling technique involves selecting an already existing class as a group in which case entire group is used to represent some large population, hence requires no procedure for selection (Hendrika, 2016).

Applying the techniques in the study, names of secondary schools each in the local government areas were written, put into a hat, reshuffled and one school picked only. The procedure was repeated to select one school each from the secondary schools in the local government areas that constitute Jalingo education zone. Thereafter, intact class sampling technique applied to select the experimental groups and the control group. Sample schools, gender, experimental and control groups are presented in.

Instrumentation

One set of researcher-modified WASSCE past questions constituted the instrument used for collection of data. The instrument was Physics Achievement Test (PAT) with scoring guide provided.

The PAT instrument contained fifty multiple-choice test item-questions consisting of five options lettered A-E with one correct response and four distracters. Each correctly answered item-question attracted 1mark. For the 50 item-questions, the maximum mark was 50. The scoring guide for the test is provided. The researcher's, modified WASSCE past question items were supplemented with questions from textbooks, basically on linear momentum in physics. Physics content sub-topics taught in linear momentum include, momentum and impulse; conservation of linear momentum; Newton's Laws of motion; weight and inertial mass; collision; application of Newton's conservation and momentum Laws. A table of specification developed by the researcher guided the construction of this instrument for content validation. The objectives of the topics in SS2 physics curriculum served as a guide for developing the items considering lower order questions and higher order questions to assess the students' achievement on the topics taught.

Validation of Instruments

Two types of validation, namely face and content validation were implemented. Being aware that validation of instruments is best handled by experts, three professors in Taraba State University, Jalingo were consulted. The three experts, two from science education department and one from educational foundations9Measurement and evaluation), were each presented with a copy of letter, requesting for validation of 50 multiple-choice (physics achievement test). In addition, two sets of lesson plans for both the experimental group and the control group, as well were attached with the instrument for validation.

The main purpose of the test which was to measure achievement of students in linear momentum in physics was initially explained to the validators and subsequently requested to review each item in relation to the overall purpose of the test. Specifically, the experts were requested to review each item based on the following criteria (a) appropriateness of the items to the purpose of the test (b) accuracy of the information presented in the items and (c) clarity of the words/phrases/diagrams.

The validators after going through the instruments, unanimously, though separately stated that the instruments appeared to measure the target variables. Further, the experts' and their comments presented suggested that most of items were appropriate and relevant in measuring the targeted achievement and critical thinking in momentum in physics. However they observed that the instruments did not cover every form of linear momentum that was stated in the lesson plan. They noted that, if some types of linear momentum as mentioned in lesson plan are left out, then the results may not be an accurate indication of students understanding of the subject.

Based on the validators' observation, comment and useful feedback on a few of the items they thought that required revision, the researcher developed a comprehensive table of specification covering the subtopics in linear momentum for the physics achievement test (PAT). The specification contained every form of linear momentum and the objectives. The table served as a large pool of items that covered a broad range of topics in linear momentum from which individual test questions were drawn. Afterwards, on presenting the comprehensive table of specification to the validators, it was confirmed that the items on the test represent the entire range of possible items that the test should cover, hence the affirmation of content validity of the test instrument.

Reliability of Instrument

The instrument was pilot tested to a small group of SS2 physics students (n=20) in schools outside those used for the main study. The choice of the school was made on the assumption that it was comparable in terms of staff strength, population and administrative competence of the schools that were used for the actual study.

The data from the pilot testing was subjected to psychometric analysis to determine the item facility index (IF), item discrimination index (ID), as well as the distractor power of the options. The following decision rules were applied to determine items that were accepted or rejected: for item facility index: when the facility index is less or equal to 0.3 is rejected and accepted when it is equal or less than 0.7 ($0.3<IF>0.7$). For the item discrimination index: when the difficulty index is greater or equal to 0.2 ($ID > 0.2$), the item is accepted otherwise rejected. For the distractor power: when the distractive index for a distractor or incorrect option is far-above or far-below 0.166 ($0.166< DP>0.166$) is rejected otherwise accepted.

Applying these rules, 39 items out the 50 items survived the psychometric analysis and was selected, while 11 items were not selected due to lack of clarity. The 39 selected items were, then subjected to reliability analysis. The reliability of the instruments for Physics Achievement Test (PAT) was determined using Kuder Richardson-20 (KR-20). The statistics was considered appropriate as it applies to items that have multiple choice options. The calculated reliability index of 0.85 was obtained for the physics achievement test. According to Achor, (2017) reliability coefficient standard ranges from 0.5 and 0.99. Since these calculated reliability values fell within this range, it was therefore considered acceptable for the study. In addition to extent to which the instruments were reliable, Dingley, (2014) maintained that reliability value greater than 0.5 shows acceptable level of internal consistency. Administration of the test lasted between 60 and 80 minutes for PAT.

Treatment Procedure

The researcher obtained from the department an introductory letter seeking for permission of the secondary school authorities whose students, teachers and facilities were used for the period of eight weeks of the study. The participating teachers for the study included the regular physics teachers that handled the intact class of each of the selected secondary school. The teachers were trained for four days using a training schedule manual, during the training the graphic organizer-enhanced learning strategy while the conventional teaching strategy was explained to the teachers verbally. Two intact classes were selected for study, one designated as experimental group while the other as control group. The experimental group received graphic organizer learning strategy treatment while the control group was taught using conventional strategy (CTS). Two sets of lesson plans on linear momentum were prepared based on Graphic Organizer Learning Strategy (GOLS) and the Conventional Teaching Strategy (CTS) were used to deliver the physics content to experimental and control groups respectively.

At the beginning of the study, using the Physics Achievement Test (PAT) as data gathering instrument, pre-test was administered to experimental group and the control group. At the end of the study, PAT was used again to administer post-test to experimental and the control groups.

Method for Data Analysis

The data that was collected for the study were subjected to analysis at two different statistical levels: descriptive and inferential statistics. At the descriptive level, the descriptive statistics of mean and standard deviation were used in order to respond to the research questions. Descriptive statistics present quantitative description of large amount of data into a simple and sensible way, to arrive at a meaningful summary that may enable comparison across people (Ajai & Amuche, 2015). Hence, the descriptive statistics was considered appropriate to answer the research questions in the current study. At the inferential level, the Analysis of Covariance (ANCOVA) was used to test the hypotheses and the Covariate prê-test. All hypotheses were tested at $P<0.05$ level of significance. The inferential statistics permit decision making whether or not to reject null hypotheses after being tested. The researcher used ANCOVA statistics in the analysis because it agreed with the opinion of Emaikwu (2013) which stated that ANCOVA is appropriate in taking care of initial group differences statistically to compare in experimental research, effectiveness of pedagogical instructions where intact classes may differ in intelligence as it is similar to the current study..

3. RESULTS AND DISCUSSION

The results of the data analysis and interpretation are presented according to the research questions that guided the study. Data related to each research questions are presented on a separate table to aid comprehension of the analysis and interpretation of results. The data presented are analyzed using means, standard deviations and bar graphs to answer research questions.

Research Question One

What is the difference in the mean score academic achievement in physics of students taught using graphic organizer-enhanced learning strategy and those taught using the conventional strategy?.

Table 1. Mean Score Academic Achievement in Physics of Students Taught Using Graphic Organizer-Enhanced Learning Strategy and Conventional Strategy

Strategies		PrePAT	PostPAT	Mean Gain
Graphic organizer-enhanced learning strategy	Mean	12.79	20.81	8.02
	N	53	53	
	Std. Deviation	6.24	2.78	
Conventional Strategy	Mean	13.86	14.70	0.84
	N	122	122	
	Std. Deviation	3.41	5.62	
Mean difference				7.18

Table 1 shows the mean score academic achievement in physics of students taught using graphic organizer-enhanced learning strategy and those taught using the conventional strategy. The table shows that 53 students were taught using graphic organizer-enhanced learning strategy and 122 students were taught using conventional strategy. The table reveals that the mean score academic achievement in physics of students taught using graphic organizer-enhanced learning strategy is 12.79 with a standard deviation of 6.24 during pre-test and 20.81 with a standard deviation of 2.78 in post test while the mean score academic achievement in physics of students taught using conventional strategy is 13.86 with a standard deviation of 3.41 during pre-test and 14.70 with a standard deviation of 5.62 in post test. The table further shows that the mean gain for graphic organizer-enhanced learning strategy is 8.02 and conventional strategy is 0.84. The difference in the mean score academic achievement in physics of students taught using graphic organizer-enhanced learning strategy and those taught using the conventional strategy is 7.18 in favour of students in graphic organizer-enhanced learning strategy class. The summary of the pretest, posttest mean academic achievement as well as the mean gain in the mean academic achievement of students in graphic organizer-enhanced learning strategy and conventional strategy is as shown in Figure 1.

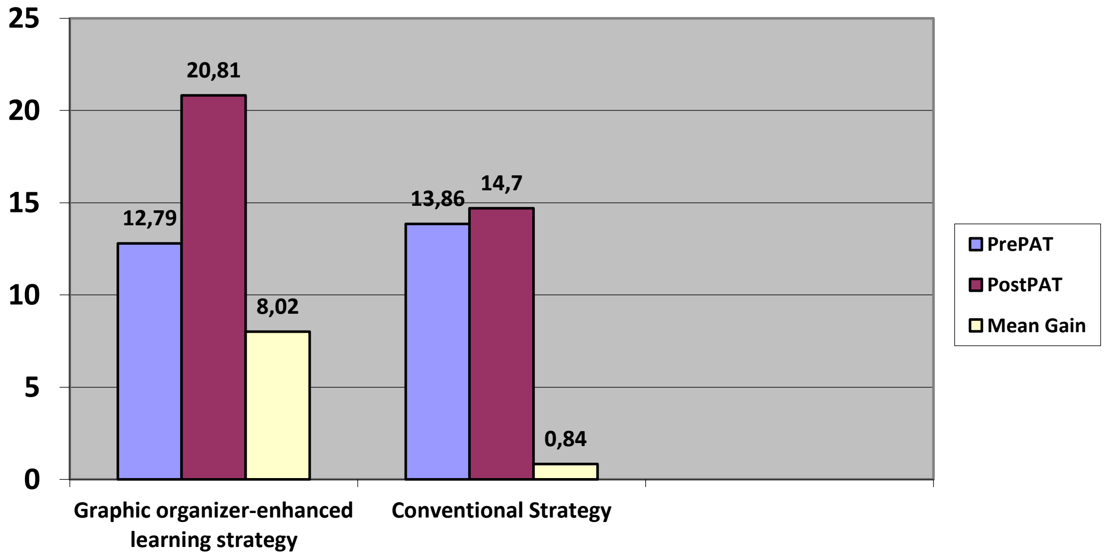

Figure 1. Pretest, Posttest and Mean Gain in Academic Achievement in Physics of Students Taught Using Graphic Organizer-Enhanced Learning Strategy and Conventional Strategy

Research Question Two

What is the difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy?

Table 2. Mean Score Academic Achievement in Physics of Male and Female Students Taught Using Graphic Organizer-Enhanced Learning Strategy

Gender		PrePAT	PostPAT	Mean Gain
	Mean	12.29	21.62	9.33
Male	N	27	27	
	Std. Deviation	6.42	2.37	
	Mean	13.30	19.96	6.99
Female	N	26	26	
	Std. Deviation	6.14	2.95	
Mean difference				2.67

Table 2 shows the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy. The table shows that 27 male and 26 female students were taught using graphic organizer-enhanced learning strategy. The table reveals that the mean score academic achievement in physics of male students taught using graphic organizer-enhanced learning strategy is 12.29 with a standard deviation of 6.42 during pre-test and 21.62 with a standard deviation of 2.37 in post test while the mean score academic achievement in physics of female students taught using graphic organizer-enhanced learning strategy is 13.30 with a standard deviation of 6.14 during pre-test and 19.96 with a standard deviation of 2.95 in post test. The table further shows that the mean gain for male students is 9.33 and female students is 6.99. The difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy is 2.67 in favour of male students in graphic organizer-enhanced learning strategy class. The summary of the pretest, posttest mean academic achievement as well as the mean gain in the mean academic achievement of male and female students in graphic organizer-enhanced learning strategy is as shown in Figure 2.

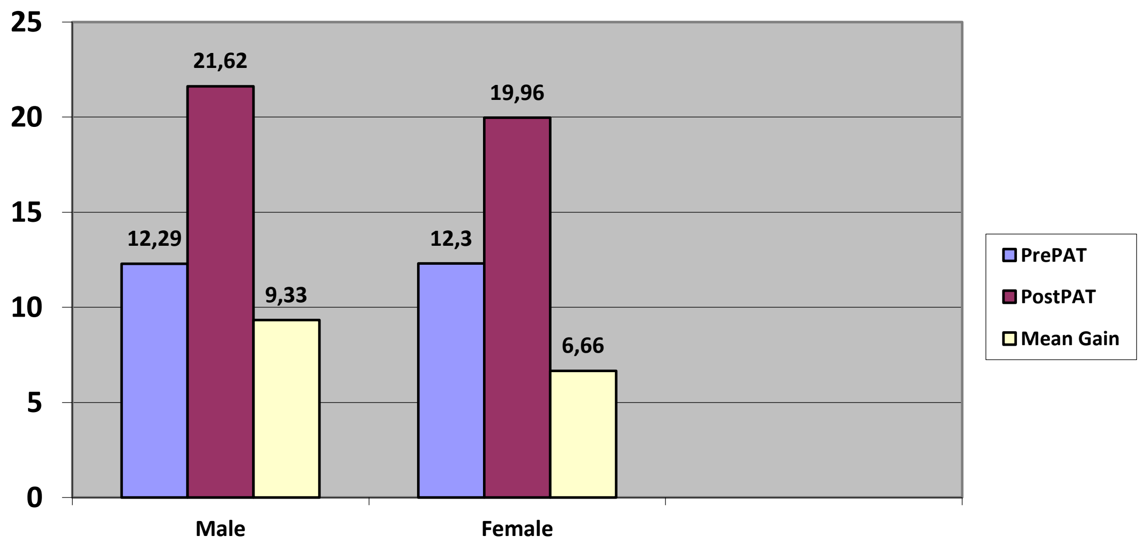

Figure 2. Pretest, Posttest Mean Gain in Academic Achievement in Physics of Male and Female Students Taught Using Graphic Organizer-Enhanced Learning Strategy

Hypotheses

The results of the data analysis and interpretation are presented according to the null hypotheses formulated for the study. Data related to each null hypothesis is presented on a separate table to aid comprehension of the analysis and interpretation of results. The hypotheses for the study were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The decision rule was that null hypotheses were rejected if the P-value was less than 0.05 and not rejected if otherwise.

Hypothesis One

There is no significant difference in the mean score academic achievement in Physics of students taught using graphic organizer-enhanced learning strategy and those thought using the conventional strategy.

Table 3. ANCOVA of Academic Achievement in Physics of Students Taught Using Graphic Organizer-Enhanced Learning Strategy and Conventional Strategy

Dependent Variable: postPAT

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1493.110[a]	2	746.555	31.196	.000	.266
Intercept	4017.303	1	4017.303	167.871	.000	.494
prePAT	115.366	1	115.366	4.821	.029	.027
strategies	1449.669	1	1449.669	60.577	.000	.260
Error	4116.124	172	23.931			
Total	53567.000	175				
Corrected Total	5609.234	174				

a. R Squared = .266 (Adjusted R Squared = .258)

Table 3 reveals that $F(1,172) = 60.577$; $p = 0.000 < 0.05$. Thus, the null hypothesis is rejected. This implies that there is significant difference in the mean score academic achievement in Physics of students taught using graphic organizer-enhanced learning strategy and those thought using the conventional strategy. Therefore, there is significant difference in the effect of graphic organizer-enhanced learning strategy and conventional strategy on the mean score academic achievement in Physics of students. The partial Eta square of 0.260 obtained for strategies means that 26.0 percent of the mean score academic achievement in Physics of students can be accounted for by the strategies**.**

Hypothesis Two

There is no significant difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy.

Table 4. ANCOVA of Academic Achievement in Physics of Male and Female Students Taught Using Graphic Organizer-Enhanced Learning Strategy

Dependent Variable: postPATGO

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	50.233[a]	2	25.116	3.569	.036	.125
Intercept	3897.042	1	3897.042	553.745	.000	.917
prePATGO	13.378	1	13.378	1.901	.174	.037
Gender	40.314	1	40.314	5.728	.020	.103
Error	351.880	50	7.038			
Total	23357.000	53				
Corrected Total	402.113	52				

a. R Squared = .125 (Adjusted R Squared = .090)

Table 4 reveals that F(1,50) = 5.728; p = 0.020 < 0.05. Thus, the null hypothesis is rejected. This implies that there is significant difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy. Therefore, there is significant difference in the effect of graphic organizer-enhanced learning strategy on the mean score academic achievement in physics of male and female students. The partial Eta square of 0.103 obtains for gender imply that 10.3 percent of the mean score academic achievement in physics of male and female students can be attributed to gender**.**

Discussion of Findings

Findings arrived at in this study are discussed in this section. The study investigated if graphic organizer-enhanced learning strategies foster physics students' academic achievement better than the conventional teaching strategy. The sample comprised male and female students therefore gender was incorporated as a moderator variable. Discussion of findings was tailored along the variables in the study as guided by the results of research questions and hypotheses.

The mean score academic achievement in physics of students taught using graphic organizer-enhanced learning strategy was higher than those taught using the conventional strategy. There was significant difference in the mean score academic achievement in Physics of students taught using graphic organizer-enhanced learning strategy and those thought using the conventional strategy. This implies that the use of graphic organizer-enhanced learning strategy fosters academic achievement in physics better than the use of conventional strategy. The finding agrees with Opara and Lami (2020) that students taught selected topics in physics and chemistry using graphic organizer had significantly higher achievement scores than students taught same selected topics in physics and chemistry using conventional method.

The finding agrees with Bizinmana, Mutangana, and Mwesigye (2020) that concept mapping and cooperative mastery learning treatment group outperform the conventional teaching method group in academic achievement in photosynthesis and there was statistically significant difference between the treatment groups (concept mapping and cooperative mastery learning) in favour of concept mapping. The finding agrees with Tirunch, De cock and Elen (2018) that participants in the immersion and infusion conditions significantly outperformed those in the control condition on domain-specific course achievement. The finding agrees with Wartono, Hudha and Batolona (2017) that the mean score achievement of the experimental group was higher than the control group. The finding agrees with Wasonga (2015) that concept mapping based instruction was significantly an effective teaching and learning tool for understanding the concept of electric current in physics. However, the finding disagrees with Samba, Achor, Bash and Iortim, (2020) that there was no significant difference between the mean score of post-CCT of students' achievement exposed to graphic organizer and those exposed to experiential learning with feedback. The finding also disagrees with Wardi, and Marcketti (2019) that quiz scores did not differ based on type of study-aid provided (graphic organizer verses conventional method).

The use of graphic organizer-enhanced as an instructional strategy in the present study organizes information in pictorial format. This graphical arrangement of information enabled students to identify missing links and visualize connecting links between concepts. The employed graphic organizer-enhanced learning as an experimental strategy has been recognized as enhancing learning as evident in the significant difference in the mean score academic achievement in Physics of students taught using graphic organizer-enhanced learning strategy and those thought using the conventional strategy. Infusing graphic organizer learning strategy as concept organizating element during teaching and learning process facilitates the functionality of the working memory to improve learning and retrieval of knowledge. This may be responsible for the significant difference found in the mean score academic achievement in

Physics of students taught using graphic organizer-enhanced learning strategy and those thought using the conventional strategy.

The mean score academic achievement in physics of male students taught using graphic organizer-enhanced learning strategy was higher than that of female students taught using graphic organizer-enhanced learning strategy. There was significant difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy. This means that the use of graphic organizer-enhanced learning strategy is gender sensitive with respect to academic achievement in physics of male and female students. The finding agrees with Bizinmana, et al (2020) that there was gender difference in the mean achievement scores of the students exposed to the cooperative mastery learning with higher achievement gain among the female students. The finding agrees with Ivana, (2017) that there was significant difference between girls and boys mean score achievement in physics in favour of boys. However, the finding disagrees with Bizinmana, et al (2020) that male and female students taught using concept mapping showed equal gain in achievement in photosynthesis. The finding also disagrees with Mahmud and Nur (2015) that there was no significant difference in the mean scores of the male and female students' achievement.

Gender stereotyping permeates physics class when graphic organizer-enhanced learning strategy was used. The present study found significant difference in the mean score academic achievement in physics of male and female students taught using graphic organizer-enhanced learning strategy. This means that the use of graphic organizer-enhanced learning strategy is gender sensitive with respect to academic achievement in physics of male and female students. This is because the use of graphic organizer-enhanced learning strategy was selective in helping male and female students activate prior knowledge by revealing what they already know about a topic, especially when prompts are included to draw pictures of what the problem look like, describe the problems component parts, suggest a real-world context for the problem and show how to solve the problem example in physics.

4. CONCLUSION AND RECOMMENDATIONS

The study has established that the use of graphic organizer-enhanced learning strategy in teaching physics content fosters students' academic achievement in physics better than conventional strategy. It was also established that graphic organizer-enhanced learning strategy is gender friendly with respect to students' academic achievement in physics. It was concluded that concepts in physics are better taught via graphic organizer-enhanced strategy since the students find themselves reassessing the importance of physics and develop interest that encourage understanding of physics concepts, and perform better in physics.

The following recommendations were made in the light of the findings of this study:

i. Physics teachers should employ graphic organizer-enhanced learning strategy in their interaction when teaching physics as the strategies have the capacity to enhance male and female students' academic achievement
ii. Physics teachers should regularly provide the structure and opportunity for students to employ graphic organizer-enhanced strategy in their learning process.
iii. In-service training programmes, seminars, work-shops and symposia should be organized by the state and federal governments to train physics teachers in the use of graphic organizer-enhanced and context-based strategies in teaching physics.
iv. Graphic organizer-enhanced learning strategies should be included in the training package of teacher education programme both in colleges and at university level to ensure that teacher-trainees acquire necessary skills to effectively implement the techniques.

5. REFERENCES

Achor, E. E. (2017). Research matters: Choice of appropriate statistics, data interpretation and explanation of often misused terminologies. In E. Y. Gyuse & I. J. Kyeleve (Eds.), *Issues in educational research and teaching: Occasional publication series no. 1*(148-177). Lagos-Nigeria: Samartrade.

Achor, E. E. (2020). *Cognitive dimensions in demystifying abstract concepts in Physics.* Inaugural lecture series, no. 15, Benue State University, Makurdi, Nigeria.

Ajai, J. T. & Amuche, C. I. (2015*).Educational research methods and statistics.* Nigeria: Academic House Publishers.

Bizinmana, E.M; Mutangana, D & Nwesigye, A. (2020).Fostering students retention in photosynthesis using concept mapping and cooperative mastery learning instructional strategies. *European Journal of Education Research, 11* (1):103-116.

Brookfield, S. (2012). *Teaching for critical thinking: Tools and techniques to help students question their assumptions.* San Francisco: Jossey-Bass.

Browne, M., & Keeley, S. (2010). *Asking the right questions: a guide to critical thinking* (9th ed.). Upper Saddle River, New Jersey: Pearson Education, Inc.

Dingley,A.C.(2014).Cronbach'sAlpha.Retrievedfromen.wikipedia.or.../.../cronbach%275.4o8am.

Emaikwu, S. O (2013). *Fundamentals of educational research methods and statistics.*(1st ed.).Makurdi, Nigeria: Selfers Publishers.

Hendrika,V.K.(2016).What is intact Sampling?.Retrievedfromhttps://www. researchgate. net/post/what-is-intact-sampling/ 71f5d1aeeac3a36f93eeb11/ ac tation/download.

Ivana, P. J. (2017). Students' gender-related choices and achievement in Physics. Center for *Educational Policy Studies Journal*, 7 (2): 71-95. DOI:10.2652/ceps/170

Mahmud, M. & Nur, S. (2015). Exploring students' learning strategies and gender differences in english language teaching. *International Journal of Language Education, 2* (5): 51-64

Nworgu, B.C. (2010). *Educational research: basic issues and methodology.* Ibadan: Wisdom Publisher.

Oswalt, G. (2020). Individualised instruction vs. differentiated instruction. Retrieved 12th April, 2021 from https://www.understood.org/en/schoollearning/partnering-with-childs-school

Opara, M. F.& Lami, A. (2020). Graphic organizer and students' achievement in physics and chemistry: integrating technology in science classroom. *Global Scientific journal, 8*(3):24-36. Retrieved, from www.Global scientific journal.com.

Samba, R.M.O., Achor, E. E., Bash, A. E. & Iortim, S. O. (2020). Fostering students' critical thinking and achievement in basic science using graphic organizer and experiential learning strategies with feedback. *Science Education International, 31*(2):220-*225.Https ://doc.org/10.33828/sei.v3112.12.*

Steinmayr, R., Meibner, A., Weidinger, A. F. & Wirthwein, L. (2014).Students' academic achievement. *International Journal of Educational Research, 5*(3):31-41. Doi: 1903/0B0/9780/99756810-0108.

Taraba State WASSCE Result (2020).Ministry of basic and secondary education resource center, Jalingo.

Taraba State Post-primary Education Management Board (2023).Population of SS2 science students in Jalingo Education Zone.

Tiruneh, D.T., De Cock, M. & Elen, J. (2018). Designing learning environments for critical thinking: examination effective instructional approaches. *International Journal Of Science and Mathematics Education, 16*: 1065-1089

Ward, J. L. & Marcketti, S. B. (2019).The effect of graphic organizers on learning outcomes, study efficiency and students' satisfaction in elective veterinary cardiology course.*Journal of Veterinary Medical Education, 46*(3):353-566, Retrieved from Https://doi.org/10.3138/jime.0817-116r1.

Wartono, W., Muhammad, N. H & John, R. B. (2017). How is students taught critical thinking skills in physics using inquiry-discovery strategy?: Empirical and theoretical overview.*EURASIA Journal of Mathematics, Science and Technology Education, 14*(2): 691-697.

Wasonga, V.O. (2015). *Effects of concept mapping based instruction on students' achievement in physics in public secondary schools, Nairobi Country Kenya*. Unpublished Master Dissertation, School of Education. Kenyatta University.