

Effects of Scaffolding and Concept Mapping Strategies on Achievement and Retention in Biology among Secondary School Students in Obio/Akpor LGA, Rivers State, Nigeria

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Abstract

This study examined the effects of scaffolding and concept mapping on students' achievement and retention of senior secondary students II in biology in Rivers State. Three research questions and three hypotheses guided the study. The study adopted quasi experimental design. Three (3) public governments owned senior secondary schools were purposively drawn for the study. In each of the schools used, intact classes were drawn from senior secondary two classes and assigned to scaffolding group and concept mapping group respectively and then compare their effects on the achievement of the students. The population of the study was 1173 Biology students in SS 2 of these schools and the sample of the study was 122 students in SS 2 assigned randomly. A sample of 122 students comprising of 63 males and 59 female were used drawn from the study area through simple random sampling technique. The strategy was to teach the above groups using scaffolding instructional strategy, concept map or lecture method respectively and compare their effect on students' achievement and retention in biology. Biology Achievement Test was used to collect data, Mean and standard deviation were used to answer research questions while the hypotheses was tested using ANCOVA at 0.05 level of significance. Bonnferroni's test of pair-wise comparison was used to find out, in which group lies the significant effect. The results revealed that learners in scaffolding group outperform concept mapping group in both achievement and retention. It was recommended that biology teachers should adopt the scaffolding learning strategy to improve learners' achievement and retention.

Keywords: scaffolding learning strategy, concept mapping, retention, gender, academic achievement.

Introduction

Biology is a branch of science that deals with the study of living things. It is the science of life. Its curriculum was designed to produce educated individuals who may or may not continue to take to biological study in their professional pursuits. But in whatever professional they finally find themselves, it is hoped that the biology education they acquired in secondary school will be of value to the totality of their education (Ndukwe et'al, 2021). Meaningful learning is the product of retention, inability of learners to retain what they have learnt has been pointed out as one of the contributing factors to learners' poor achievement in the sciences (Moemeke, and Okpuvwie, 2025). According to WAEC (2022-2024), learners performed poorly due to inability to retain what is learnt in the classroom. Despite the importance, the learners' achievement and retention in biology at secondary school level remain a concern, evidenced by persistent poor performance in internal and external examination. It stated that if one cannot retain what one has learned, then there is no reason to expect they will perform better in examination. As a science of life, it has been emphasized that the teaching and learning of biology should involve the use of innovative methods and strategies (Patesan, Balagiu and Zechia, 2016). Hence, efforts are continuously being made to improve the quality of biology instruction, which has culminated in series of curriculum innovations in the field of biology. There is need for a shift from traditional instructional styles to which poor performance of learners has been attributed, to innovative teaching strategies through which learners can be exposed. Innovative methods example scaffolding has the potentials to improve learner's achievement and retention. Also in recent years, educational researchers and curriculum experts have advocated for learner centered method that actively engage learners in knowledge construction. Among such approaches are scaffolding and concept mapping. Therefore, the researcher sought for an innovative learning strategy that improves students' achievement and retention in biology in Rivers State.

Scaffolding instructional strategy is rooted in Vygotsky's social constructivism theory, emphasizes guided support that enables learners to accomplish learning tasks beyond their immediate ability. Nwakamma (2022) stated that scaffolding in education is an instructional method where a teacher provides temporary support to help learners learn new concepts. The study investigated the effect of scaffolding and lecture methods on senior secondary students' achievement in biology. The study state that scaffolding instructional methods have statistically significant effect on students mean performance score in biology when compare with lecture method. This present study is investigated the Effects of scaffolding learning strategy

Effects of Scaffolding and Concep Mapping Strategies on Achievement and Retention in ... Nwakamma, A. A. (2026)

and concept mapping on secondary school students' Achievement and Retention in Biology. According to Kim et al (2020), scaffolding significantly improves students' conceptual understanding and academic achievement compared to conventional teaching methods. This study revealed that scaffolding strategy enables students to engage actively in scientific inquiry and develop independent learning skills. Also, Adeyemi and Ogunleye (2023) examined the influence of students scaffolding instructional strategy on students, retention of biology concepts among secondary school learners. Their findings indicated that students taught through scaffolding retained biological concepts longer than their counterparts taught using traditional approaches. The study emphasized that scaffolding encourages meaningful learning by helping learning connect prior knowledge with new concept, thereby strengthening memory and understanding. Other empirical studies indicate that scaffolding instructional strategy positively influences learners' achievement, retention and motivation in biology education. Although both scaffolding and concept mapping have shown considerable promise in enhancing learning outcomes, their combined effect on students' achievement and retention in biology remains inadequately explored in many secondary school setting. Most studies reported that students taught using scaffolding performed better than those taught through conventional methods. However, variations in research settings, sample characteristics, and instructional procedures suggest the need for further studies but this present study seeks to contribute to the existing literature by examining the effect of scaffolding learning strategy and concept mapping on secondary school learners' achievement and retention in biology. Gender refers to the personal sexual identity of an individual, regardless of the person's biological and outward sex (Ibitoye, 2021). It can also be seen as a socially ascribed attribute which differentiates male from female (Mbonu& Okoli 2019). Etokeren et al (2019) showed that there was no significant difference between male and female students. Based on the inconsistency on the results of male and female students' academic achievement in science, it is pertinent to examine the interaction effect of teaching methods and gender on students mean achievement in retention and, effect of scaffolding and concept mapping respectively at retention by gender. Retention of learning is a repeat performance of the activity learned earlier, elicited after a time interval by the learner. It is the ability to hold, keep or recall past experience and reproduce a learnt concept when the need arises (Delmang,et al 2025).

Objectives of the study

The study was conducted to achieve the following objectives:

1. To ascertain if differences exist in the achievement scores on a researcher made achievement test in biology using scaffolding and concept map at retention.
2. To determine if differences exist in the achievement scores on a researcher made test in biology of scaffolding group and concept mapping group at retention by gender.
3. To determine if differences exist in the interaction effect of teaching methods and gender on a researcher made test on students' mean achievement score in biology at retention.

Research questions

The following research questions guided the study:

1. What are the mean scores in a researcher-made biology achievement test (RMBAT) of students taught using scaffolding, lecture methods or concept map respectively at retention?
2. What is the mean scores in a researcher-made Biology Achievement test (RMBAT) of students taught using scaffolding, lecture method or concept map respectively by gender?
3. What is the interaction effect of teaching methods and gender on students' mean achievement score in biology at retention?

Hypotheses

The following null hypothesis was tested at an alpha level of 0.05.

- H₀₁:** The mean scores in a (RMBAT) of students taught using scaffolding, lecture method or concept map do not differ significantly at retention
- H₀₂:** The mean scores in a RMBAT of students taught using Scaffolding, Lecture method or concept map do not differ significantly at retention by gender.
- H₀₃:** The interaction effects of teaching methods and gender on students mean achievement score in biology at retention do not differ significantly.

Methodology

This study adopted a quasi-experimental research design. Intact classes were used and there was no random assignment of subjects was made. The population of the study was one thousand one hundred and seventy-three (1173) senior secondary two (SSII) in the three (3) public governments schools in Obio/Akpor Local Government of Rivers state selected purposively. The sample of the study was one hundred and twenty-two (122) students comprising of 63 males and 59 female students drawn from simple random sampling technique. Intact classes were used and assigned to scaffolding group, concept mapping group and lecture method group. Data was collected researcher made biology achievement retention test (RMBART). The RMBART was a multiple- choice instrument with four responses. The items were drawn from tissues and supporting tissues in animals in senior secondary year two (SSII) Biology curriculum used in Rivers state. The RMBART was validated by experts in measurement and evaluation and Biology teachers in federal government college Port Harcourt. The reliability co-efficient of biology achievement test was 0.79. The reliability of the instruments was established using Kuder-Richardson formula (K-R20). The treatment sessions were conducted in three phases-pretreatment phase, treatment phase and retention phase. During the pre-treatment phase, the researcher visited each of the schools and obtained permission to use the schools for the research work. The pre-test was also administered. During the treatment phase student were taught tissues and supporting tissues, the scaffolding group were taught using scaffolding instructional strategy, concept mapping group were taught using concept map. In the retention phase the RMBAT was re administrated to the students to test for retention. The pre-test, posttest and retention test contain the same questions but in different sequence. Hence the design is represented thus:

Groups	Pre-test	Treatment	Post test	Retention Test
Scaffolding group	O ₁	X ₁	O ₂	O ₃
Concept mapping group	O ₄	X ₂	O ₅	O ₆
Lecture method group	O ₇	X ₃	O ₈	O ₉

Where: O = observation/Test (Pre-Test, Post Test, and Retention Test).

X₁= Treatment using scaffolding strategy.

X₂=Treatment using concept mapping.

X₃= Treatment using lecture method.

Presentation of Results

1. What are the mean scores in a researcher-made biology achievement test (RMBAT) of students taught using scaffolding, lecture methods or concept map respectively at retention?

Table 1: Mean and Standard Deviation of the students' Mean score on RMBAT (Teaching methods and gender) at Retention.

Gender	Groups	Mean(x)	SD	N
Male	Scaffolding (SCA)	23.8148	4.29702	27
Female	SCA	24.8667	5.42305	15
Total	SCA	24.1905	4.69165	42
Male	Lecture method (LM)	15.0000	2.28709	14
Female	LM	13.9231	1.57285	26
Total	LM	14.3000	1.89737	40
Male	Concept Map (CM)	19.0455	3.83564	22
Female	CM	18.4444	2.91492	18
Total	CM	18.7750	3.42306	40

Where N = No. Of subjects

X = Mean

SD = Standard Deviation

Data presented on table 1 show that the mean achievement score of students taught using scaffolding is (24.19 with S.D 4.69), Lecture method had mean (14.30 with S.D1.89) while Concept map had mean (18.78 with S.D 3.42) at retention.

Effects of Scaffolding and Concep Mapping Strategies on Achievement and Retention in ... Nwakamma, A. A. (2026)

Research question 2: What is the mean scores in a researcher-made Biology Achievement test (RMBAT) of students taught using scaffolding, lecture method or concept map respectively by gender?

Data still presented on table 4 show the mean score for male students using the scaffolding method is (23.81 with S.D 4.29) and females (24.87 with S.D 5.42). For lecture method, males have (15.00 as mean and S.D 2.29) while females have (13.92 as mean and S.D 1.57). Concept map had mean for males as (19.05 with S.D as 3.84, females had 18.44 mean and S.D 2.91).

Researcher question 3: What is the interaction effect of teaching methods and gender on students' mean achievement score in biology at retention?

Data still presented on table 1 above show that students' mean achievement scores in biology appear to vary across both teaching methods and gender. The extent of this variation of students' mean achievement score in Biology with teaching methods was further inferred from the following hypothesis:

H₀₁: The mean scores in a (RMBAT) of students taught using scaffolding, lecture method or concept map do not differ significantly at retention

Table 2: Analysis of Covariance (ANCOVA) of biology students' overall achievement scores by Teaching methods and Gender at Retention.

Sources of variation	Sun of squares	Df	Mean squares	Fcal	Sig	Decision at P<0.05
Pre-test (covariates)	122.393	1	122.393	10.406		
Groups	1386.339	2	693.169	58.932	.000	S
Gender	5.038	1	5.038	.428	.514	NS
Groups *Gender	35.074	2	17.537	1.491	.229	NS
Error	1352.660	115	11.762			
Corrected Total	3513.385	121				

Where S –Significant

NS-Not Significant

Data presented on table 2 shows that teaching methods as a main effect on students' achievement in biology at retention is significant. This is because the probability value of the 0.000 at which this main effect is shown to be significant is lower than the level of 0.05 at which it is being tested. This implies that teaching methods have statistically significant effect on student' mean achievement score in Biology. In other words, the null hypothesis effect is rejected at 0.05 level of confidence. Thus, the earlier observed difference between the overall mean achievement scores of the method groups as in table 1 is a real difference which could not be attributed to chance associated with the study.

H₀₂: The mean scores in a RMBAT of students taught using Scaffolding, Lecture method or concept map do not differ significantly at retention by gender.

Data still presented on table 1 show that gender is not significant on students' achievement in biology at retention. This is so since the probability value of 0.514 is greater than 0.05.

H₀₃: The interaction effects of teaching methods and gender on students mean achievement score in biology at retention do not differ significantly.

Data still presented on table 2 shows that the interaction of teaching method by gender is also not significant. The probability value of 0.229 is greater than 0.05.

Table 3: Pair-wise Comparisons was run to find out which of the pairs that caused the significant difference in the group

GROUP (J)	GROUP	Mean	Std. (Error)	Sig.
	LM	9.8905*	.78782	.000
SCA	CM	5.4155*	.78782	.000
LM	SCA	-9.8905*	.78782	.000
	CM	-4.4750*	.78782	.000
CM	SCA	-5.4155*	.78782	.000
LM		4.4750*	.79737	.000

Effects of Scaffolding and Concep Mapping Strategies on Achievement and Retention in ... Nwakamma, A. A. (2026)

Data on table shows that for SCA and LM groups, Prob (0.00) is less than the level of significance (0.05). This Implies that the mean different of the groups is significant at 0.05. One can conclude that SCA group with higher mean improved performance more than the LM group with lower mean. Similarly, for LM and CM groups, Prob (0.000) is less than the level of significance (0.05). This implies that the mean difference of the groups is significant at 0.05. One can conclude that CM group with higher mean improved Achievement in Biology more than the LM group with lower mean. Again, for CM and SCA group, Prob (0.000) is less than the level of significance (0.05). This implies that the mean difference of the groups is significant at 0.05. One can conclude that SCA group with higher mean improved achievement in Biology more than the CM group with lower mean.

Summary of Findings

The result of data analysis reveals the following:

1. There was significant interaction effect on teaching methods and gender on students' achievement in biology at posttest.
2. There was no significant interaction effect of teaching methods and gender on students' achievement in Biology at retention.
3. Significant differences did not exist by gender both at posttest and retention.

The study investigated the effect of scaffolding and concept mapping on secondary school students' achievement and retention in Biology. Three (3) research questions were raised and three null hypotheses was formulated and tested at 0.05 level of significance. The research design for this study was quasi-experimental non-equivalent control group design. The population for the study consisted of all the SS2 students of the three public secondary school selected in Obio/Akpor LGA of Rivers State. The sample comprised of 122 students of these three schools used in their intact class setting. The Researcher Made Biology Achievement Test (RMBAT) was used in collecting data for the study. The instruments was passed WAEC objective questions and periodic lesson plans which was validated by the Education measurement and Evaluation Expert, the supervisors of the research and two senior Biology teachers at Federal government College Port Harcourt. The reliability of the instrument was determined using the Kuder Richardson approach (K-R 20). The research questions raised were answered using mean and standard deviation while the hypotheses were tested using the Analysis of Co-Variance (ANCOVA) at 0.05 level of significance. Bonfernni's test of pair-wise comparison was used in finding out in which group lies the significant effect. The result of the finding revealed that scaffolding strategy significantly enhances higher achievement and retention of students in Biology than the concept mapping or lecture method.

Discussion of Findings

The results were discussed under the following headings:

1. Effect of scaffolding, lecture method or concept map on students' achievement in Biology at retention.
2. Effect of scaffolding, lecture methods or concept map on student' achievement in Biology by gender.
2. Interaction effect of teaching methods and gender on students' mean achievement score in Biology at retention.

Effect of Scaffolding, Lecture method or Concept map on Students' Retention in Biology.

The finding of this study reveal that there is significant difference in the retention mean scores of students taught using scaffolding instructional strategy than those taught using concept mapping or lecture method. The scaffolding group retained significantly higher than those thought with concept mapping or lecture method. Put differently, the difference in mean score between the groups is significantly higher in favour of the scaffolding. The implication of this finding is that scaffolding instructional strategy has a higher positive effect in promoting students' achievement in Biology at retention. This result is in consonant with the finding of Igwe in Oledibe (2015) who examined the effect of scaffolding method of instruction and concept mapping on student achievement and retention. The effectiveness of the teaching methods was also maintained at retention. Hence, application of scaffolding instructional strategy is a veritable tool for boosting of students' achievement in Biology concept. The result also corroborate with Nwakamma (2022) who stated in a study that those taught with scaffolding outperform those taught with lecture method.

Interaction Effect of Teaching Methods and Gender on Students' Retention in Biology

The result on this study showed that there was no interaction effect of teaching method and gender on students' achievement in Biology at retention. Also significant differences did not exist by gender both at post-test and retention. This result corroborate with the finding of Mbonu and Okoli (2019) whose study revealed that gender did not significantly influence students' achievement, indicating that both male and female students benefited similarly from the scaffolding.



Effects of Scaffolding and Concep Mapping Strategies on Achievement and Retention in ... Nwakamma, A. A. (2026)

Conclusion

The major result obtained from this study shows that scaffolding instructional strategy is superior to, and hence more effective than concept map or lecture method in fostering higher achievement and retention of secondary school students in Biology. It is a good teaching strategy in ensuring higher retention of Biology concept in secondary school students. And there was significant interaction effect on teaching methods and gender on students' achievement in biology at posttest.

Recommendations

Based on the findings of the study, it was recommended that students should

1. Be given enough support (scaffold) to learn on their own to enhance their achievement and retention in biology.
2. Biology teachers should undergo more training on the effective use of scaffolding instructional strategy.
3. Biology teachers should adopt the use of scaffolding instructional strategy at the secondary school level.

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