



Effect of Spaced Repetition Instructional Strategy on Students' Interest, Performance and Retention in Organic Chemistry among Senior Secondary School Students in Plateau State

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ABSTRACT

This study determined the effect of the spaced repetition learning strategy on students' interest, performance, and retention in Organic Chemistry among senior secondary school students in Plateau State, Nigeria. A quasi-experimental research design was employed with a sample of 86 students, comprising 50 students in the experimental group taught using the spaced repetition learning strategy and 36 students in the control group taught using the conventional lecture method. Data were collected using the Students' Interest in Chemistry Inventory Scale (SICIS), Chemistry Performance Test (CPT), and a retention test administered four weeks after the intervention. The results revealed that students taught Organic Chemistry using the spaced repetition learning strategy had a similar level of interest to those taught using the conventional lecture method. However, students taught using the spaced repetition learning strategy performed better than those taught using the conventional lecture method. The results also showed that students taught using the spaced repetition learning strategy had higher retention than those taught using the conventional lecture method. There was no significant difference between the mean interest scores of students taught Organic Chemistry using the spaced repetition learning strategy and those taught using the lecture method. However, significant differences were found between the mean performance and retention scores of students taught using the spaced repetition learning strategy and those taught using the lecture method. The study recommended the use of the spaced repetition learning strategy to improve students' academic performance and long-term retention in Organic Chemistry.

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INTRODUCTION

Science has a major role in this modern era of technology worldwide. Acquisition of appropriate scientific and technological skills is necessary to cope with the challenges presented by the evolving needs of modern work place in industries, also there is a great importance of scientific knowledge in boosting national income and international rating of the country. In Nigeria, science is so important that a lot of emphasis has been laid on its teaching and learning with the major aim of achieving scientific literacy among the citizenry as contained in the National Policy on Education (FRN, 2014). It is in view of this that, science education has been accorded a prime position in school curriculum in Nigeria and worldwide. Within the context of science education, chemistry has been identified as a very important science subject and its importance in scientific and technological development of any nation has been reported (Eya, et al, 2020).

Organic Chemistry is often perceived as a challenging subject by senior secondary school students due to its abstract nature, intricate mechanisms, and extensive content. Traditional teaching methods, which are largely based on lectures, have been shown to be less effective in promoting long-term retention of the subject matter (Ebbinghaus, 2020). Given that Organic Chemistry requires students to grasp complex concepts and apply them in various contexts, there is a need for teaching strategies that not only improve performance but also facilitate better retention of learned material.

One promising strategy that has gained attention in recent years is spaced repetition, a technique that involves reviewing material at increasing intervals over time. Research has shown that spaced repetition can enhance retention by counteracting the forgetting curve, which is particularly valuable for subjects like Organic Chemistry, where concepts build upon one another and require frequent recall (Cepeda et al., 2021).

Spaced repetition is grounded in cognitive psychology and involves the review of material at gradually increasing intervals. This strategy is designed to exploit the brain's natural forgetting curve and counteract memory decay (Ebbinghaus, 2020). Numerous studies have demonstrated that spaced repetition leads to better long-term retention compared to massed practice (Roediger & Butler, 2020). Spaced repetition techniques are especially effective for subjects that require the retention of complex information, such as Organic Chemistry, where students need to recall a range of concepts, mechanisms, and reactions over time (Li & Wei, 2021).

Studies have consistently shown that spaced repetition can improve academic performance by encouraging deeper processing and understanding of content. For instance, Pan et al. (2022) found that students who engaged in spaced repetition performed better on exams compared to those who engaged in traditional study methods. This is especially true for

subjects like Organic Chemistry, where students need to master a significant amount of interconnected content. The key benefit of spaced repetition lies in its ability to enhance retention. Research by Cepeda et al. (2021) highlights that spaced repetition leads to better recall over longer periods, reducing the likelihood of forgetting key concepts. In the context of Organic Chemistry, where students often forget reaction mechanisms and functional group characteristics, spaced repetition offers a systematic method for ensuring these concepts are retained in long-term memory (Li & Wei, 2021). This study seeks to explore the effectiveness of spaced repetition as a learning strategy in improving both performance and retention in Organic Chemistry among senior secondary school students in Plateau State, Nigeria. The research aims to provide empirical evidence on the impact of this strategy on student outcomes in an educational context characterized by large class sizes and limited resources.

Statement of the Problem

Organic Chemistry is a subject that many senior secondary school students struggle with, resulting in poor academic performance and low retention of key concepts. Traditional teaching methods, which often rely heavily on lectures and rote memorization, fail to engage students and do not promote meaningful learning or long-term retention of Organic Chemistry principles. Consequently, students often forget critical content shortly after examinations, leading to a cycle of poor performance.

The problem becomes more pronounced in senior secondary schools, where students are expected to apply complex knowledge of Organic Chemistry to problem-solving scenarios. These challenges point to the need for innovative teaching strategies that can enhance both performance and retention. Spaced repetition, an evidence-based strategy known for its effectiveness in improving memory retention, may offer a solution to this problem. However, there is limited research on the impact of spaced repetition on performance and retention in Organic Chemistry within the context of Nigerian senior secondary schools.

Objectives of the Study

The objectives of the study are as follows:

- 1 determine the difference between the mean interest scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.
- 2 determine the difference among the mean performance scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

- 3 determine the difference among the mean retention scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

Research Questions

The following research questions were rise to guide the study:

- 1 What is the difference between the mean interest scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method?
- 2 What is the difference between the mean performance scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategies and those taught using lecture method?
- 3 What is the difference among the mean retention scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategies and those taught using lecture method?

Hypotheses

The following hypotheses were formulated to be tested at 0.05 level of significance.

H₀₁: There is no significant difference between the mean interest scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

H₀₂: There is no significant difference between the mean performance scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

H₀₃: There is no significant difference between the mean retention scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

METHODOLOGY

Research Design: This study employed a quasi-experimental design with a pre-test, post-test, post-

posttest, control group. The experimental group was taught using the spaced repetition strategy, while the control group received traditional lecture-based instruction.

Sample of the study: A total of 86 senior secondary school students were selected from two schools in Plateau State. The experimental group consisted of 50 students, while the control group had 36 students. Participants were selected through purposive sampling techniques.

Instruments: Students Interest in Chemistry Inventory Scale (SICIS): A 21-item questionnaire designed to measure student interest in Organic Chemistry, with items rated on a 4-point Likert scale. The SICIS was administered before and after the intervention.

Chemistry Performance Test (CPT): A 50-item multiple-choice test assessing understanding of Organic Chemistry concepts, was administered as pre-test, post-test and post-posttest.

Procedure: Pre-test Phase: Both groups completed the SICIS and CPT to establish baseline measures of interest and performance. Intervention Phase: The experimental group participated in a series of Organic Chemistry lessons that incorporated spaced repetition activities, such as group discussions and collaborative problem-solving. The control group received traditional lecture-based instruction. Post-test Phase: After the intervention, both groups completed the SICIS and CPT again to assess changes in interest and performance. Post-posttest phase: Four weeks after the post-test, the retention test was administered to both groups to assess how well they retained Organic Chemistry concepts.

Method of Data Analysis: Data were analyzed using descriptive statistics means and standard deviations and inferential statistics (t-tests) to determine significant differences between the experimental and control groups. A significance level of $p < 0.05$ was set for all statistical tests.

RESULTS

Research Question One: What is the difference between the mean interest scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method?

Table 1: Summary of Descriptive Statistics showing, the effect of spaced repetition learning strategy on Students Interest in Organic Chemistry

Treatment	N	Pre-interest $\bar{x}$	Pre-interest SD	Post-interest $\bar{x}$	Post-interest SD	Mean Gain
Spaced repetition method (SP)	50	2.85	0.40	2.95	0.32	0.10
Conventional method (CM)	36	2.87	0.25	2.92	0.35	0.05
Total	86					

The results in table 1 above reveal that the students taught organic chemistry with spaced repetition instructional strategy have pre-interest mean score of 2.85 and standard deviation of 0.40, while the post-interest mean score have a value of 2.95 with a standard deviation of 0.32. This showed a mean difference of 0.10. While the students taught with conventional methods have a mean interest score of 2.87 and standard deviation of 0.25 for pre-interest. The post-interest mean score and standard deviation have values of 2.92 and

0.35 respectively with a mean gain of 0.05. This result revealed that students taught organic chemistry with spaced repetition method developed similar interest to those taught with conventional method.

Research Question Two: What is the difference between the mean performance scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategies and those taught using lecture method?

Table 2: Summary of Descriptive Statistics showed the effect of spaced repetition strategy on academic performance

Treatment	N	Pretest $\bar{x}$	Pretest SD	Posttest $\bar{x}$	Posttest SD	Mean Gain
Spaced repetition method (SP)	50	48.78	6.84	59.08	8.38	10.30
Conventional method (CM)	36	47.66	6.49	49.83	5.22	2.17
Total	86					

From table2 above, the academic performance mean scores of students taught organic Chemistry with spaced repetition instructional strategy have a pretest mean score and standard deviation of 48.78 and 6.84 respectively and the posttest mean score and standard deviation were 59.08 and 8.38 respectively, while the mean gain for spaced repetition instructional strategy was 10.30. While students taught with conventional method have pretest mean score of 47.66 and a standard deviation of 6.49, while the posttest mean score was 49.83 and a standard deviation of 5.22 with a mean gain of 2.17. This showed that the students taught with

spaced repetition teaching method performed better than conventional method with a mean difference of 8.13. This showed that students taught with spaced repetition instructional strategy performed better than the conventional teaching methods.

Research Question Three: What is the difference among the mean retention scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategies and those taught using lecture method?

Table 3: Summary of Descriptive Statistics showed the effect of spaced repetition strategy on retention

Treatment	N	Pretest		Post-Posttest		Mean Gain
		$\bar{x}$	SD	$\bar{x}$	SD	
spaced repetition method (BS)	50	48.78	6.84	62.80	8.65	14.02
Conventional method (CM)	36	47.66	6.49	50.84	4.39	3.18
Total	86					

From table 3 above, the mean retention scores of students taught organic Chemistry with spaced repetition instructional strategy have a pretest mean score and standard deviation of 48.78 and 6.84 respectively. While students taught with conventional method have pretest mean score of 47.66 and a standard deviation of 6.49. The result showed that the students in all the groups have similar entry level. The result in table 3 showed that, the students taught organic chemistry with spaced repetition instructional strategy have a mean score of 62.80 and standard deviation of 8.65 for post-posttest, which was higher than the mean score of 50.84 for

conventional method with standard deviation of 4.39. This showed that students taught organic chemistry with spaced repetition have more retention than those taught with conventional method.

Hypotheses

H₀₁: There is no significant difference between the mean interest scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

Table 4: Summary of independent sample t-test showing effect of spaced repetition on students' interest in organic chemistry

Teaching Methos	N	$\bar{x}$	SD	Df	t-value	p-value	Decision
spaced repetition	50	2.95	0.33	84	1.021	0.310	Not Significant
Lecture method	36	2.87	0.35				
Total	86						

The table 4, above shows that the effect of spaced repetition instructional strategy on students' post-interest mean score in organic chemistry was significant as p-value of 0.310 is greater than 0.05, $p > 0.05$. Therefore, hypothesis 1 was not rejected. There was no significant difference between the mean interest scores of senior secondary school students taught organic

chemistry using spaced repetition instructional strategy and those taught using lecture method.

H₀₂: There is no significant difference between the mean performance scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

Table 5: Summary of independent sample t-test showing effect of spaced repetition on students' performance in organic chemistry

Teaching Methos	N	$\bar{x}$	SD	Df	t-value	p-value	Decision
spaced repetition	50	59.08	8.38	84	6.288	0.000	Significant
Lecture method	36	49.83	5.22				
Total	86						

The table 5, above shows that the effect of spaced repetition instructional strategy on students' post-interest mean score in organic chemistry was significant as p-value of 0.000 is less than 0.05, $p < 0.05$. Therefore, hypothesis 2 was rejected. There was a significant difference between the mean performance scores of senior secondary school students taught organic

chemistry using spaced repetition instructional strategy and those taught using lecture method.

H₀₃: There is no significant difference between the mean retention scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

Table 6: Summary of independent sample t-test showing effect of spaced repetition on students' retention in organic chemistry

Teaching Methos	N	$\bar{x}$	SD	Df	t-value	p-value	Decision
spaced repetition	50	62.80	7.45	84	10.71	0.000	Significant
Lecture method	36	50.84	4.39				
Total	86						

The table 6, above shows that the effect of spaced repetition instructional strategy on students' post-interest mean score in organic chemistry was significant as p-value of 0.000 is less than 0.05, $p < 0.05$. Therefore, hypothesis 3 was rejected. There was significant difference between the mean retention scores of senior secondary school students taught organic chemistry using spaced repetition instructional strategy and those taught using lecture method.

DISCUSSION

The results of this study indicate that the spaced repetition learning strategy significantly improved both performance and retention in Organic Chemistry. The substantial improvement in performance among the experimental group supports the notion that spaced repetition enhances understanding and mastery of complex material. Additionally, the superior retention scores suggest that spaced repetition helps students retain Organic Chemistry concepts for a longer period, addressing the common issue of forgetting critical content. The finding of the study aligns with results of Ali, et al, (2024), they investigate the effect of spaced learning on the learning outcome and retention of nurse anesthesia students and after the intervention, the mean scores of learning outcome and retention in the intervention group were significantly higher than those in the control group. These findings align with the work of; Okeke, et al, (2022), they investigated the effect of spaced learning on primary school pupils' interest and retention in mathematics. In contrast, the control group, which used traditional teaching methods, showed only a modest improvement in performance and retention. This suggests that traditional lecture-based methods may not be as effective in promoting long-term learning in subjects like Organic Chemistry.

CONCLUSION

This study examined the effect of the spaced repetition instructional strategy on senior secondary school students' interest, academic performance, and retention in Organic Chemistry in Plateau State. The findings revealed that although the strategy did not produce a statistically significant improvement in students' interest, it resulted in significantly higher academic performance

and better retention than the conventional method. The study therefore concludes that spaced repetition is an effective instructional strategy for improving students' learning outcomes in Organic Chemistry, particularly in enhancing conceptual understanding and long-term retention. Its adoption in Chemistry classrooms has the potential to strengthen students' mastery of difficult concepts and improve overall achievement in the subject.

RECOMMENDATIONS

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

1. Chemistry teachers should adopt the spaced repetition instructional strategy in the teaching of Organic Chemistry to enhance students' academic performance and improve their long-term retention of learned concepts.
2. Curriculum planners and educational authorities should integrate spaced repetition instructional strategy into Chemistry curriculum implementation and organise regular training programmes to equip teachers with the necessary skills for its effective classroom application.
3. Future researchers should replicate this study using larger and more representative samples from different geographical locations and investigate the effectiveness of spaced repetition instructional strategy in other science subjects and educational levels.

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