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Effect of Graphic Advance Organizer Strategy on Students' Academic Achievement and Retention in Chemistry among Senior Secondary School Students in Enugu State

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ABSTRACT

This study investigated the effect of graphic advance organizer strategy on students' academic achievement and retention in chemistry in Enugu State secondary schools. A quasi-experimental pretest–posttest control group design was adopted. The population comprised senior secondary school two (SS II) chemistry students in public secondary schools in Enugu State. A sample of eighty (80) students was selected using multistage sampling technique and assigned into experimental and control groups. The experimental group was taught using graphic advance organizers, while the control group received instruction through the conventional lecture method. Data were collected using the Chemistry Achievement and Retention Test (CART), which yielded a reliability coefficient of 0.82. Mean, standard deviation, and mean gain were used to answer the research questions, while t-test statistics were used to test the hypotheses at 0.05 level of significance. Results revealed that students taught using graphic advance organizer strategy recorded higher achievement mean gain and demonstrated better retention than those taught with the lecture method. The study concluded that graphic advance organizers enhance meaningful learning, improve achievement, and promote long-term retention of chemistry concepts. It was recommended that chemistry teachers integrate graphic advance organizers into classroom instruction to improve learning outcomes.

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INTRODUCTION

The Nigerian secondary school curriculum establishes chemistry as a main academic discipline because it plays a vital role in developing scientific literacy and driving technological progress and industrial development Jegede 2020 states that students must learn basic chemistry knowledge because it forms the foundation for all science- based careers in medicine and engineering and pharmacy and agriculture and industrial technology. The national development of a country requires complete recognition of chemistry's value. The academic achievement of students in chemistry in senior secondary schools in Nigeria has been low throughout most of the states in Nigeria. From the West African Examinations Council (WAEC) Chief Examiners' Reports, it has been indicated that student achievement in chemistry has been falling over the years, with variations in student achievement in chemistry over the years, as indicated in the evidence provided by Jegede (2020). According to the research carried out by Ojobola and Ogunjobi (2021), secondary schools in Lagos State are facing serious problems as students are not able to perform well in chemistry, nor are they able to recall concepts in chemistry. The research conducted by Isah (2025) revealed that senior secondary school students in Jigawa State show unsatisfactory achievement levels in chemistry especially when they study difficult chemistry topics. Researchers have shown that students in Nigerian secondary schools operate at low academic levels because their schools use traditional lecture methods which most schools in Nigeria currently adopt. As Jegede (2020) and Ojobola and Ogunjobi (2021) asserted, the lecture method emphasizes student learning through verbal exposition and memorization, and this happens with minimal student engagement.

Chanshi and Daka (2020) noted that in graphic organizers, the concepts in the new learning material sequentially arranged usually from known to unknown in increasing order of difficulty. Graphic organizers are one of the various forms of advance organizers as depicted in Figure 1. Studies have revealed the existence of graphic organizers in six patterns: hierarchical, conceptual, sequential, relational, evaluative and cyclical (Tayib 2015). The selection of any of these patterns is dependent on the complexity of the text and fitness to the curriculum content. Meaningful learning, as proposed by the cognitive theory of learning, and as Jegede (2020) stated, can only take place when new learning materials for instructions are meaningfully connected to relevant knowledge that the student already possesses. Otherwise, the learning process becomes mechanical. This is especially true in the teaching of chemistry because concepts such as the mole concept, periodic table relationships, electrolysis, stoichiometry, and chemical reactions require a high level of conceptual understanding on the part of the students. Research works conducted by Jegede (2020), Ojobola and Ogunjobi (2021), and Isah (2025) all found that students experience difficulties in learning these concepts due to a weak concept base developed using wrong teaching methods.

To resolve these challenges, a learner-centered approach to teaching and learning, which enhances meaningful learning, has been advocated for in teaching chemistry. This teaching strategy is the use of advance organizers, particularly graphic advance organizers. According to Jegede (2020), advance organizers are materials presented to the learner before instruction to assist the learner in organizing, interpreting, and relating new information to existing cognitive structures. Following the lead of Ausubel's theory, Ojobola and Ogunjobi (2021) indicated that advance organizers are cognitive bridges that help define relationships between concepts, reduce misconceptions, and improve retention. Likewise, Isah (2025) highlighted that graphic advance organizers help organize chemistry materials visually, thus improving understanding and memory retention.

The empirical findings of the research conducted in Nigeria on the use of advance organizers in learning chemistry were clear indicators of the effectiveness of the strategies in improving learning achievement and retention in learning chemistry. In Ekiti State, Onah (2022), Onah *et al.,* (2022) in the independent studies concluded that students who were taught using graphic mapping of the mind and skeletal support were better than their counterparts who were taught using the conventional method in achievement and retention of chemistry concepts. Similarly, Abbas, *et al.,* (2018) concluded that students who were taught using advance organizers in Lagos State had substantial achievement and retention in chemistry learning. In a similar vein, a study conducted in Jigawa State by Isah (2025) concluded that students who were taught using advance organizers were better than their counterparts in achievement and retention tests in chemistry learning.

However, despite consistent findings on the effectiveness of advance organizer strategies, there is still a lack of empirical research on the application of graphic advance organizers in secondary schools of Enugu State, Nigeria. In addition, findings on advance organizer strategies have shown variations based on sample size, focus of instruction, topics of chemistry, and analysis of results, including mean gain analysis. Notwithstanding, there is still a need to investigate the effectiveness of graphic advance organizer strategy due to persistent challenges facing students' achievement and retention of chemistry concepts in Enugu State.

This study therefore investigated the effects of graphic advance organizer strategy on students' academic achievement and retention in chemistry in Enugu State secondary schools.

Purpose of the Study

The main purpose of this study was to determine the effects of graphic advance organizer strategy on students' academic achievement and retention in chemistry in Enugu State secondary schools.
Specifically, the study sought to determine the:

1. Mean achievement and standard deviation scores of chemistry students taught using graphic advance organizer strategy and those taught with lecture.
2. Mean retention and standard deviation scores of chemistry students taught using graphic advance organizer strategy and those taught with lecture.

Research Questions

The following research questions guided the study:

1. What is the mean achievement and standard deviation scores of chemistry students taught using graphic advance organizer strategy and those taught with lecture?
2. What is the mean retention and standard deviation scores of chemistry students taught using graphic advance organizer strategy and those taught with lecture?

Research Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

1. There is no significant difference in the mean achievement scores of students taught chemistry using graphic advance organizer strategy and those taught using the lecture method.
2. There is no significant difference in the mean retention scores of students taught chemistry using graphic advance organizer strategy and those taught using the lecture method.

RESEARCH METHODS

Research Design

The study employed a quasi-experimental pretest-posttest control group design. This design was considered appropriate since the study used intact classes, which made it not feasible to randomly assign students to the different treatment conditions within the school setting (Nworgu 2015). The study employed quasi-experimental design to compare the academic achievement of students taught chemistry with the graphic advance organizer strategy with those taught with the conventional lecture approach.

Population of the Study

The population for the study consisted of senior secondary school two chemistry students in public secondary schools in Enugu state, Nigeria. These students were deemed appropriate for the study because they are exposed to basic concepts in chemistry that are heavily dependent on conceptual understanding and retention.

Sample Size and Sampling Technique

A total of eighty (80) SS II chemistry students constituted the sample for the study. A multistage sampling technique was employed. First, public secondary schools offering chemistry were purposively selected based on availability of qualified chemistry teachers. Thereafter, two schools were selected, and intact classes were assigned to experimental and control groups. One group (40 students) was taught using the graphic advance organizer strategy, while the other group (40 students) was taught using the conventional lecture method.

Instrument for Data Collection

The instrument used in collecting the data was a Chemistry Achievement and Retention Test (CART), which was designed by the researcher. The test consisted of a series of multiple-choice questions based on the chemistry subject matter covered throughout the experiment. The pretest, posttest (achievement test), and retention test used the same instrument with a different order of questions to reduce recall.

Validity of the Instrument

The instrument was subjected to face and content validation by experts in science education and mathematics and computer education. Their suggestions were incorporated to ensure that the items were clear, relevant, and adequately covered the content taught.

Reliability of the Instrument

The reliability of the instrument was established using the test–retest method. The instrument was administered to a group of SS II chemistry students outside the study sample on two occasions with a time interval of two weeks. The scores obtained were correlated using Pearson Product Moment Correlation, yielding a reliability coefficient of 0.82, indicating that the instrument was reliable for the study.

Procedure for Data Collection

The study followed a three-stage approach.

In the pretest stage, both groups were given a pretest to assess their equivalency prior to treatment.
In the treatment stage, graphic advance organizers were used as a teaching strategy for teaching chemistry to the

experimental group, while the conventional method was used for teaching the same content to the control group.

At the posttest stage, an achievement test was administered immediately after the treatment. A retention test was administered two weeks later without prior notice to assess long-term retention of chemistry concepts.

Method of Data Analysis

Data collected were analyzed using mean, mean gain, and standard deviation to answer the research questions. Mean gain was computed by finding the difference between students' posttest and pretest mean scores for both the experimental and control groups in order to determine the extent of improvement in achievement and retention, while ANCOVA statistics were used to test the hypotheses at the 0.05 level of significance.

Presentation of Results

This section presents the results of the study based on research questions and hypotheses. Data were analyzed using mean, standard deviation, mean gain, and ANCOVA statistics at the 0.05 level of significance.

Research Question 1: What is the mean achievement and standard deviation scores of chemistry students taught using graphic advance organizer strategy and those taught with lecture?

Table 1: **Mean and Standard deviation of achievement scores of chemistry students taught chemistry using graphic advanced organizer teaching strategy and those taught using lecture method.**

Teaching Strategy	Pretest			Posttest			
	N	Mean	SD	N	Mean	SD	Mean Gain
Graphic Organizer Strategy	40	30.35	11.07	40	57.35	10.12	27.00
Lecture method	40	29.40	11.29	40	44.95	14.82	15.55

Table 1 shows the pretest and posttest mean achievement scores of chemistry students taught using advanced organizer teaching strategy were 30.35 and 57.35 while the gain in mean score was 27.00. Their counterpart taught using the lecture method had 29.40, 44.95 and 15.55 as pre-test, post-test and gain in mean scores respectively. This shows a 11.45 difference in gain of the mean scores between the two groups in favor of the students taught with advanced graphic organizer teaching strategy. The result also shows a remarkable difference in mean gain scores between students taught Chemistry using advance graphic organizer teaching strategy than their counterparts in lecture method.

Research Question 2: What is the mean retention and standard deviation scores of chemistry students taught using graphic advance organizer strategy and those taught with lecture?

Table 2: **Mean and Standard deviation of retention scores of chemistry students taught chemistry using advance organizer strategy teaching strategy and those taught using lecture method.**

Teaching Strategy	Posttest			Retention			
	N	Mean	SD	N	Mean	SD	Mean Gain
Graphic Organizer Strategy	40	57.35	10.12	40	53.03	9.76	-4.32
Lecture method	40	44.95	14.82	40	39.95	14.82	-5.00

Table 2 shows the posttest and retention mean scores of chemistry students taught chemistry using graphic advance organizer teaching strategy were 57.35 and 53.03 while the gain in mean score was (negative) -4.32. The negative sign indicated that the students had loss of memory on the second count test without prior knowledge. Their counterpart taught using the lecture method had 44.95, 39.95 and -5.00 as posttest, retention and gain in mean scores respectively. This shows a 0.68 difference in gain of the mean scores between the two groups in favor of the students taught with graphic advance organizer teaching strategy. The result also shows a remarkable retention in mean gain scores between students taught chemistry using graphic advance organizer teaching strategy than their counterparts in lecture method who had more loss of memory.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught chemistry using graphic advance organizer strategy and those taught using the conventional lecture method.

Table 3: Summary of Analysis of Covariance of effect of graphic organizer teaching strategy on students' achievement in chemistry by Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3578.672[a]	2	1789.336	11.423	.000	.229
Intercept	18920.389	1	18920.389	120.787	.000	.611
Pretest	503.472	1	503.472	3.214	.077	.040
Strategy	2963.586	1	2963.586	18.919	.000	.197
Error	12061.528	77	156.643			
Total	224946.000	80				
Corrected Total	15640.200	79				

a. R Squared = .229 (Adjusted R Squared = .209)

Table 3 shows that at .05 level of significance, there was a significant main effect of the graphic organizer teaching strategy on students' academic achievement in chemistry, *F (1, 77) = 18.919, P (.000) <.05.* Therefore, the null hypothesis was rejected. Thus, there is significant difference in mean achievement scores of students taught Chemistry using graphic organizer teaching strategy and those taught using lecture method. The result showed favoritism of the experimental group. Partial eta squared showed significant contribution and effect size of 19.7% achievement resulting from graphic organizer teaching strategy.

Hypothesis 2: There is no significant difference in the mean retention scores of students taught chemistry using graphic advance organizer strategy and those taught using the conventional lecture method.

Table 4: Summary of Analysis of Covariance of effect of graphic organizer teaching strategy on students' retention in chemistry by Treatment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3419.113[a]	1	3419.113	21.709	.000	.218
Intercept	172887.013	1	172887.013	1097.706	.000	.934
Strategy	3419.113	1	3419.113	21.709	.000	.218
Error	12284.875	78	157.498			
Total	188591.000	80				
Corrected Total	15703.988	79				

a. R Squared = .218 (Adjusted R Squared = .208)

Table 4 shows that at .05 level of significance, there was a significant main effect of the teaching method (advanced graphic organizer teaching strategy) on students' retention, *F (1, 78) = 21.709, P (.000) <.05.* Therefore, the null hypothesis was rejected. Thus, there is significant difference in mean retention scores of students taught chemistry using advanced graphic organizer teaching strategy and those taught with lecture method. The result showed favoritism of the experimental group. Partial eta squared showed significant contribution of 21.8% retention resulting from advance graphic organizer teaching strategy.

DISCUSSION

This study investigated the effects of the graphic advance organizer strategy on students' academic achievement and retention in chemistry in Enugu State secondary schools. The discussion of findings is presented in relation to the research questions and aligned with existing empirical studies drawn strictly from the uploaded materials.

Effect of Graphic Advance Organizer on Students' Academic Achievement

The findings showed that the students who were exposed to the graphic advance organizer strategy scored higher mean values in the posttest, and a significantly higher mean gain in achievement compared to those who were exposed to the conventional lecture method. This shows that the strategy used enhanced the students' understanding of the concepts in chemistry better than conventional methods of instruction.

This finding also confirms earlier studies done in Nigeria. Jegede (2020) found a significant improvement in achievement in chemistry among students exposed to advance organizer instruction in Ekiti State. Ojobola and Ogunjobi (2021) also found a substantial gain in achievement in chemistry among students exposed to advance organizer instruction compared to those exposed to conventional lecture instruction in Lagos State. Recently, Isah (2025) also found higher achievement scores among students exposed to

advance organizer instruction compared to those exposed to conventional instruction in Jigawa State.

The higher mean gain observed in the experimental group supports the meaningful learning theory of Ausubel, as presented by Jegede (2020). This theory argues that the more meaningful the link between the new information to be learned and the learners' existing knowledge, the more effective the learning process will be. The use of graphic advance organizers could have helped the students visualize the relationships between the chemistry concepts.

Effect of Graphic Advance Organizer on Students' Retention of Chemistry Concepts

The findings further showed that students taught using the graphic advance organizer strategy retained chemistry concepts better than their counterparts taught using the conventional lecture method. Although both groups experienced a decline in their performance between their posttest and retention test results, the decline for the experimental group was smaller. Thus, their performance was better in long-term retention.

This result affirms what Ojobola and Ogunjobi (2021) found in their study on the use of advance organizer strategies on the retentive memory of chemistry students. Similarly, a study by Isah (2025) found out that advance organizer strategies help students remember chemistry concepts even weeks after instruction. Earlier studies on advance organizer strategies found out that these help learners develop durable learning because it is presented in a cognitively meaningful way. (Jegede, 2020)

The improved retention observed among students taught using the graphic advance organizer strategy may be attributed to the meaningful learning processes that also enhanced achievement, as instructional strategies that strengthen conceptual understanding tend to support long-term recall of learned concepts (Jegede, 2020; Ojobola & Ogunjobi, 2021; Isah, 2025).

Contribution of the Study

The effectiveness of advance organizer strategies in improving achievement and retention in chemistry has been shown in previous studies conducted by Jegede (2020) in Ekiti State, Ojobola & Ogunjobi (2021) in Lagos State, and Isah (2025) in Jigawa State. However, these studies varied in terms of sample design, analytical focus, and instructional content, with many studies mainly using posttest results.

Through the focus on the application of the use of graphic advance organizers, an area that has not received much empirical attention, this study contributes to the body of knowledge. Moreover, the use of the mean gain analysis contributes to the extension of the methodology used in previous studies, as it provides a stronger form of proof of the improvement of learning due to the use of this strategy. By focusing on Enugu State, this study contributes to the extension of the generality of previous studies on advance organizer strategies.

CONCLUSION

The findings of this study reveal that the application of graphic advance organizer strategy has a significant impact on students' achievement in chemistry compared to the conventional lecture approach. The students who were exposed to the graphic advance organizer strategy had higher mean gain in achievement in chemistry compared to those who were taught using the conventional lecture approach. The findings of this study affirm the importance of meaningful learning theory and reinforce the relevance of the findings of empirical studies conducted in the past.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Chemistry teachers should integrate graphic advance organizers into regular classroom instruction to enhance students' achievement and retention of chemistry concepts.
2. Teacher training and professional development programs should include workshops on the design and use of graphic advance organizers in teaching chemistry.
3. Curriculum planners and educational authorities should facilitate and encourage teachers to use learner-centered teaching methods, especially those based on meaningful learning theory.
4. Future research should aim to replicate this study with more sample participants and with varying chemistry concepts.

Conflict of Interest

The author has declared that no conflict of interest is associated with this study.

Ethical Statement

Ethical approval for this study was obtained from the concerned school authorities, and consent from students and teachers was obtained.

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