

EFFECT OF BLENDED LEARNING ON STUDENTS' ACADEMIC ACHIEVEMENT IN BIOLOGY IN EBONYI STATE

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Abstract

The study investigated the Effect of blended learning (BL) on Students' Academic Achievement in Biology in Ebonyi State. Three (3) research questions guided the study, and three (3) null hypotheses were formulated and tested at the 0.05 level of significance. The design used was a quasi-experimental, pre-test and post-test non-equivalent control group design, for a population of 496 SS1 biology students in Ikwo L. G. A. of Ebonyi State. The sample size was 83 students from intact classes of two schools. One school was randomly assigned to the experimental group and taught using BL, while the other was assigned to the control group and taught with the lecture method. The instruments used to collect data for the study were the Biology Achievement Test (BAT), face-validated by experts in biology education, and measurement and evaluation. The reliability index of BAT, determined using the Kuder-Richardson formula (KR-20), was 0.80. Research questions were answered using mean and standard deviation, while Analysis of Covariance (ANCOVA) was used for testing the formulated hypotheses. The findings of the study were that BL was more effective than the lecture method in enhancing the academic achievement of the students in biology; there was no significant difference in the academic achievement scores of male and female students when taught biology with BL; there was no interaction effect of methods and gender on the academic achievement of the students in biology. The study recommended Government funding of educational training and the provision of adequate computers at schools for staff and students' blended learning in schools.

Keywords: Biology, Academic Achievement, Blended Learning, Conventional Method of Teaching, Gender

Introduction

Biology is a scientific discipline that encompasses the study of living organisms and their interactions with the environment (Odimekpa et al., 2024). It explores various levels of biological organization, ranging from molecules and cells to organisms and ecosystems, contributing to the understanding of fundamental processes such as evolution, genetics, physiology, and ecology. The field of biology is integral to numerous interdisciplinary subjects, including medicine, agriculture, environmental science, and biotechnology. Advancements in molecular biology, genetics, and biotechnology have revolutionized our understanding of life processes and have significant implications for medical research, genetic engineering, and the development of novel therapeutic interventions (Nwaokolo, 2023). In contemporary education, biology provides students with up-to-date insights into various aspects of life sciences. From genetics and molecular biology to ecology and environmental science, it enables learners to explore cutting-edge research and developments that shape our understanding of life on Earth (Dwiastuti et al, 2021). Moreover, biology curricula often incorporate practical laboratory experiences, enabling students to apply theoretical knowledge and engage in hands-on experimentation, which is crucial for developing

scientific expertise (Odimkpa et al., 2024). Its relevance in education is underlined by the continuous advancements in the field and its profound impact on our understanding of life and the world we inhabit. It is the key to economic, intellectual, sociological, and human resource development and the well-being of any society. That is why there is a need for Biology to be properly taught not just in secondary schools but in tertiary institutions to improve students' achievement in the subject.

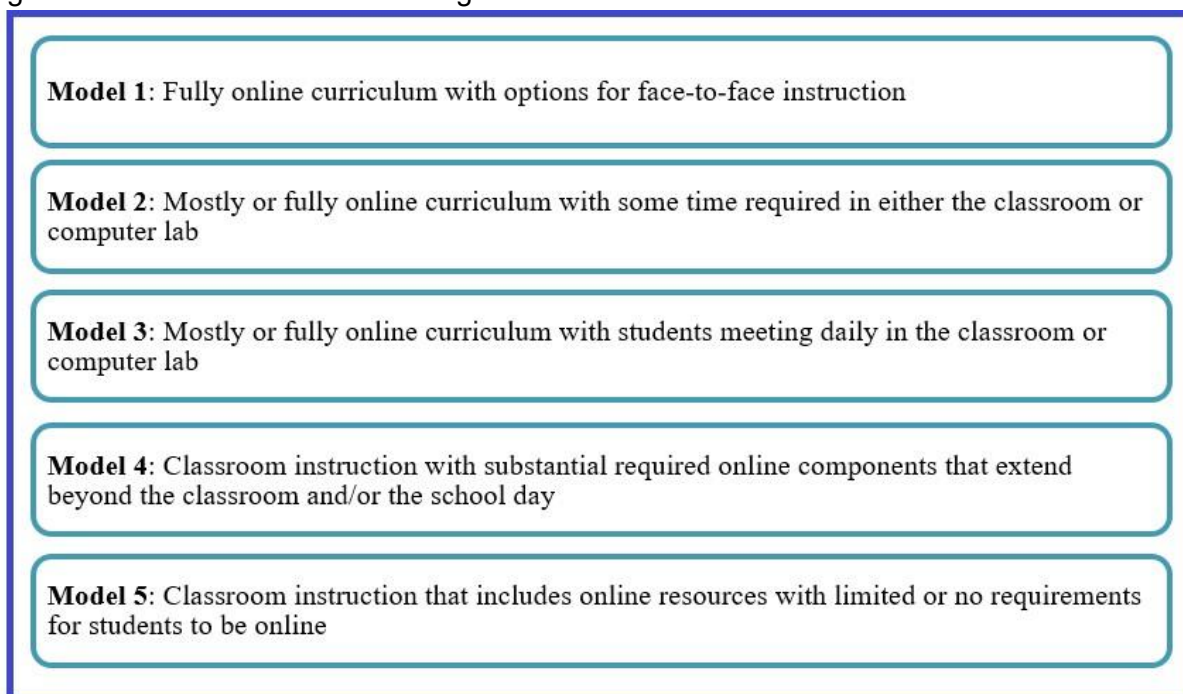
Academic achievement in biology is a critical indicator of a student's understanding of biological concepts and their ability to apply them effectively in academic settings (Smith, 2017). However, it has been observed by many researchers that biology students persistently have low academic achievement in biology. Despite the importance of biology, the West African School Certificate Examination Council (WASSCE) has observed that biology students fail certain aspects of the subject. Many reasons have been advanced for this fluctuating state of students' achievement in Biology. Some of the reasons for the poor achievement have been attributed to the wrong application of teaching strategies and techniques (Udu, et al. 2020; Bulus & Bwari, 2023). The lecture teaching method has been the most frequently used method for teaching biology in Nigerian secondary schools. It is strictly teacher-centered and authoritarian in nature. In this type of learning environment, students' participation is minimal. The use of the lecture method has been found to have negative effects on most of the students, which reduces their concentration in class. For students to concentrate and participate actively in class, it means that teachers should shift from teacher-centered methods of instruction to student-centered instructional strategies. Methods used during the teaching and learning process play a very significant role as they help in the deep understanding of the concepts to be learned. Teachers thus need to learn and apply new pedagogy, such as technology-mediated methods to their classroom instruction. The rapid advances in information and communications technologies (ICTs) have acted as a catalyst for educational transformation in recent years the world over (Abamuche & Ibe, 2022). Nigeria is also attempting to take advantage of this technological revolution in order to make strides in the advancement of science education. Nowadays, due to rapid advancement in technology, there are huge gaps in the subject material used in the past and that used at present (Abdullah, 2023). There is now a shift in the roles of both teachers and students, along with classroom settings and schools. Learning is now been upheld with numerous technologies, like radio, TV and internet learning with computer-based learning and with web-based learning. Technology has appeared as maps, slides, diagrams, models, computers, overhead projectors, iPads, interactive white sheets, and internet-based life, for example, Facebook, WhatsApp, online journals, podcasts, Instagram, wikis, and so forth, These has led to a shift in the educational approach from a teacher-centered to a student-centered approach where the learner structures the information and the teacher only acts as a facilitator (Nwaokolo, 2023). These technologies offer tremendous hope towards meeting the present-day educational challenges of a lack of access to quality education. Therefore, there is a growing consensus that Ebonyi state needs to explore the potential of technology-mediated education if it is to survive in the global competitive digital world (Odimkpa et al, 2024). Some literature on ICTs for education reveals that one trend for improving quality in education involves BL (Abamuche & Ibe, 2022; Bulus & Bwari, 2023). BL refers to designing and delivering the right content in the right format using the right mix of media (AL-Muqaiseeb, 2022).

Blended learning is a mixture of traditional and online learning. It is an innovative method used in the teaching and learning process to enhance the understanding level of students (Radulović et

al., 2023). BL supports all the benefits of e-learning (asynchronous), including cost reductions, time efficiency, and location convenience for the learner, as well as the essential one-on-one (synchronous) personal understanding and motivation that face-to-face instruction presents. BL is a type of e-learning where e-learning is incorporated and combined in one system with conventional learning. In this form, e-learning tools, Lessons, seminars, and training workshops are mostly held in actual classrooms with internet access, whether computer-based or networkbased, which is the flipped classroom in BL (Abamachi & Ibe, 2022). Additionally, BL, according to Volodavchyk (2022), is the extensive use of media in electronic teaching in conjunction with conventional teaching approaches.

Blended learning requires the instructor to be capable of using digital teaching methods, and students to be able to use technology such as laptops, the internet, and email, which assist in translating this education to schoolrooms (Dwiastuti et al, 2021). Blended curriculum is a successful emerging approach in terms of preparing students for lifelong learning. It attempts to improve analytical and innovative thinking skills. BL is anchored on Piaget's theory of cognitive development, which argues that people can produce knowledge and form meaning to the knowledge acquired based on their experience (Abamuche & Ibe, 2022). Piaget believes that for people to learn, they must assimilate and accommodate. BL environments can provide opportunities for learners to engage in hands-on activities, experiments, and problem-solving tasks, both online and offline. This experiential learning approach helps learners actively construct their understanding in meaningful ways, promoting a deeper understanding of concepts, allowing for individualized and differentiated instruction to cater to the varying needs and abilities of learners (Udu, 2020). Alsalmi et al (2021) found that BL can be applied using a variety of models. The models are shown in Figure 1 below.

Figure 1: Models of Blended Learning



BL integrates indirect and direct e-learning forms and often involves the intranet and the internet. Among others, components applied in BL are web-based tests, simulations, and emails. Three

major models, namely, competency-based, skill-oriented, and attitude-based, can be used in BL. Each model entails an overview of topics to be covered (AL-Muqaiseeb, 2022). Also, they involve the announcements of the initiatives that shall be involved in the delivery of educational ideas during classroom sessions. While teachers and class training sessions offer intermediate fundamental education, learning programs that provide research resources and study materials directly on the internet would be an example of a blended type.

The importance of BL in the educational environment has been illustrated in several reports. Previous findings have demonstrated the effectiveness of integrated learning, causing the attainment of multiple educational advantages in cognitive, behavioral, psychomotor, and emotional abilities, according to the study of previous studies. In Areji and Onuba (2022), the researchers mentioned that in BL, students pause the lesson at any time and resume watching it later. Furthermore, students could watch the lesson several times over a period of time. According to Umeana et al (2022), the activities and experiences of the schoolroom, content, and the instructor inspire and empower learners to learn more intensely, resulting in a greater understanding of the intellectual content.

Many researchers in these studies have focused on the impact on achievement as a dependent variable because of its significance in improving teaching methods and better reflecting the improvement of the learners' skills, talents, attitudes, and interests in learning (Udu, 2017). Both research works' findings showed that BL has a significant effect on students' academic success. Several findings have shown that BL improves academic performance, increases enthusiasm, and fosters optimistic attitudes toward science learning. Among these studies are the following: a study conducted by Abamuche & Ibe (2022), Olatunde-Aiyedun (2022), and Dwiastuti et al (2021) confirmed the influences of BL on undergraduate students' self-efficacy and achievement on difficult science topics. The findings showed that the BL setting had generated a significant difference in students' academic achievement, to the benefit of the experimental group. Likewise, Alsahhi et al (2021) identified the impact of a BL on learning outcomes and skills of the scientific method on students of a statistics Bluman course at the University of Ajman. Their results indicate that, when compared to the traditional learning approach, the BL strategy was substantially more successful in improving students' comprehension of the topics taught in the statistical course, with the experimental group's grades being better than the control group. Also, these findings are in line with those of Radulović et al (2023), who compared the BL experience to a conventional learning environment in order to assess students' academic success. The results indicated that the averages of the final test grades of the experimental group students were higher than those of the control group students. Nnoli and Ugwuoti (2024) conducted a study with 87 Biology students in Awka educational zone, Nigeria, investigating the effect of the BL approach on secondary school students' academic interest. The findings of the study revealed that students taught with BL significantly improved in their interest in learning biology more than those in the control group. Similarly, Njoku (2024) investigated the effect of the BL method on students' academic achievement in Biology in secondary schools in Obio/Akpor, Rivers State. The result revealed that there is a significant difference in the mean score of students taught Biology with BL and those taught with the discussion method in favour of BL. This research has confirmed that integrated learning increased students' motivation to study and enhanced their academic achievement. Nonetheless, the results were on related works but are different because of the level of education, geographical limitation, methods of teaching, population, sample size, instrument used for data collection, and did not investigate the interaction of gender and teaching

method on the students' academic achievement when BL was used as the teaching method. To bridge the yawning gaps, the study seeks to investigate the effect of Blended Learning on the achievement of students in Biology in Ebonyi State.

Gender refers to the cultural characteristics of both males and females and is a social connotation with a strong psychological foundation. According to Odimkpa et al (2024), it is used to refer to particular cultural patterns of behavior that are ascribed to human sexes. Girls, women, males, and people who identify as having a different gender all have roles, behaviors, expressions, and identities that are socially constructed. It affects how people behave and interact, see themselves and other people, and how authority and resources are distributed in society (Eya et al, 2024). Gender disparities in academic achievement have been a subject of significant concern and research in the field of education. While gender should not be a determining factor in one's academic success, various factors and societal expectations can influence the educational outcomes of individuals. Research by Odimkpa et al (2024) suggests that gender differences in academic achievement may begin to emerge as early as elementary school. These early disparities can have long-term consequences for educational trajectories and career choices. For example, girls may feel less confident in pursuing science, technology, engineering, and mathematics fields due to stereotypes that suggest these subjects are more suitable for boys (Eya et al, 2024). In biology, in teaching about subjects like reproduction and sex hormones, it was noticed that female students were less engaged, active, and open-minded than their male peers. Gender disparities have also been recorded by some researchers in online learning. At the early stage of Internet use, the main online gender difference was that there were more men than women using the Internet. However, with the recent advances and development in Internet technologies, such online gender differences are believed to be less significant. In another study, Dang et al. (2016) found that women were more likely to use the Internet as a communication tool while men tended to use it as a way of information seeking. In technology-supported learning, some research also identified considerable gender differences. They found that female students had less computer knowledge and fewer computing experiences than male students. In addition, female students were more anxious about using computers and presented lower levels of general computer self-efficacy when compared with their male counterparts. It is therefore imperative to investigate the interaction effect of teaching methods and gender on male and female students' achievement in biology. **Statement of the problem**

The persistent poor achievement of students in Biology, as revealed by research results, calls for concern, especially for teachers of Biology. The problem has to a large extent been attributed to the ineffective teaching methods employed by the teachers, especially the lecture teaching method, which is teacher-centered. There is an urgent need to improve the quality of education to bridge the gap between developed and developing nations, and BL should be considered as a tool for this purpose. Studies have shown the importance of blended learning in the teaching of Biology. This study, therefore, is geared towards finding out if the use of blended learning could bring a solution to the problem of poor achievement of students in biology.

The following research questions were raised to guide the study:

1. What is the difference between the mean achievement scores of students taught biology using BL and those taught with the conventional method?
2. What is the difference between the mean achievement scores of male and female students taught biology using the BL instructional approach?

3. What is the interaction effect of teaching method and gender on students' achievement in biology?

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

Ho₁: There is no significant difference in the mean achievement scores among students taught biology using the BL instructional approach and those taught without the blended learning instructional approach.

Ho₂: There is no significant difference in the mean achievement scores of male and female students taught biology using the BL instructional approach.

Ho₃: There is no significant interaction effect of teaching methods and gender on students' achievement in biology.

METHODOLOGY

This study adopted the non-equivalent pre-test, post-test control group quasi-experimental design. Both the experimental and control groups were pre-tested to establish baseline equivalence, exposed to different instructional treatments, and later post-tested to measure the effect of the intervention.

The population was 496 Senior Secondary One (SS1) biology students in Ikwo L G. A. of Ebonyi State.

The sample size was eighty-three (83) SS1 students, made up of fifty (55) females and twentyeight (28) males from intact classes of two schools. Intact classes were used to avoid disruption of the normal school timetable. The two schools were randomly selected using a simple coin toss. One school was randomly assigned to the experimental group and taught using BL, while the other was assigned to the control group and taught using the lecture method. The experimental group had 13 males and 30 females, while the control group had 15 males and 25 females.

The instruments used to collect data for the study were a researcher-developed Biology Achievement Test (BAT), face-validated by experts in biology education, and measurement and evaluation. The reliability index of BAT, determined using the Kuder-Richardson formula (KR-20), was 0.80. BAT consisted of two sections: Section A collected demographic information such as school name, class, and gender, while Section B measured students' academic achievement in Biology using the BAT, which contained 20 test items. The test items were drawn from Photosynthesis, which is among the topics in the SS1 Curriculum. The instrument (BAT) was designed in a multiple-choice test format. Each test item has four options: A, B, C, and D, with only one correct answer among the options, while the other three serve as distractors. The items were drawn using a table of specifications. Any correct answer was awarded one mark and scored in percentage; hence, the minimum score was 0% while the maximum score was 100%. The research questions were answered using mean and standard deviation, while the hypotheses were tested using a two-way Analysis of Covariance (ANCOVA) at a 95% confidence level.

Results

Research question 1: What is the difference between the academic achievement mean scores of biology students taught with the blended learning teaching method and the conventional method?

Table 1: Pre-test, Post-test, and Standard deviation of Mean Achievement Scores of Students Taught Biology with Blended learning teaching method and Lecture Method

Method	N	Pre-test		Post-test		Gain
		Mean	SD	Mean	SD	
		11.02	3.07	20.65	4.34	9.63
Control (LM)	40	9.05	2.97	16.13	5.62	7.08
Total/Gain Score Difference	83	10.07	3.16	18.47	5.47	2.55

Table 1 shows that the students in the experimental group had a pre-test mean score and standard deviation of 11.02 and 3.07, with a post-test mean score and standard deviation of 20.65 and 4.34, respectively. The result shows a mean gain score of 9.63. Likewise, the students in the control group had a pre-test mean score and standard deviation of 9.05 and 3.97, with a post-test mean score and standard deviation of 16.13 and 5.62, respectively. The result shows a mean gain score of 7.08. These results show that the experimental group taught biology with BL had a higher mean achievement gain score than their counterparts in the control group taught with the lecture method, with a mean achievement gain score difference of 2.55.

Research question 2: What is the difference between the academic achievement mean scores of male and female students taught with the blended learning teaching method?

Table 2: Pre-test, Post-test, and Standard Deviation of Mean Achievement Scores of Male and Female Students taught Biology with BLM

	N	Post-test				Pre-test Gain
		Mean				
		Mean	SD	SD	Score	
Gender		Mean	SD		SD	Score
Male	13	10.31	3.09	19.00	5.24	8.69
Female	30	11.33	3.06	21.37	3.76	10.04
Total/Gain Score Difference	43	11.02	3.07	20.65	4.34	-1.35

Table 2 shows that the male students had a pre-test mean score and standard deviation of 10.31 and 3.09, with a post-test mean score and standard deviation of 19.00 and 5.24, respectively, and a mean achievement gain score of 8.69. On the other hand, the female students had a pre-test mean score and standard deviation of 11.33 and 3.06, with a post-test mean score and standard deviation of 21.37 and 3.76, respectively, and a mean gain score of 10.64. This result shows that the female students in the experimental group had a higher mean achievement gain score than their male counterparts, with a numerical difference of -1.35. Furthermore, the standard deviation of the female students in the post-test was lower than that of their male counterparts. This implies

that the individual scores of the female students were more clustered around their overall mean than the individual scores of their male counterparts.

Research question 3: What is the interaction effect of method and gender on students' academic achievement in Biology?

Table 3: Adjusted Mean Achievement Scores and Standard Error of Method and Gender Interaction

Dependent Variable: Post-test score

<u>Group</u>	<u>Gender</u>	<u>Mean</u>	<u>Std. Error</u>	<u>95% Confidence Interval</u>	
				<u>Lower Bound</u>	<u>Upper Bound</u>
Experimental	Male	19.00 ^a	1.39	16.24	21.76
	Female	21.37 ^a	0.94	19.49	23.25
Control	Male	15.20 ^a	1.32	12.57	17.83
	Female	16.68 ^a	1.01	14.67	18.69

a. Covariates appearing in the model are evaluated at the following values: Pretest = 10.07.

Table 3 shows the adjusted mean achievement scores and standard errors of the students to determine the interaction of method and gender. The Table shows further that the adjusted mean achievement score of the female students in the experimental group was higher than that of their male counterparts. On the other hand, the adjusted mean achievement score of the female students in the control group was also higher than that of their male counterparts.

Testing of the Null Hypotheses

Hypothesis 1: There is no statistically significant difference in the achievement mean scores of students taught Biology with the blended learning teaching method and the conventional lecture method.

Table 4: Summary of ANCOVA Results of Mean Achievement Scores of Students taught Biology with Blended learning teaching Method and Lecture method

Tests of Between-Subjects Effects

Dependent Variable: Post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	495.87 ^a	4	123.97	4.95	0.00	0.20
Intercept	2198.69	1	2198.69	87.82	0.00	0.53
Pre-test	0.00	1	0.00	0.00	0.99	0.00
Method	305.47	1	305.47	12.20	0.00	0.14
Error	1952.81	78	25.04			
Total	30763.00	83				
Corrected Total	2448.68	82				

a. R Squared = 0.203 (Adjusted R Squared = 0.162)

The results in Table 4 show that there was a statistically significant difference in the post-test mean scores ($F(1,78) = 12.20, p = 0.00 < 0.05$) between the experimental and control groups. Therefore, the null hypothesis 1 (H_01), which states that there is no statistically significant difference in the achievement mean scores of students taught Biology with a blended learning teaching method, and those taught with the conventional lecture method, was, therefore, rejected at a 0.05 alpha level. This means that the earlier observed difference in the mean academic achievement scores of the students in the two groups, as shown in Table 1, was statistically significant.

Hypothesis 2: There is no statistically significant difference between the academic achievement mean scores of male and female students taught biology with the BL teaching method.

Table 5: Summary of ANCOVA Result of Mean Achievement Scores of Male and Female Students Taught Biology with Blended learning teaching method

Tests of Between-Subjects Effects

Dependent Variable: Post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	55.52 ^a	2	27.76	1.51	0.23	0.07
Intercept	1379.74	1	1379.74	74.96	0.00	0.65
Pre-test	4.72	1	4.72	0.26	0.62	0.01
Gender	54.44	1	54.44	2.96	0.09	0.07
Error	736.24	40	18.41			
Total	19130.00	43				
Corrected Total	791.767	42				

R Squared = 0.070 (Adjusted R Squared = 0.024)

The results in Table 5 show that there was no statistically significant difference in the mean achievement scores ($F(1,40) = 2.96, P = 0.09 > 0.05$) between the male and female students taught with the BL in biology. Therefore, the null hypothesis 2 (H_02), which states that there is no statistically significant difference between the academic achievement mean scores of male and female students taught biology with the BL, was accepted at a 0.05 alpha level. This implies that the earlier numerical difference observed in the mean academic achievement scores of the students, as shown in Table 2, was not statistically significant.

Hypothesis 3: There is no significant interaction effect of method and gender on the students' academic achievement in Biology.

Table 6: Summary of One-way Analysis of Covariance Results of the Interaction Effect of Method and Gender on Academic Achievement of Students Tests of Between-Subjects Effects

Dependent Variable: Post-test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	495.87 ^a	4	123.97	4.95	0.00	0.20

Intercept	2198.69	1	2198.69	87.82	0.00	0.53
Pre-test	0.00	1	0.00	0.00	0.99	0.00
Gender	3.63	1	3.63	0.15	0.71	0.00
Error	1952.81	78	25.04			
Total	30763.00	83				
Corrected Total	2448.68	82				

a. R Squared = 0.203 (Adjusted R Squared = 0.162)

The result in Table 6 shows that there was no statistically significant interaction effect of method and gender on the students' academic achievement in biology ($F(1,78) = 0.15$, $P = 0.71 > 0.05$). Therefore, null hypothesis 3, which states that there is no statistically significant interaction effect of method and gender on the students' academic achievement in Biology, was accepted. This implies that the methods of instruction and the students' gender did not interact significantly to influence the students' academic achievement scores in biology.

Discussion

In the findings on the effect of blended learning on biology students' academic achievement in Ebonyi state, the results show that there was a significant difference between the achievement mean scores of students taught biology with blended learning and those taught without blended learning, with those taught biology with blended learning having greater achievement scores. The disparity observed in the mean achievement scores of students was expected because the BL encourages active participation of students more than the conventional method of teaching. The result agreed with Areji and Onuba (2022), who stated that in BL, students pause the lesson at any time and resume learning at a convenient time and on several occasions later. The finding is also in line with that of Umeana et al (2022), who explained that the activities and experiences of the schoolroom, content, and the instructor inspire and empower learners to learn more intensely, resulting in a greater understanding of the intellectual content. The finding is also in consonance with the findings of Abamuche and Ibe (2022) and Olatunde-Aiyedun (2022), who maintained that BL's features of Online lectures and videos, digital tools, e-books, and virtual classrooms, together with face-to-face interaction with students and lecturers, enhance student academic achievement. The finding on the effect of gender on students' mean achievement scores in biology showed that there was no significant difference between the mean achievement scores of male and female students taught biology with blended learning. It combines the benefits of digital technology, such as flexibility and personalized learning, with the advantages of in-person instruction, such as social interaction and immediate feedback. The result was in agreement with Eya et al, (2024), who found that students' acquisition of science process skills is not gender specific. Also, the studies by Dang et al. (2016), who found that women were more likely to use the Internet as a communication tool while men tended to use it as a way of information seeking, lend credence to a non-significant gender effect in science achievement. However, the result disagrees with that of Alsalhi et al (2021) and Njoku (2024), who found that gender influences students' conceptual shift in favour of males.

The finding on the interaction effects of methods and gender showed that there was no significant interaction effect of method and gender on the academic achievement of students in biology. This

finding is in line with the findings of Radulović et al (2023) and Nnoli and Ugwuoti (2024), who found no interaction effect of gender and instructional treatment.

Conclusion

From the results of the study, it was concluded that the BL is significantly better than the conventional teaching method in enhancing students' achievement in biology, and that there is no statistically significant interaction effect of gender and teaching method on students' achievement in biology. For both male and female students, the BL is superior to the conventional method in fostering achievement in biology.

Recommendations

Based on the findings of the study, the following recommendations were made.

1. Biology teachers should be encouraged to adopt BL in their lessons to attract and motivate students to learn biology.
2. The government should fund educational training, workshops, and conferences where BL could be explained to secondary school teachers and provide adequate computers at schools for staff and students' blended learning.

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