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Enhancing Chemistry Learning through Advance Organizer Strategy: Evidence from Nigerian Secondary Schools.

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Abstract

This study examined the effect of the advance organizer teaching strategy on academic achievement and retention in senior secondary school chemistry in Gumel, Jigawa State, Nigeria. A pretest-posttest quasi-experimental design was employed, involving Senior Secondary II Chemistry students was used. Findings revealed that students taught with the advance organizer strategy significantly outperformed peers taught with the conventional method in both academic achievement and retention tests. Male students taught using advance organizer strategy performed better than their female counterparts in achievement and retention, with the difference being statistically significant. The results demonstrate that the advance organizer strategy facilitates meaningful learning by linking prior knowledge with new content, thereby enhancing comprehension and long-term retention of chemistry concepts. It is recommended that chemistry teachers integrate advance organizers into instructional practice to improve student engagement, conceptual understanding, and retention. Special attention should also be given to encouraging female students to participate actively in science lessons.

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1.Introduction

Effective teaching and learning of sciences especially chemistry in Nigerian secondary schools has become a subject of discussion and needs urgent attention. Despite the importance and educational values of Chemistry which is relevant to the need of the individual learner, economic and technological breakthrough of a nation, and the efforts being made by the researchers to improve on its teaching and learning, the academic achievement of students in the subject is not encouraging [1]. Poor academic achievement in chemistry may be linked to the use of conventional lecture method which does not actively involves the students [2].

According to Ausubel meaningful learning theory, meaningful learning occurs when new learning is related to a relevant, pre-existing knowledge in the individual cognitive structure. The existing structure/knowledge is termed as "subsumers" according to Ausubel which acts as an anchor for new ideas. According to Ausubel, the most important factor influencing learning is what the learner already knows [4]. To facilitate the process of meaningful learning, Ausubel proposed the use of Advance organizers that can served as an introductory material usually presented at a higher level of abstraction, generality and inclusiveness when compared to the learning materials.

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Advance organizer is an information presented to the students prior to teaching a given concept which might help the learners to organize and interpret new information. Advance organizer is described as information presented to the learners and which can be used to organize and interpret new incoming information [5]. It is a kind of cognitive bridge which the teachers can use to help the learners to make a link between what they already know and what is to be learnt. Studies have shown that advance organizers might be an effective and innovative teaching strategy that can enhance academic achievement [5,6] and long-term retention, and encourage meaningful learning of concepts in sciences.

Retention is the ability to store and retrieve information learned over a long period of time. Retention is particularly important in chemistry where concepts are interconnected [7]. While Studies reported significant gains in retention through advance organizers [8,9,10], however, others showed mixed results for gender [11,12,13,14,15]. This inconsistencies requires further study in local contexts.

In Jigawa State, Nigeria, limited work investigated the combined effect of advance organizers on achievement, retention and gender. This study therefore, examines the impact of the advance organizer strategy on academic achievement and retention among senior secondary school chemistry students in Gumel Educational Zone, with the aim of informing instructional practices and improving learning outcomes.

The study aims to examine the effectiveness of the advance organizer strategy in chemistry education by determining its impact on students' academic achievement and retention of chemistry concepts. It also seeks to investigate whether there are significant gender differences in students' achievement and retention when chemistry is taught using the advance organizer strategy.

1.1 Research Hypotheses

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

H_{01}: There is no significant difference in mean achievement scores between students taught with advance organizers and those taught with conventional methods.

H_{02}: There is no significant difference exists in mean retention scores between students taught with advance organizers and those taught with conventional methods.

H_{03}: There is no significant difference exists in mean achievement scores between male and female students taught with advance organizers.

H_{04}: There is no significant difference exists in mean retention scores between male and female students taught with advance organizers.

2. Methodology

The study adopted a pretest–posttest quasi-experimental design with non-equivalent control groups. This design was chosen to allow comparison between an experimental group taught using the advance organizer strategy and a control group taught using the conventional lecture method. The population comprised 1,583 Senior Secondary II (SS II) chemistry students from 13 public senior secondary schools in Gumel Educational Zone, Jigawa State. Stratified random sampling was used to categorize schools into male and female, after which four schools (two male and two female) were randomly selected. A total of 134 students participated: 72 male and 62 female students. Due to the nature of the school time-table and school authority would not allow the researcher to fully randomize the subjects, the research subjects were successfully assigned to experimental and control groups based on the intact classes.

The instrument used was the Chemistry Achievement Test (CAT), comprising multiple-choice items designed to assess understanding and retention of the periodic table concepts. The CAT was validated by subject experts and piloted to determine clarity and appropriateness. Reliability was established using the test–retest method, yielding a Pearson correlation coefficient of 0.91.

The experimental group received instruction for six weeks (80 minutes per week), using graphic advance organizers designed to provide a conceptual framework before each lesson (1 lesson per each week). The organizer visually depicted relationships among concepts in the periodic table, helping students connect prior knowledge with new content. The control group was taught the same content using the conventional lecture method. Instruction lasted six weeks, with both groups receiving equal

instructional time (80 minutes per week and once per week).

Pretests were administered to both groups to homogeneity before the start of the intervention. Posttests measuring academic achievement were administered immediately after the intervention. Retention tests were conducted two weeks later without prior notice to the students.

The data collected were analyzed using t-tests at the 0.05 significance level were employed to test the null hypotheses. The t-test was chosen because the study involved two independent groups and the data collected was a continuous data.

2.1 Effect of Advance Organizer Strategy on Students' Academic Achievement

Table 1 presents the t-test analysis for the posttest achievement scores of the two groups.

An independent samples t-test revealed a statistically significant difference between the experimental group (M=18.85, SD=5.56) and the control group (M=9.64, SD=2.15), t(132)=12.18, p<0.001. The effect size, Cohen's d=2.12, indicated a very large effect, suggesting that the treatment substantially improved students' PostCAT performance. This supports prior research indicating that advance organizers enhance comprehension by linking prior knowledge to new content [6,7].

2.2 Effect of Advance Organizer Strategy on Students' Retention

Table 2 shows the t-test analysis for posttest retention scores between the two groups

The result from independent samples t-test indicated significant difference in the RetCAT scores at t(132)=7.07, p<.001 between the experimental group (M=15.47, SD=4.40) and control group (M=10.75, SD=3.03.The computed effect size (Cohen's d=1.23) indicated a large effect, confirming that the treatment had a strong positive effect on students' retention ability. The result aligned with earlier studies [8,9,10].

2.3 Gender Differences in Academic Achievement (Experimental Group)

Table 3 presents the t-test analysis for male and female achievement scores in the experimental group.

PostCAT scores show a significant difference favoring male students (M=22.29, SD=3.09) when compare to female students (M=13.50, SD=4.55) at t(71)=9.83, p<.001 and d=2.37 indicating a large effect size. This suggests that the difference is not by chance. This study is in consistent with some earlier findings [15] and it is in contrast with some findings [11,12,13,14].

2.4 Gender Differences in Retention (Experimental Group)

Table 4 presents the t-test analysis for male and female retention scores in the experimental group.

At t(71)=8.87, p<.001, the Cohen's d=1.79 indicating a large effect size suggesting a substantial difference in RetCAT scores between male students (M=18.11, SD=2.73) and female students (M=11.50, SD=3.62). The effect size is unlikely due to chance but may have real-world implications. This finding agrees with studies reporting male advantage in retention under similar instructional strategies [15].

Table 1: t-test Analysis of Posttest Mean Achievement Scores for Experimental and Control Groups

Group	N	Mean	SD	T(df)	p-value	Mean Dif	Cohen' d
Experimental	73	18.85	5.56				
				12.18(132)	0.00	9.21	2.12
Control	61	9.64	2.15				

Table 2: t-test Analysis of Posttest Mean Retention Scores for Experimental and Control Groups

Group	N	Mean	SD	t(df)	p-value	Mean Dif	Cohen's d
Experimental	73	15.47	4.40				
				7.07(132)	0.00	4.71	1.23
Control	61	10.75	3.03				

Table 3: t-test Analysis of Posttest Mean Achievement Scores for Male and Female Students in the Experimental Group

Gender	N	Mean	SD	t(df)	p-value	Mean Dif	Cohen's d
Male	45	22.29	3.09				
				9.83(71)	0.00	8.79	2.37
Female	28	13.50	4.55				

Table 4: t-test Analysis of Posttest Mean Retention Scores for Male and Female Students in the Experimental Group

Gender	N	Mean	SD	t(df)	p-value	Mean Dif	Cohen's d
Male	45	18.11	2.73				
				8.87(71)	0.00	6.61	1.79
Female	28	11.50	3.62				

Conclusion

The study demonstrated that the advance organizer teaching strategy significantly improved both academic achievement and retention in senior secondary school chemistry compared to the conventional lecture method. The approach provided students with a conceptual framework that facilitated the integration of new information with prior knowledge, resulting in deeper understanding and better long-term recall. Additionally, gender differences were observed in both achievement and retention within the experimental group, with male students outperforming their female counterparts. The findings affirm the value of learner-centered strategies such as advance organizers in enhancing meaningful learning and addressing persistent challenges in chemistry education in Nigerian secondary schools.

Recommendations

Based on the findings of this study, it is recommended that chemistry teachers integrate the advance organizer strategy into regular teaching practice to enhance students' comprehension, academic achievement, and retention of chemistry concepts. Teacher education and professional development programs should include focused training and workshops on the effective design and implementation of advance organizers across various chemistry topics. In addition, teachers should adopt inclusive instructional approaches that actively engage female students, address participation gaps, and build confidence in science learning. Furthermore, curriculum planners and educational authorities should formally incorporate the use of advance organizers into chemistry syllabi and provide appropriate instructional materials to support their effective classroom application.

Limitations of the Study

This study is limited in scope as it was conducted in only four senior secondary schools out of the thirteen available in Gumel, Jigawa State, which may affect the generalizability of the findings. The content coverage was restricted to the periodic table, and therefore the results may not fully represent students' performance in other areas of chemistry. Additionally, the study was confined to the Gumel educational zone of Jigawa State. Owing to the constraints of school timetables and administrative regulations, random assignment of students was not feasible; consequently, intact classes were used to form the experimental and control groups, which may have influenced the internal validity of the study

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