Academic Impact of Blended Learning in Basic Science: A Case Study from Oredo, Nigeria

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ABSTRACT

This study investigated the impact of blended learning (BL) on the academic performance of basic science students in Oredo Local Government Area (L.G.A.) of Edo State, Nigeria. The research employed a quasi-experimental setting of non-equivalent (pretest, posttest) and control group design. The population for this study comprised 35,386 basic science students in Junior Secondary School II (JSS II), and stratified random sampling was employed to select two schools (a public and private school) as the experimental and control groups. The experimental group received the BL method, while the control group continued with the conventional method. The study lasted for five (5) weeks; thereafter, a posttest was conducted. The Basic Science Achievement Test (BSAT) was the instrument used for data collection. Mean, standard deviation, t-test, and analysis of variance (ANOVA) tested the five hypotheses at a 0.05 level of significance and the results showed that students taught in a blended classroom performed better academically than those in traditional settings. From the study, there was no significant interaction effect of gender, school type, or ability level on performance. BL methods are recommended for teaching basic sciences in JSS because they promote student retention and academic performance.

Keywords: BSAT, blended learning, academic performance, basic science education, educational methods

INTRODUCTION

The growth and progress of a nation is defined by its educational attainment [1]. The advent of technology has transformed several aspects of life, among which is the sector of education, referred to as e-learning [2]. Learning can transpire through several modalities. This includes face-to-face classroom education, virtual learning, and both asynchronous and synchronous modalities [3]. Currently, technology is predominantly employed for asynchronous and virtual learning, alongside the incorporation of face-to-face classroom learning known as blended learning [4]. Blended learning (BL) originates from the concepts of "blend" and "learning." It is an educational approach that blends a variety of learning methodologies [5] and also enables teachers to present students with as much knowledge as possible [6]. The impact of BL on science process skills and educational outcomes is significant [7].

Learning at home greatly affects the productivity of parents and the social and educational growth of children [8]. Numerous educational institutions have replaced traditional examinations with online evaluation systems [9]. Furthermore, the introduction of technology such as computers, smartphones, tablets, and cloud-based tools has transformed the delivery of education [10, 11]. The teacher's role in implementing BL entails more than just acquiring new skills or redistributing pedagogical responsibilities [12].

Academic performance refers to the evaluation of a student's success across various academic disciplines using objective indicators such as grade point average (GPA), exam scores, or overall course grades [13]. Non-academic outcomes serve as a way to assess a student's overall attitude toward learning through subjective indicators such as student satisfaction, engagement, and attitude toward learning [14, 15]. While digital learning positively influences non-academic results [16], research indicates that a significant number of students lack self-regulation in their learning processes.

Implementing blended learning models (BLMs) in educational settings offers teachers several benefits, such as

easier access to teaching resources, improved communication, and the freedom to move around the classroom with educational materials [17]. As a result, many individuals are embracing new technologies to improve their overall learning experience [18, 19, 20, 21].

Therefore, this study aims to address the following key questions:

1. Are there significant differences in academic performance between students exposed to BL and those who receive traditional classroom instruction in basic science?
2. What factors, such as access to technology and instructional quality, might mediate or moderate the correlation between BL and academic performance?
3. How can the findings from this study inform recommendations for the effective implementation of BL strategies to improve basic science education in junior secondary schools (JSS) in Nigeria?

Research Questions

The research questions and hypotheses are consistent with the study's research objectives:

1. How does the difference in pre-test and post-test mean achievement scores compare between basic science students taught using blended learning (BL) and those taught using conventional teaching methods?
2. How does the mean achievement score of basic science students differ between those taught using the blended learning (BL) method and those taught with the conventional method, considering gender as a variable?
3. What is the difference in the mean scores of basic science students taught using blended learning (BL) compared to those taught using conventional teaching methods, categorized by school type?
4. Does the interaction between teaching methods, student gender, and school ownership influence students' academic achievement?

Hypotheses

The following null hypotheses are formulated and tested at the 0.05 level of significance:

Ho_1: There is no significant difference in the pretest and posttest mean scores of basic science students taught with BL and those taught with conventional methods of teaching.

Ho_2: There is no significant difference in the mean achievement score of the basic science students taught using the BL method of teaching and those taught with the conventional method of teaching based on gender.

Ho_3: There is no significant difference in the mean score of basic science students taught with BL and those taught with conventional methods of teaching based on school type.

Ho_4: There is no significant difference in the interaction effect of gender, school type, and ability levels of basic science students taught with the BL method of teaching and those taught with the conventional method of teaching.

This study will be beneficial to students, educational planners, administrators, and the general public. It will add to the pull of knowledge that would improve performance in terms of teaching and learning abilities of students in Nigerian institutions. Additionally, it would empower the administrators of educational institutions to optimize resources, enhance student achievements, and have the ability to adjust to the evolving environment of education.

LITERATURE REVIEW

The efficacy of blended learning models (BLM) compared to traditional teaching and learning methods has

been explored in various studies. According to [22, 23, 24], BL merges in-person classroom sessions with online learning experiences that follow pedagogical principles. It also gives students flexibility in terms of time and place for interacting, communicating, working in groups, discussing, and sharing resources [25, 26].

[27] examined graduates and undergraduate students enrolled in programming courses within a BL setting. The results indicated that students adept in specific computer applications and software gain greater advantages from the BL approach. The findings also elucidate students' preferences for learning in collaborative, knowledge-sharing environments. [28] investigated the impact of BL on enhancing comprehension teaching and learning in a mixed English as a foreign language (EFL) course. The results showed a significant improvement in students' attitudes and enthusiasm toward engaging with computer-based activities and learning English.

[29] investigates how a BL paradigm affects junior high school students' learning results and attitudes about mathematics. The findings indicated that classroom activities leveraging the BL method positively influenced students' perceptions of this instructional method. It was also revealed that male students were more motivated in BL. In light of the increasing interconnectedness of information and communication technologies (ICTs), [30] addressed a variety of consequences, ramifications, and potential prospects for BL in higher education. Despite BL predating modern instructional technologies, it was observed that the advancement of these technologies will always be intertwined with certain aspects of human cognitive processes.

[31] looked at students' perceptions of BL and related concepts such as paperless and traditional classrooms. According to the study, students in an EFL setting prefer integrated learning to traditional classroom education, although they favored paper-and-pencil examinations for English over internet assessments. [32] analyzed the impact of BL on ninth-grade students' science performance and their attitudes toward its use. The results revealed significant differences between the experimental and control groups, with the experimental group outperforming the control group. They exhibited positive attitudes related to their academic performance in a science subject.

[33] investigated the effects of BL on students' memory of physics in federal colleges of education in Southeast Nigeria. The study concluded that students who participated recalled more physics content owing to BL. It was also demonstrated that students' recollection of the physics material was gender-independent.

Several studies have explored the concept of B-learning as an instructional method of teaching, yet no research has specifically addressed the variables related to achievement, gender, ability level, and school type within Basic Science. This study seeks to bridge the gap by exploring the variables to examine their impact on students learning. Therefore, this research is focused on examining the impacts of blended learning on the academic performance of basic science students in JSS in Oredo L.G.A., Edo State, Nigeria.

MATERIALS AND METHODS

Research Design

The study employed a quasi-experimental setting of non-equivalent (pretest, posttest) and control group design. This approach was chosen because intact classes will be randomly assigned to either experimental or control groups since complete randomization of subjects is not feasible.

0_1 = Pre-achievement test

0_2 = Post-achievement test

X_1 = Experimental treatment (blended learning method)

X_0 = Control no treatment (conventional method)

----------Broken lines indicate non-randomization.

Table 1: Design Over Variables

GROUP	PRE-TEST	TREATMENT	POST-TEST
EXPERIMENTAL	O_1	X_1	O_2
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CONTROL	O_1	X_0	O_2

The design establishes the differential effectiveness of the independent variables (BL and traditional method of teaching) jointly and separately on the dependent variable (student achievement). The dependent variables in this study are achievement mean scores of JSS II students offering Basic Science, while the independent variables are BL instructional method of teaching (X_1) and conventional method of teaching (X_0). The moderating variables are gender, and school type.

Population of the Study

This study focused on all JSS II students in public schools and government-approved private schools in Oredo L.G.A., Edo State. There are fourteen (14) public schools with a population of thirteen thousand and sixty-eight (13,068) JSS II students, while there are one hundred and ten (110) private schools with a population of twenty-two thousand three hundred and eighteen (22,318) JSS II students. Therefore, the total population was thirty-five thousand three hundred and eighty-six (35,386) JSS II students.

Sample Size and Sampling Technique

The sample size of the study consisted of one hundred and twenty-nine (129) JSS II basic science students. The sampling technique employed was the stratified sampling technique. All the schools were stratified into single-sex schools and mixed-sex schools, with only the mixed-sex schools being selected due to the relevance of sex as a variable in the study. The selected schools were further stratified into public and private schools so that two schools were randomly selected from each type to form the study sample. A public and a private school formed the experimental group, while another public and a private school formed the control group, as represented in Table II.

Table II: Sample Distribution of Selected Schools

s/n	SCH.	TYPE	GROUP	M	F	TOTAL
1.	A	PUBLIC	EXP.	19	23	42
2.	B	PRIVATE	EXP.	14	16	30
3.	C	PUBLIC	CONTROL	14	18	32
4.	D	PRIVATE	CONTROL	11	14	25
			TOTAL	58	71	129

SCH. = SCHOOLS

EXP. = EXPERIMENTAL

M = MALE

F = FEMALE

Instrument for the Study

The Basic Science Achievement Test (BSAT) was the instrument used in this study. The BSAT is for the collection of pretest and posttest achievement scores and is also an investigative tool that assesses the general ability of the students in basic science. 30 multiple-choice objective questions were drawn from JSS II curriculums. This test was administered as an initial testing device before the commencement of the treatment exercise to the experimental and control groups. Thereafter, it will be rearranged five weeks later and used as a post-testing device.

Reliability of the Instrument

To ascertain the reliability of the BSAT instrument, a pilot test of the instrument was carried out on selected basic science JSS II students who were in the population but were not part of the main sample used for the study. The pilot testing was carried out using the test-retest method of reliability by administering the instrument to twenty (20) students. The scores obtained were used to estimate the reliability coefficient, which was ascertained using the Kuder-Richardson formula 21 (K R-21), and a reliability coefficient of 0.82 was obtained.

Method of Data Collection

A pretest was conducted for both experimental and control groups to ascertain their initial conception. Thereafter, both groups were post-tested.

Procedure for Experimental Group

The study was implemented for five (5) weeks. The first week was for the pretest, while weeks two (2) to four (4) were used for treatment, and week five (5) was used for the post-test. Two sessions of 80 minutes each were allocated for the treatment. Firstly, the week starts with the teacher introducing the course, discussing the syllabus, and explaining the overall structure. Consequently, the online component will be held from Tuesday to Friday: students are required to read a chapter from the textbook, watch a video lecture, and participate in an online discussion forum on a learning management system (LMS). The students will complete these activities at their own pace throughout the week.

Control Group: Conventional Method

The control group was treated with the traditional lecture method. The students were made to learn the selected topics using the same content materials devoid of the selected enhancement procedures of the BL method.

Data Analysis

The data collected were analyzed using mean, standard deviation, t-test, and analysis of variance (ANOVA), with hypotheses tested at the 0.05 level of significance.

RESULTS AND DISCUSSION

This section deals with the presentation of results and discussion of findings.

Presentation of Results

Research Question 1 (RQ1): What is the difference in the pretest and posttest mean achievement scores of Basic Science students taught with BL compared to those taught with conventional methods?

Table 3: Mean and Standard Deviation of Students Taught With Blended Learning Methods and Conventional Method of Teaching

Group	N	Mean	SD	Mean Gain
Experimental	72	20.14	1.61	
Control	57	12.56	2.57	7.58
Total	129	32.7	4.18	

Hypothesis 1: There is a significant difference in the pretest and posttest mean scores of Basic Science students taught with BL and those taught with conventional methods.

Table 4: T-Test on Significant Difference in the Mean Achievement Scores of Student Taught With Blended Learning and Those Taught Using the Lecture Method

Variables	No.	$\bar{x}$	SD	t	Df	Sig(2- Decision tailed)
Exp.	72	20.14	1.61			H_o Rejected
				14.16	112	.00
Control	57	12.56	2.57			

RQ2: What is the difference in the mean achievement score of Basic Science students taught using the BL method of teaching and those taught with the conventional methods based on gender?

Table 5: Mean and Standard Deviation of the Scores of Female Students Taught Probability Using Bl Methods Based on Gender

Group	N	Mean	SD	Mean Gain
Male	42	12.23	1.25	
Female	30	13.14	1.39	0.91
Total	72	25.27	2.64	

Hypothesis 2: There is no significant difference in the mean achievement score of the Basic Science students taught using the BL method of teaching and those taught with the conventional method of teaching based on gender.

Table 6: T-Test on Significant Difference between the Mean Scores of Male and Female Students Taught Using Bl

Variable	No.	$\bar{x}$	SD	t	Df	Sig (2-Decision tailed)
Male	42	12.23	1.25			H_0 Accepted
				.512	68	.237
Female	30	13.14	1.39			

RQ3: What is the difference in the mean score of Basic Science students taught with BL and those taught with conventional methods based on school type?

Table 7: Mean and Standard Deviation of the Scores of Students Taught Using Bl Based On School Type

Group	N	Mean	SD	Mean Gain
Public Schools	42	6.27	1.58	
Private Schools	30	5.94	1.47	0.33
Total	72	12.21	3.05	

Hypothesis 4: There is no significant difference in the mean score of Basic Science students taught with BL and those taught with conventional methods based on school type.

Table 8: T-Test on Significant Difference between the Mean Scores of Students Taught Using Bl by School Type

Variable	No Exp.	$\bar{x}$	SD	t	Df	Sig (2-Decision tailed)
Public Schools	40	15.69	6.64			H_0 Accepted
				.504	112	.347
Private Schools	33	16.41	6.50			

RQ5: Is there an interactive effect of methods, sex, and school ownership on the student' s academic achievement?

Table 9: Descriptive Statistics of the Interactive Effect of Methods, Sex, and School Ownership on the Students' Academic Achievement

Group	Owner	Sex	Mean	SD	N
Exp.	Public	Male	14.32	1.45	119
		Female	13.16	1.32	23
	Private	Male	12.13	1.76	14
		Female	11.19	1.96	16
Control	Public	Male	9.20	2.85	11
		Female	9.72	3.22	14
	Private	Male	9.00	3.29	10
		Female	8.55	1.87	9

Hypothesis 5: There is no significant interaction effect of methods, sex, and school ownership on the student's academic achievement

Table 10: Three-Way Anova on the Interactive Effect of Methods, Sex, and School Ownership on the Students' Academic Achievement

Source	Type III Sum of Squares	df	F	Sig
Intercept	28020.40	1	4980.18	.00
Methods	4584.64	1	814.84	.00
Owner	10.21	1	1.81	.18
Sex	.05	1	.01	.97
Methods*Owner	.30	1	.05	.81
Methods*Sex	.08	1	.01	.90
Owner*Sex	6.85	1	1.21	.27
Method*Owner *Sex	.01	1	.00	.98

DISCUSSION OF FINDINGS

Effect on Students' Academic Achievement

The results presented in Table 3 showed students taught using BL (experimental group) outperformed those in the traditional conventional method. The t-test statistics were conducted in Table 4 to determine the significant difference. The analysis revealed a degree of freedom of 112, a t value of 14.16, and a significant value of .00, which is below the acceptance level of 0.05; the null hypothesis was rejected.

This implies there was a significant difference favoring the experimental group over the control group. Therefore, it can be concluded that the student's performance in basic science in secondary schools can be improved through the use of BL. The findings of this study substantiate the claims of previous researchers that BL had a positive effect on students' academic achievement [34, 35, 36, 37, 38].

The Influence of Sex, Ability Level, and School Ownership on the Mean Achievement Score of Students'

The findings in Table 5 revealed no significant sex difference in students taught with BL. The male students had a mean of 12.23, while the female students had a mean of 13.14. However, when the score was subjected to the t-test analysis as presented in Table 6, it was found that the dissimilarity was not significant. Table 6 shows a degree of freedom of 68, a t-value of .512 and a significant value of .237, which is greater than the acceptance level of 0.05.

Consequently, when ability level was investigated in Table 7, learners with low ability had a mean of 9.38, while those with high ability level had a mean of 10.13. This implies the students with high ability levels taught in a blended classroom achieved more, but when subjected to t-test analysis, it was revealed that the variance was not significant, as illustrated in Table 8. This table shows a degree of freedom of 74, a t-value of .532 and a significant value of .437 which is greater than the acceptance level of 0.05.

Also, findings in Table 9 reveal that learners in public senior secondary schools taught in a blended classroom had a mean of 6.27, while their counterparts in private senior secondary schools had a mean of 5.94. Table 10 further shows there was no significant difference in the mean achievement scores of students in both categories. The table shows a degree of freedom of 112, a t-value of .504 and a significant value of .347 which is greater than the acceptance level of 0.05.

The Three-Way Interaction Effect of Method by Sex and School Ownership on Students Achievement

Table 11 indicates a difference in the mean score of students in the experimental and control groups. To test whether the difference was significant, a three-way ANOVA statistic was conducted, as presented in Table 12. It can be seen that the F-value is .00 with a degree of freedom of 1, and the level of significance is 0.98, which is more than the set alpha level of 0.05. Therefore, the null hypothesis, which states there will be no significant interactive effect of methods, sex, and school ownership on the student's academic achievement, was accepted.

CONCLUSION

By and large, blended education proves to be more effective in teaching basic science because it improves the academic achievement of students and helps clarify abstract concepts. It also incorporates various learning methods that may not be present in the traditional classroom, thereby making learning more enjoyable. From this study, there was no significant interaction effect of methods, sex, and school type on the student's mean achievement scores. This implies that irrespective of any method employed, sex and school type do not influence the academic performance of male and female students enrolled in both public and private schools.

RECOMMENDATION

Based on the findings and conclusion drawn from this study, the recommendations made are:

1. BL approaches should be integrated into the teaching of basic sciences in junior secondary schools (JSS).

2. Curriculum developers, textbook authors, and basic science teachers should encourage the application of BL in their teaching practices.

3. Blended learning should be used in both public and private schools for teaching male and female students.

4. Basic science instructors should be trained and retrained to stay updated on the application of BL techniques.

5. School administrators should ensure that the technologies needed for effective blended learning are available in schools.

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