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Research Article

The Impact of Blended Learning on the Academic Performance of Physics Students in the Bwari Area Council of Abuja

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Abstract
This study examined the impact of blended learning on the academic achievement of Physics students in the Bwari Area Council of the Federal Capital Territory (FCT), Nigeria. The research was guided by two objectives, two research questions, and two hypotheses. The target population consisted of 3,870 Physics students enrolled in secondary schools within the Bwari Area Council. A total of 120 students were randomly selected from four secondary schools that offer Physics as a subject. Data were collected using a 50-item researcher-developed multiple-choice test titled Researcher Made Light and Optics Achievement Test (RMLOAT). The reliability of the instrument was established using the test-retest method, yielding a temporal stability coefficient of 0.88 and an internal consistency coefficient of 0.79. A pretest was also conducted to ensure the appropriateness of the sample. Data analysis involved the use of mean and standard deviation. The findings revealed that blended learning significantly enhanced the academic performance of Physics students in the study area. Additionally, the results indicated no significant differences in performance based on gender, suggesting that blended learning is equally effective for both male and female students. Based on these findings, the study recommends that blended learning be adopted as a mandatory instructional approach in secondary schools, particularly for technology-oriented subjects such as Physics. It also advocates for regular and mandatory training and retraining programs for secondary school teachers on 21st-century instructional strategies, including blended learning.

Keywords: Blended Learning, Physics, Students, Academic Performance

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1. INTRODUCTION

Contemporary society is fundamentally driven by technology, with individuals of all genders integrating it into their daily lives. Technology now constitutes a core component of virtually every sector, contributing significantly through various functions and innovations. For instance, in the banking industry, transactions can be conducted remotely without the need to physically visit a bank. With mobile phones, individuals can easily transfer funds to relatives, friends, or business partners from the comfort of their homes. Additionally, Automated Teller Machines (ATMs) allow users to deposit or withdraw money regardless of their bank affiliation, reflecting the convenience brought about by technological advancements. The field of education is no exception to these developments. According to Nwobi (2014), the forces of globalization and rapid technological evolution have transformed the global economy over recent decades. The author emphasizes that the widespread integration of technology profoundly influences the structure and aims of education. In essence, technology represents the practical application of scientific knowledge, embodying human ingenuity and creativity in the pursuit of overall well-being. Vikoo (2017) describes technology as the creation, modification, utilization, and comprehension of tools, machines, techniques, systems, and organizational structures to address problems, enhance existing solutions, fulfill objectives, and perform specific functions. Among the various branches of technology, educational technology has gained prominence. The Association for Educational Communications and Technology (AECT), as cited in Reiser (2012), defines educational technology as "the study and ethical practice of

facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources." The design and implementation of such resources have great potential to enhance educational outcomes and support sustainable national development. Historically, educational technologies primarily involved tangible hardware such as projectors, visual aids, and models. However, the current era is dominated by Information and Communication Technology (ICT), which encompasses tools used in telecommunications, broadcasting, intelligent building systems, audiovisual processing, network-based control, and monitoring systems (Techopedia, 2015). ICT has introduced dynamic transformations in various domains, especially in education, providing both students and teachers with enhanced opportunities to tailor teaching and learning processes to individual needs. Consequently, educational institutions are challenged to adapt effectively to these technological shifts. Pacansky-Brock (2013) categorizes these innovations as "emerging technologies"—tools that are beginning to influence teaching and learning practices but are not yet fully integrated into mainstream education. These technologies are "reinvisioning college learning" and are grouped into four primary categories: cloud-based applications that offer online accessibility across devices; Web 2.0 tools that simplify the creation and sharing of multimedia content; social media platforms that enable highly interactive communication; and mobile applications specifically designed for use on smartphones and tablets.

Physics provides foundational knowledge essential for scientific progress, which serves as a key driver of national development. However, the comprehension of physics concepts becomes more effective when traditional teaching methods employed by educators are supplemented with hands-on approaches that foster active learning through self-exploration and inquiry. Effective instruction involves guiding students through meaningful experiences and providing relevant learning activities that enable them to achieve optimal educational outcomes (Revathi et al., 2022). Students' attitudes toward physics have been linked to their academic performance. Han et al. (2023) emphasize that both positive and negative attitudes significantly influence science learning. Similarly, research by Luka and Ineta (2023) identifies student attitudes as one of the key factors impacting their achievement in physics. Schiering et al. (2023) argue that educators should maintain positive attitudes and adopt engaging instructional strategies in science education to enhance student performance and foster enduring positive attitudes toward the subject. Furthermore, Nachimuthu et al. (2022) investigated pedagogical content knowledge (PCK), highlighting how teacher education can facilitate the development of advanced teaching competencies and support the acquisition of this knowledge. Studies on the use of cartoon-based worksheets also demonstrate their effectiveness in addressing students' misconceptions, particularly regarding electric current circuits (Siong et al., 2023).

Horn and Staker (2015) characterize blended learning as a formal educational approach wherein students engage in part through online learning, allowing them a degree of autonomy over aspects such as time, location, learning pathway, and pace. The authors emphasize the importance of achieving an effective integration between technological tools and traditional face-to-face teacher–student interaction to enhance the overall learning experience. This pedagogical method, driven by technological advancements, has the potential to improve the teaching and learning process in Physics. Empirical observations reveal that a significant number of students tend to avoid Physics, both at the secondary and tertiary levels. Isola (2010) notes that Physics, as one of the core science subjects, is perceived as one of the most challenging disciplines in the school curriculum, as acknowledged by the Nigerian Educational Research and Development Council (NERDC). Furthermore, enrolment rates in Physics are often reported to be the lowest among science subjects (Mekonnen, 2014). Academic performance refers to the extent to which students successfully fulfill their academic responsibilities and objectives. Duruji, Azuh, and Oviasogie (2014) assert that grades are the most commonly used metric to evaluate academic performance, serving as an indicator of student achievement across individual subjects and overall academic engagement. In most educational settings, success is commonly measured by academic performance, typically determined by a student's ability to meet the standards established by the institution or external assessment bodies, whether governmental or independent. According to Bala (2014), academic performance reflects the realization of educational objectives by either students or teachers. It encompasses students' abilities to manage their studies effectively and complete assigned tasks. Moreover, it involves the capacity to study, retain information, and communicate knowledge either orally or in written form. Consequently, academic performance serves as a measure of how well a student performs relative to peers in comparable educational contexts.

This study aims to investigate the impact of blended learning on the academic performance of physics students in Bwari Area council of FCT Nigeria.

1.1. Research Objectives

Two research objectives guided the research work

1. To determine the post-test performance, mean score of physics students taught with blended learning and those taught with convectional learning method
2. To determine the post-test performance mean score of male and female physics students taught with blended learning.

1.2. Research Questions

Two research questions also guided the work

1. What is the post-test performance mean score of Physics students taught with blended learning and those taught with convectional method?
2. What is the post-test performance of male and female Physics students taught using blended learning?

1.3. Research Hypotheses

H01. There is no significance difference in the post-test performance mean score of Physics students taught using blende learning and those taught using convectional method.

H02. There is no significance difference in the post-test performance mean score of male and female Physics students taught using blended learning.

2. RESEARCH METHODOLOGY

2.1. Research Design

This study adopted a quasi-experimental design, specifically a post-test-only non-randomized control group design, to investigate the effect of blended learning on the academic performance of Physics students in the Bwari Area Council of the Federal Capital Territory (FCT), Nigeria.

2.2. Sample for the study

The study sample consisted of 120 secondary school Physics students aged 12 to 17 years from the 2023/2024 academic year. These students were randomly selected from four secondary schools within the Bwari Area Council. Two schools were designated as experimental groups and the other two as control groups. These schools were purposively chosen based on the presence of well-established Physics departments and the availability of qualified Physics teachers.

2.3. Instrument for the Study

The instrument employed in this study is a researcher-developed assessment tool titled the Researcher Made Light and Optics Achievement Test (RMLOAT), comprising two sections: A and B. Section A was designed to collect students' demographic information, including school name, class, and gender. Section B consists of 50 multiple-choice items aimed at evaluating students' performance in the subject areas related to light and optics. The test was administered to both the experimental and control groups. The face validity of the instrument was established through expert reviews from the fields of Physics Education, Guidance and Counseling, and Educational Technology. The RMLOAT was further validated by specialists in Physics Education, and their feedback and recommendations were meticulously implemented prior to its use for data collection. In addition, the study utilized an instructional tool referred to as BLP, which integrates physics content on 'light and optics' with an internet-accessible website, operable via a computer system. This digital learning package was exclusively provided to the experimental

group. The research was conducted during the first academic term of the 2024/2025 session and involved Senior Secondary II (SS II) students enrolled in physics courses.

2.4. Methodology

Prior to the commencement of the study, students and Physics instructors from the selected schools received appropriate training on the use of computers and internet facilities. The study spanned a duration of six weeks. A pre-test, in the form of a Physics Achievement Test, was administered to both the control and experimental groups before the intervention to assess their initial equivalence and suitability as research participants. During the intervention phase, students in the experimental group received instruction on "light and optics" through the Blended Learning Instructional Package (BLP), conducted in the laboratory using computers and internet resources. These students were encouraged to engage in literacy-based exercises, pose questions, and submit assignments online, all under the guidance of trained and experienced Physics instructors. Conversely, the control group was taught the same content using conventional instructional methods. Upon completion of the intervention, a post-test was administered to both groups using the RMLOAT instrument. The collected data were subsequently analyzed using independent samples t-tests.

3. RESULTS

3.1. Research Hypotheses One

H_{01}. There is no significance difference in the post-test performance mean score of Physics students taught using blende learning and those taught using convectional method.

Table 1. Post-Test Result Performance Mean Score and Standard Deviation of Control and Experimental Groups

Group	N	Mean	SD	t-value	p-value	0.05 Level of Sig.
Conventional Method	60	11.08	2.11	0.23	0.5130	Significant
Blended learning Method	60	15.54	4.32			

Based on the data presented in Table 1, the analysis revealed that at the 0.05 significance level, the calculated t-value was 0.23 ($p = 0.513$), with degrees of freedom (df) equal to 118. This value exceeded the critical value at the 0.05 level of significance. These findings indicate a statistically significant difference in the post-test mean achievement scores between students taught Physics using the blended learning approach and those instructed through the conventional method. Consequently, the null hypothesis, which posited no significant difference in students' achievement mean scores, was rejected. Therefore, it can be concluded that the blended learning method had a significant effect on students' academic achievement in Physics.

3.2. Research Hypotheses Two

H_{02}. There is no significance difference in the post-test performance mean score of male and female Physics students taught using blended learning.

Table 2. Post-Test Result Performance Mean Score and Standard Deviation of Control and Experimental Groups Based on Gender

Variables	N	Mean	SD	t-value	p-value	0.05 Level of Sig.
Male Students	65	13.03	3.08	0.16	0.213	Not Significant
Female Students	55	12.64	2.88			

Based on the data presented in Table 2, the mean score and standard deviation for male students who received instruction through a blended learning approach were 13.03 and 3.08, respectively. For female students exposed to the same instructional method, the mean score and standard deviation were 12.88 and

2.88, respectively. At the 0.05 level of significance, the calculated t-value of 0.16 ($p = 0.213$) is lower than the critical value at the corresponding degrees of freedom. This indicates that the difference is not statistically significant. Consequently, the null hypothesis is retained, suggesting that there is no significant difference in the Physics achievement scores between male and female students taught using the blended learning approach.

4. DISCUSSION

The results of this study indicated that students in the experimental group, who were taught using the blended learning approach, demonstrated significantly higher achievement in Physics, with a post-test mean score of 4.32, compared to a mean score of 2.11 recorded by the control group. This substantial difference effectively addresses the research question: What are the post-test mean scores of Physics students taught through blended learning compared to those taught using a conventional method? The findings suggest a statistically significant difference in performance between the two groups, highlighting the positive impact of the blended learning approach on student outcomes. Furthermore, the study revealed that the experimental group outperformed the control group following the instructional intervention, indicating that exposure to blended learning significantly enhanced students' academic performance. These findings are consistent with the study by Meng et al. (2023), which emphasized the influence of online learning behaviors on students' academic achievements in Physics during the COVID-19 pandemic. Consequently, the implementation of the Blended Learning Instructional Approach can be considered an effective pedagogical strategy for improving student achievement in Physics.

The second hypothesis aimed to examine whether there was a significant difference in the mean achievement scores between male and female students who were taught using a blended learning approach. The findings demonstrated that the use of blended learning in Physics instruction resulted in positive outcomes and was equitable across genders. Specifically, gender did not have a statistically significant effect on students' achievement in Physics, thereby indicating that blended learning is a gender-inclusive instructional method. These results directly address the research question concerning the post-test performance of male and female students taught through blended learning. Furthermore, the findings align with those of Ironsi et al. (2023), who emphasized the value of integrating educational resources to enhance certain aspects of academic performance. This study provides clear evidence supporting the adoption of technology-based instructional strategies, such as blended learning, to enhance teaching and learning in accordance with global best practices. Ultimately, this research contributes to the existing body of knowledge by affirming that blended learning is not only effective in Physics education but also promotes gender inclusivity.

5. LIMITATION AND RECOMMENDATIONS

One of the basic limitations of the study is the poor technical know-how of some of the students in the use of technology-based learning materials, though exciting to the learners, they are limited in the knowledge of some practical use. Another limitation of the study is in the cost of carrying out the study, as most the materials used to blend the learning are quite expensive.

Based on the findings of this study, the following recommendations was given:

1. Blended learning method should be adopted among secondary school learners, considering the fact that the method is gender friendly
2. Training and retraining of secondary school teachers should be carried out regularly to ensure proper use of the method.

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Research Ethics. This research work was carried out under the full approval of the heads of the institutions in Bwari Area council of the federal capital territory

Data Availability Statement. All data for this work are original and authentic and can be obtained from the corresponding author.

Conflicts of Interest. With regards to this research work, there is no conflict of interest.

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