EFFECTS OF BLENDED AND SPACED LEARNING STRATEGIES ON THE PERFORMANCE OF SENIOR SECONDARY SCHOOL STUDENTS IN BIOLOGY IN EKITI STATE – NIGERIA.

[1]OLAYINKA, FOLASADE OLUYEMISI, *Ph.D* & **[2]TONIBOR, PEREFIYEBO EVELYN**
[1&2]Department of Science Education, Faculty of Education, Federal University Oye-Ekiti, Ekiti State - Nigeria.
folasade.olayinka@fuoye.edu.ng ptonibor@gmail.com
+2348066269653 +2349139019674

Abstract

The effect of blended and spaced learning strategies on academic performance of students in the field of biology was explore among secondary school students in Ekiti State, Nigeria. The study aimed at discerning any significant differences in pre-test and post-test mean scores among students exposed to these instructional strategies. The study adopted quasi-experimental, pretest, posttest (two experimental group and one control group), non-randomized control group design. 109 Biology students drawn from the secondary schools in Ekiti State were selected as the sample for the study, using multi-stage sampling procedure. Biology Performance Test (BPT) was used to collect data for the study. The reliability of the BPT was determined using Kuder Richardson 21 after carrying out a pilot testing and a reliability coefficient of 0.72 was obtained. The data from the pretest and post-test administered were analyzed using frequency count, bar charts, mean and standard deviation. The research hypotheses were tested using Analysis of Variance (ANOVA) statistics at 0.05 level of significance. The research findings reveal no significance difference (Fcal = .473, df = 106; P= 0.473) in the pre-test performance of students exposed to blended learning, spaced learning and conventional strategies in teaching biology which established the homogeneity of the group at the commencement of the experiment. Also, there was a significant difference (F = 101.138; df = 106; P<0.05) in the post test mean score of the students exposed to blended learning, spaced learning and conventional strategies. Based on the findings of the study, it is recommended among others, that educators should consider incorporating a mix of teaching strategies which could involve blending traditional methods with innovative approaches like blended and spaced learning to cater for diverse learning preferences and aptitudes among students.

Keywords*:* Biology, Teaching, Blended Learning, Spaced Learning, Strategies, Performance.

Introduction

A comprehensive understanding of biology in secondary school is essential for individuals who wish to pursue professional career in diverse disciplines, including; but not limited to medicine, nursing, culinary science, and pharmacy. A thorough understanding and mastery of biology provide the groundwork for success in these fields by offering crucial information and abilities that are fundamental to the corresponding fields. The relevance of a strong biological education is shown by how it applies to pharmaceutical research, medical practices, food industry developments, and the larger healthcare domain. Therefore, having a solid understanding of biology improves grades and is a necessary precondition for a variety of exciting and varied jobs and pre-requisite to the study of courses in the fields of medical, nursing, food science, pharmacy, and other related fields (Olayinka & Ogundare, 2023).

As important as Biology is, it becomes difficult to learn if not approach with the right instructional strategy. It would become quite difficult to get a complete understanding of concepts in biology if

the teaching is not efficient. Students need to be guided carefully and taught via a methodical manner that would avail them the opportunity to comprehend and traverse the many ideas, procedures, and relationships within the field. Thus, the significance of careful and thorough biology education cannot be understated, since it has a direct bearing on how easily students can interact with and succeed in this important scientific discipline.

The goal of teaching a subject is to transfer information through a variety of activities that are carried out by both teachers and students (Rajagopalan, 2019). Teaching methods in this context encompasses the many strategies and techniques that teachers and students use throughout the course of a lesson. These techniques are intended to make it easier for students to master concepts, information, abilities, and values that are in line with the goals and objectives of the lesson (Rajagopalan, 2019). Researchers have noted that teachers often gravitate towards teaching approaches that align with their personal interests, convenience, and familiarity, typically favoring methods they have used extensively. These approaches tend to be teacher-centered, emphasizing the instructor's preferences rather than prioritizing the needs and perspectives of the students (Falebita & Olofin, 2020). This teaching approach is commonly referred to as traditional teaching method. Olayinka (2019) argues that traditional learning takes place in a classroom setting where information is passed directly from teacher to student in an oral and written format. The student takes on more of a passive role as a receiver in this kind of instruction.

Traditional teaching methods are deemed insufficient since they rely on a one-way flow of information from teacher to student. These approaches have been particularly criticised for teaching biology and other science subjects. This method falls short in that it doesn't help students build the necessary process skills for an extensive understanding of the subject (Safia & Jawaid, 2013; Gillies, Nichols, Burgh and Haynes, 2014). One hallmark of traditional teaching is its focus on imparting knowledge, with memorization often serving as the mode of learning. There is therefore need for Biology teachers to utilize methods that are students centered, methods that allows active interactions between the teacher and the students

Blended learning, which combines online learning with more conventional classroom teaching, has become a popular approach to education in the modern day as it gives learner the privilege to learn at their pace. This provides teachers with new ways to get students involved and improve their learning as the adoption of technology brings dynamism into the classroom. Blended learning methods provide students with opportunity to have more control over their learning and more prospects for interaction and collaboration (Means, Toyama, Murphy & Baki, 2013).

An increasing number of academic fields are adopting blended learning as a pedagogical strategy mostly after the pandemic. This method combines traditional classroom teaching with access to online resources or instruction. It provides learners with the opportunities to learn at their own pace and as well encourage critical thinking. Blended learning provides a flexible framework that expands students' access to learning materials beyond the four walls of a typical classroom. Digital tools, multimedia materials, and interactive platforms are being used in the classroom to increase student engagement, accommodate different learning styles, and encourage students to study independently.

Blended learning is a kind of online education that combines online learning with conventional classroom instruction via the use of computers, intranets, or smart classrooms. In this approach, students and instructors engage in individual, and the course is designed to encourage interaction

between the two. It evolved naturally from computer-assisted and programmed learning. Blended learning was defined by the researchers as a novel learning strategy that combines conventional learning in its many forms with e-learning in its various models in order to boost student enthusiasm and academic success. Maccoun (2016), Khader (2016) and Okaz (2015) were at different times confirmed BL as an effective learning strategy which helps in improving students' academic achievement. Wei, et al. (2017) reveal that the effect of blended learning on the performance of students when compared to those taught with traditional method was not significant. It was also concluded by Tosun (2015) that BL has no positive impact on the achievement of students.

Spaced learning, as identified by Smolen, Zhang & Byrne (2016), is a teaching strategy designed to enhance information retention through the utilization of the spacing effect. This phenomenon, also known as the advantage of scattered practice, has been extensively studied for over a century (Cohen & Yean, 2013). The key principle of spaced learning involves distributing learning sessions over time with intermittent breaks (Pavlo, 2010). Shana (2022) emphasizes that spaced learning allows students to reinforce and consolidate their understanding of biological concepts effectively. By spacing out study sessions, individuals benefit from increased opportunities for long-term retention and a deeper comprehension of the subject matter. This pedagogical approach includes three rounds of condensed learning material, each followed by two or three 5 to 10-minute breaks for distraction-free activities, often involving physical activity.

Ejinwa (2019) points out that spaced learning, based on neuroscience research findings, was specifically designed to enhance long-term memory retention. The strategy involves breaking a lecture into up to three learning sessions, each followed by a break of two to ten minutes. The same material is covered three times over the learning periods, contributing to a more comprehensive understanding. Pavlov (2010) notes that researchers, including Cohen & Yean (2013), have employed various methods, such as the use of repeated, spaced stimuli, to comprehend the mechanisms involved in long-term memory (LTM). Fabiyi & Binuyo (2022) suggest that for optimal learning outcomes, it is advisable to distribute study, review, or practice sessions over time rather than conducting them consecutively, even when the overall study time remains constant. In summary, spaced learning emerges as a well-supported and effective approach to maximize the benefits of the spacing effect for enhanced information retention and understanding in STEM education.

According to Ejinwa (2019), these essential parts make up a standard spaced repetition system: (1) A plan for when information will be reviewed; Regular intervals such as several minutes, an hour, a day, every other day, weekly, biweekly, monthly, or every six months are typical in most systems. (2) Pick a pattern for the distances between objects. Regular time allotted for reviewing material; The focus and memory both suffer following practice for lengthy periods of time. Similarly, it takes a lengthy enough session to really immerse oneself. It is generally advised to keep review sessions to no more than 30 minutes, with a brief rest in between.

Fs blog (2018) states that spacing effect is much better for learning and remembering things. Spacing is a phenomenon that helps us remember things better when we learn them in smaller, more spaced-out chunks. Using spaced repetition, we can gradually learn almost anything by capitalizing on this effect. You may obtain near perfect recall using a learning approach called spaced repetition. It neatly organizes knowledge. According to Lambert (2009), learning that is both extensive and spread out

over a lengthy period of time does not seem to be effective. Simply put, the notion of spacing effect states that information may be better retained when presented and repeated at regular intervals.

Fabiyi & Binuyo (2022) revealed from their study on the effect of spaced and blended learning on students' performance in Mathematics that the spaced learning group outperformed both the blended learning and conventional groups, with the blended learning group demonstrating superior performance compared to the conventional group. Adeleye & Omotayo (2020) opine that both spaced learning and blended learning increased students' interest in biology compared to the traditional method. To the best of the researchers' knowledge, there are not many studies on the effect of blended learning and spaced learning on students' performance in biology. Giving the paucity of studies, the researchers believe it is essential to investigate the effects of blended learning and spaced learning on students' biology performance.

The exploration of blended learning and spaced learning's impact on students' performance in biology appears to be a relatively uncharted or less explored area. With a noticeable scarcity of studies in this area, the researcher underscores the significance of delving into the effects of both blended learning and spaced learning methods on students' performance in biology among secondary schools' students. Due to the highlighted research gap, a full analysis is required to shed light on the possible effects of these learning methods on students' biology performance.

The Problem

In Nigeria, students' performance in secondary school biology has not been encouraging. According to WAEC Chief Examiners' report, there has been a poor record of students' performance in biology over the years. Despite its popularity, students' performances are low reflected at the senior school certificate examinations over the years. Evidence indicates that students are facing challenges in performing well in the subject, as reflected in both the West African Examination Council (WAEC) and the National Examination Council's (NECO) Secondary School Certificate Examinations.

The WAEC results showed that for the over one million students that registered for biology annually, 49.47%, 38.28%, 35.67%, 51.73%, 55.07%, 53.21%, 73.82%, 65.85%, 62.49%, 74.42% and 84.65% passed at A-C6 level for 2010,2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 and 2020 respectively. Teachers' inappropriate use of instructional approaches, insufficient facilities, disorganized laboratory activities, students' and teachers' lack of dedication to lab work, a poorly equipped lab, a shortage of competent biology teachers, and the methods used for conducting laboratories are all factors that have contributed to students' poor performance in biology classes. This needs immediate action if we are to keep up with this challenging and continuously growing body of knowledge and knowledge and achieve the SDGs (Watts, 2013).

The poor performance of students could be attributed to inadequacy of the method of teaching adopted by the biology teachers. This study examined the effects of blended and spaced-learning on senior secondary school students in Biology in Ekiti State, Nigeria.

Research Question

To guide the study, a research question was raised:

i. What are the effects of blended learning, spaced learning and conventional strategies on the academic performance of the students in Biology?

Research Hypotheses

The following null hypotheses were developed for this study in an effort to provide answers to the problems highlighted above:

i. Students exposed to blended learning spaced learning and conventional learning strategies do not exhibit a significant difference in their pre-test mean performance in Biology.
ii. Students exposed to blended learning, spaced learning and conventional learning strategies do not exhibit a significant difference in their post-test mean performance in Biology.

Methodology

The research employed a quasi-experimental design with three groups, involving pre-test and post-test assessments. Two groups were designated as experimental, and one served as the control. The pre-test aimed to establish homogeneity among the groups, while the post-test assessed students' performance in biology. The population of the research comprised all 5,378 SSS 2students offering biology in all the public secondary schools in Ekiti State, Nigeria. The sample comprised 109 Biology students selected from intact classes in three public secondary schools in Ekiti State, Nigeria, using a multistage sampling technique. In the first stage, one Local Government Area (LGA) was randomly chosen from each of the three senatorial districts in Ekiti State. Following this, a stratified random sampling approach was used to select one public secondary school from each chosen LGA. For the third stage, schools with dependable electricity, computers, and computer accessories were purposefully included in the study. At the fourth stage, the random grouping of schools into two experimental groups was carried out. The participants were Senior Secondary Class two students in an intact class.

Biology Performance Test (BPT) was the instrument used for data collection. The instrument was divided into Sections A and B. Section A collected the respondents' biodata, including school name, identification number, location, and gender. Section B comprised 25 objective items with four options, covering all topics taught during the study.

The study utilized the BPT for both pre-test and post-test data collection. The pre-test aimed to assess the homogeneity of the three groups, with question options shuffled for the post-test to prevent a carry-over effect. The instruments' face and content validity were ensured by experts in Tests and Measurement, Biology teachers, and the researcher's supervisor.

To assess the instruments' reliability, the internal consistency of the BPT was determined using Kuder Richardson (KR21). The resulting reliability coefficient values of 0.72 were considered statistically high, indicating that the instruments were reliable for the study's purposes.

The data from the pretest and post-test administered were analyzed using frequency count, bar charts, mean and standard deviation. The research hypotheses were tested using Analysis of Variance statistics at 0.05 level of significance.

Results

The responses to research questions and the testing of hypotheses are as follows:

Research Question One: What are the effects of blended learning, spaced learning and conventional strategies on the academic performance of the students in Biology?

Table 1: Mean and Standard Deviation of Pre-test and Post-test Scores for the Groups.

Strategies	Test	N	Mean	S.D.	Mean Diff.
Blended Learning	Pretest	35	16.14	2.63	**37.26**
	Posttest		53.40	3.54	
Spaced Learning	Pretest	34	15.44	2.54	**42.06**
	Posttest		57.50	4.57	
Conventional	Pretest	40	15.58	2.47	**18.70**
	Posttest		34.28	11.29	
Total		**109**			

Table 1 revealed the effect of blended learning, spaced learning and conventional learning strategies on senior secondary school students' performance in biology. The mean difference in performance scores for Biology students between the pre-test and post-test in the blended learning group is 37.26, spaced learning group is 42.06while conventional learning group is 18.79. It appears that the treatment influences students' performance in Biology as the performance mean score of the spaced learning group is greatest while that of the blended learning group is greater than the conventional learning group. The chart below provides additional insight into the impact of blended learning, spaced learning, and conventional learning strategies on the academic performance of senior secondary school students in biology.

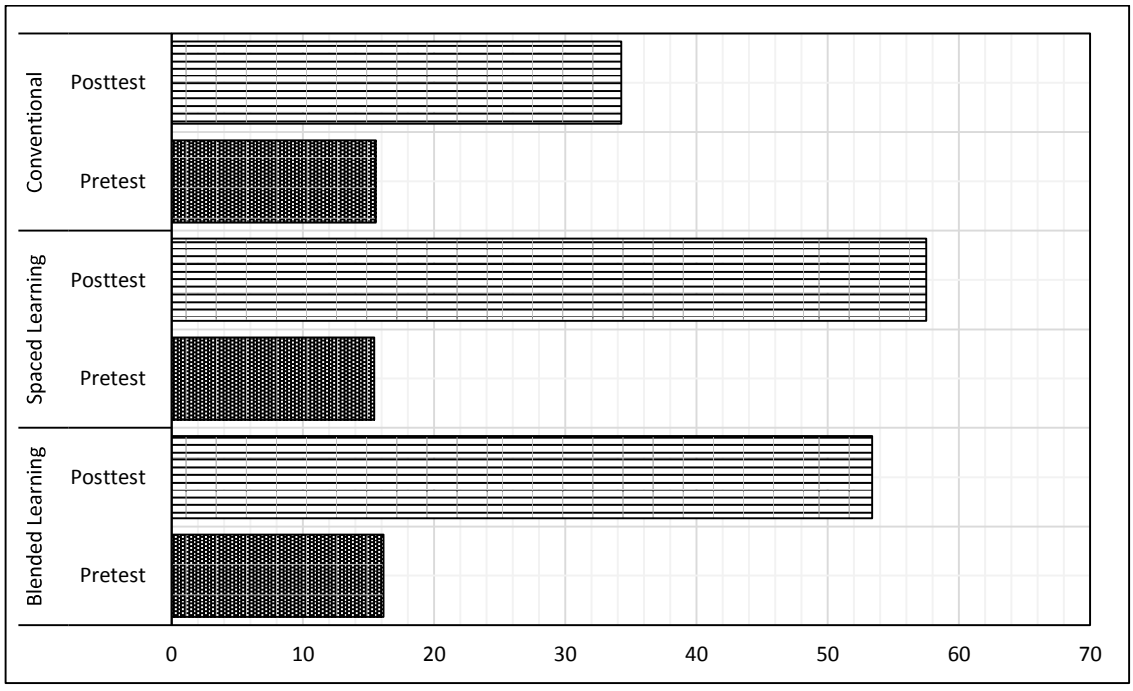

Figure 1: A bar chart illustrating the mean scores of students in Biology for both the pre-test and post-test periods in both experimental and control groups.

Hypothesis 1: Students exposed to blended learning spaced learning and conventional learning strategies do not exhibit a significant difference in their pre-test mean performance in Biology.

Table 2: ANOVA of the Pre-Test Mean Scores of Students in Biology in the Experimental and Control Groups

Group	N	Mean	SD	DF	F-value	Sig.	Remark
Blended Learning.	35	16.14	2.63	106	.754	.473	NS

Spaced Learning	34	15.44	2.54
Conventional.	40	15.58	2.47
Total	109	15.72	2.54

Sig. at $p < 0.05$; $MS_{Btw} = 4.870$; $MS_{Within} = 6.457$

The result presented in table 3 shows that there is no significance difference (F_{cal} = .473, P= 0.473) at 0.05 level of significance. This result led to non-rejection of the hypothesis. By implication, students exposed to blended learning spaced learning and conventional learning strategies do not differ significantly in their pre-test mean performance in Biology. This is also an indication that the groups were homogenous at the commencement of the experiment.

Hypothesis 2: Students exposed to blended learning, spaced learning and conventional learning strategies do not exhibit a significant difference in their post-test mean performance in Biology.

Table 4: ANOVA of the Post-test Mean Scores of Students in Biology in the Experimental and Control Groups

Group	N	Mean	SD	DF	F-value	Sig.	Remark
Blended Learning.	35	53.40	3.54		101.138	.000	
Spaced Learning	34	57.50	4.57	106			S*
Conventional.	40	34.28	11.29				
Total	109	47.66	12.80				

Sig. at $p < 0.05$; $MS_{Btw} = 5805.783$; $MS_{Within} = 57.404$

Table 4 revealed that students in the Blended learning group had posttest mean score of 53.40 and standard deviation of 3.54. also, the spaced learning group had posttest mean score of 57.50 and standard deviation of 4.57, while their counterparts in the conventional group had posttest mean score of 34.28 and standard deviation of 11.29. The table revealed significant difference: (F = 101.138; df = 106; $P < 0.05$). Hypothesis 2 is therefore rejected. This shows that students exposed to blended learning, spaced learning and conventional learning strategies do differ significantly in their post-test mean performance in Biology.

Discussion of the Findings

The finding of the study reveals that there is no significance difference in the pre-test mean scores of students taught biology using the blended learning, spaced learning, and conventional strategies. This implies that, prior to the intervention; students across these groups were, on average, at a similar level of understanding in biology. This aligns with the assumption that the random assignment of students to these teaching methods resulted in comparable groups at the outset.

Also, from the finding of the study, it was shown that there was significant difference in the post test mean score of the students exposed to blended learning, spaced learning and conventional strategies. The finding of the study aligns with the submission of Fabiyi & Binuyo (2022) who revealed that blended learning and spaced learning were both more effective in enhancing students' performance when compared with the conventional learning strategy. The finding of the study also indicates that there is significant difference in the pre-test and post-test mean score of students exposed to blended, spaced and conventional strategies. This implies that the instructional methods did not merely maintain the status quo but actively influenced changes in students' understanding of biology. This study also highlights that students' performance improves more with spaced learning than blended learning while students' performance is better with blended learning than conventional

learning strategy. This finding conforms with Maccoun (2016) and Khader (2016) and Okaz (2015) who have shown that blended learning helps in improving students' academic performance. This dynamic aspect of the learning process highlights the potential of these strategies to foster meaningful shifts in students' knowledge, suggesting that educators should consider not only the starting point but also the trajectory of learning outcomes when selecting teaching approaches.

Conclusion

In conclusion, spaced learning and blended learning strategies are effective in enhancing students' academic performance in biology. Also concluded in the study is that spaced learning strategy is more effective than blended learning and conventional learning strategies in improving students' academic performance in biology. Also, blended learning strategy has demonstrated more potency in improving students' academic performance than the conventional learning strategy.

Recommendations

Based on the findings of the study, the following recommendations were proposed to optimize biology instruction and enhance student outcomes:

i. Biology teachers should embark on diversification of teaching strategies. Dynamism should be brought into the choice of instructional approach.
ii. Teachers should implement blended learning and spaced learning approaches for biology instruction in secondary schools.

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