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Effects of Moodle Instructional Strategy on Achievement of Pre-Service Biology Teachers in Tertiary Institutions in South-West Nigeria

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Abstract. This study examined the impact of Modular Object-Oriented Dynamic Learning Environment (MOODLE) instruction on the achievement of pre-service teachers in vertebrate physiology in South West Nigeria. The study was guided by two research questions, and two null hypotheses were tested at a 0.05 level of significance. A quasi-experimental pre-test and post-test research design was employed for the study. The Vertebrate Physiology Achievement Test (VPAT) served as the data collection instrument, with its reliability established using Kuder Richardson 21 (Kr21), yielding a reliability coefficient of 0.74. Data analysis involved the use of mean, standard deviation, and Analysis of Covariance (ANCOVA) to test the hypotheses at a 0.05 significance level. Findings revealed that the application of Moodle significantly enhanced pre-service teachers' achievement in vertebrate physiology. Additionally, the results indicated no significant difference in the achievement of male and female pre-service Biology teachers exposed to vertebrate physiology instruction via Moodle. Based on these findings, it was recommended that biology lecturers incorporate Moodle in teaching pre-service teachers to promote higher achievement in vertebrate physiology.

Keywords: Moodle, Achievement, Vertebrate Physiology, Pre-Service Teachers

1. Introduction

In 2019, the world was taken by surprise with the outbreak of the COVID-19 pandemic, which significantly disrupted social, educational, and religious activities globally. Specifically, educational institutions across the world were forced to shut down for months, leading to an unprecedented halt in formal learning. To mitigate the disruption in education, particularly at the tertiary level, various instructional strategies were introduced to ensure the continuity of teaching and learning. Among these strategies, online learning platforms became essential tools for delivering instruction in various subjects, Akande, R. M. (2024). This including Biology.

Biology, as a field of study, plays a crucial role in fostering a sustainable relationship between nature and human society. It is deeply beneficial to human life, providing essential knowledge for understanding biological systems, environmental conservation, and health sciences. This significance is reinforced by Agboghoroma and Oyovwi (2015), who asserted that Biology is vital as it equips students with the necessary skills and knowledge to comprehend the world around them and contribute to societal advancement.

The Nigerian Biology curriculum, as outlined in the National Policy on Education (NERDC, 2013), aims to achieve specific objectives, including:

- Developing an understanding of fundamental biological concepts necessary for positive living in an era of scientific and technological advancements.
- Addressing societal concerns related to sex education, reproduction, growth, pollution, and public health.
- Encouraging the application of scientific knowledge in personal and community health as well as in agriculture.
- Facilitating technological progress and dispelling superstitions through scientific reasoning.
- Fostering environmental awareness and conservation efforts.

Despite the robust and well-structured objectives of the Biology curriculum, students continue to encounter significant challenges in comprehending various biological concepts at all educational levels. This persistent difficulty has resulted in poor academic performance and low achievement in the subject. At the tertiary level, one particularly challenging area for students is vertebrate physiology, which focuses on the

functional mechanisms of biological systems in animals. Reports from some Federal Colleges of Education in South West Nigeria indicate that pre-service teachers struggle significantly with vertebrate physiology, leading to consistently low academic performance.

Several factors have been identified as contributing to the poor achievement of pre-service teachers in vertebrate physiology. One major factor is the application of inappropriate teaching methods that fail to engage students effectively (Badmus, 2021). Furthermore, studies by Adewale, Nzewuihe, and Ogunshola (2016) have highlighted additional causes of poor performance in Biology, including the complexity of biological science content, the qualifications and instructional methods of educators, ineffective teaching strategies, insufficient educational resources, and inadequate assessment methods. The reliance on conventional lecture-based teaching methods has further exacerbated learning difficulties, as many students struggle to grasp biological concepts through passive instruction. Research by Ndayambaje, Bikorimana, and Nsanganwimana (2021) has shown that the continued use of lecture-based methods and rote memorization contributes to poor student performance in Biology.

In contrast, there is growing evidence that integrating Information and Communication Technology (ICT) into teaching strategies can significantly enhance instructional effectiveness and learning outcomes. Scott and Dube (2014) emphasized that ICT integration in education improves teaching efficiency, increases student engagement, and enhances conceptual understanding. The use of visual aids, such as pictures, videos, projectors, and online learning platforms, has been shown to facilitate better comprehension of complex and abstract concepts in Biology.

The COVID-19 pandemic has accelerated the adoption of ICT-based instructional methods in education, leading to an increased reliance on e-learning platforms and online resources for remote teaching and learning. One notable e-learning platform introduced during this period is MOODLE. MOODLE, an acronym for Modular Object-Oriented Dynamic Learning Environment, is a learning management system (LMS) designed for online education. Papadakis, Kalogiannakis, Sifaki, and Vidakis (2018) define MOODLE as a free, open-source LMS that provides a flexible and interactive online learning experience. It enables educators to create customized digital learning environments, track student progress, and facilitate collaborative learning. Additionally, MOODLE allows teachers to access its source code, modify it when necessary, and utilize its built-in reporting features to monitor student participation and activity. The system has also been noted for its gender-neutral accessibility, making it an inclusive educational tool for both male and female learners.

Another critical factor in science education is gender and its influence on academic achievement. Gender refers to the socially and culturally constructed roles and characteristics assigned to males and females within a society. Research on gender differences in science education has produced conflicting findings. While some studies suggest that male students tend to outperform their female counterparts in science subjects (Egwu & Okigbo, 2021; Omwirhiren, 2015), other studies indicate no significant gender-based differences in academic achievement. For instance, Oludipe (2012) found no statistically significant difference in male and female students' performance when using cooperative learning strategies. Similarly, Yusuf, Gambari, and Olumorin (2012) reported that gender did not have any significant influence on Biology achievement.

Given the mixed findings on gender and academic achievement in Biology, this study aimed to examine whether MOODLE instruction would influence gender differences in pre-service teachers' achievement in vertebrate physiology. Specifically, the study explored the effectiveness of MOODLE as an instructional strategy in improving learning outcomes in vertebrate physiology at the tertiary education level. This research sought to determine whether the adoption of MOODLE as a technology-enhanced teaching tool could address existing challenges in Biology education, enhance students' understanding of vertebrate physiology, and promote equitable learning opportunities regardless of gender.

1.1 Statement of the Problem

The outbreak of COVID-19 led to a transformation in science education, particularly in Biology, as tertiary institutions adopted digital learning platforms such as Zoom, Google Classroom, and teleconferencing to ensure continuous learning. Among these, MOODLE emerged as a widely used Learning Management System (LMS) for both virtual and blended instruction in Nigerian institutions. Despite its potential benefits, there is limited empirical evidence on its effectiveness in improving students' understanding and performance, especially in complex Biology concepts like vertebrate physiology. Traditional teaching methods have contributed to poor student achievement, raising concerns about the need for more engaging instructional strategies. Additionally, the role of gender in science education remains inconclusive, necessitating an investigation into whether MOODLE-based instruction affects male and female students differently. This study, therefore, seeks to assess the impact of MOODLE as an instructional tool in Biology education within tertiary institutions in southwestern Nigeria, providing insights into its effectiveness and implications for teaching and learning.

1.2 Research Questions

The following research questions guided the study:

- What are the mean achievement scores of Moodle and conventional methods on pre-service teachers taught vertebrate physiology in southwest Nigeria?
- What are the mean achievement scores of male and female pre-service teachers taught vertebrate physiology using Moodle instruction method in Federal Colleges of Education in southwest Nigeria?

1.3 Statement of the Hypotheses

The following null hypotheses were tested at a 0.05 level of significance.

Ho_1: There is no significant difference in the mean achievement scores of pre-service teachers taught vertebrate physiology using MOODLE and conventional methods.
Ho_2: There is no significant difference in the mean achievement scores of male and female pre-service teachers taught vertebrate physiology using MOODLE instruction method.

1.4 Methodology

This study adopted a quasi-experimental research design, specifically a pre-test and post-test control group design, to examine the effect of MOODLE-based instruction on pre-service Biology teachers' achievement in vertebrate physiology. The target population consisted of 200-level pre-service Biology teachers in Federal Colleges of Education across southwestern Nigeria. A total of 258 pre-service teachers, both male and female, were randomly selected to form the study sample. Participants were divided into experimental and control groups, with the experimental group receiving instruction via MOODLE, while the control group was taught using traditional lecture methods.

The primary instrument for data collection was the Vertebrate Physiology Achievement Test (VPAT), a self-structured, 40-item multiple-choice test designed to measure students' achievement in vertebrate physiology. The test was divided into two sections: Section A, which collected demographic information, and Section B, which contained 40 multiple-choice questions with four response options (A–D). Each correct response was awarded one point, while incorrect responses received zero points. The VPAT was administered as both a pre-test (before instruction) and a post-test (after instruction) to evaluate learning gains.

To ensure validity, the VPAT was subjected to expert review for content and face validity. A pilot test was conducted, and the instrument's reliability was determined using the Kuder-Richardson Formula 21 (KR-21), yielding a reliability coefficient of 0.74, indicating good internal consistency.

The collected data were analyzed using both descriptive and inferential statistics. Descriptive statistics (mean and standard deviation) were used to answer the research questions, while Analysis of Covariance (ANCOVA) was employed to test the hypotheses at a 0.05 level of significance. ANCOVA helped control for initial differences in students' prior knowledge and determine the actual effect of the instructional method on learning outcomes.

2. Result

What are the mean achievement scores of pre-service teachers taught vertebrate physiology using Moodle and conventional instructions method in southwest Nigeria?

Table 1: Mean and Standard Deviation of Pre-service Teachers Exposed to MOODLE and Conventional Methods in Southwest Nigeria

		Pre-test		Post-test	
Group	N	Mean	S.D	Mean	S.D
Moodle	69	17.96	4.005	37.67	2.411
Conventional Method	104	15.98	3.914	18.82	4.208

Note: S. D= Standard deviation

Table 1 displays the descriptive statistics of the pre-service teachers' achievement scores. The mean pre-test score for Moodle was 17.96 with a standard deviation of 4.005 and the mean post-test score for Moodle was 37.67 with a standard deviation of 2.411 while the Conventional method had pre-test mean scores of 15.98 with a standard deviation of 3.914 and conventional method post-test mean score of 18.82 with a standard deviation of 4.208.

Research Question Two: What are the mean achievement scores of male and female pre-service teachers taught in vertebrate physiology using MOODLE instruction method in Federal Colleges of Education in southwest Nigeria?

Table 2: Mean and Standard Deviation, of Male and Female Pre-Service Teachers Taught Vertebrate Physiology Using Moodle

			Pre-test		Post-test	
Group	Gender	N	Mean	SD	Mean	SD
Moodle	Male	29	18.79	4.229	37.79	3.773
	Female	40	17.35	2.366	37.58	2.469

Table 2 displays the descriptive statistics of the male and female pre-service teachers' achievement scores. The mean pre-test score of male in Moodle was 18.79 with a standard deviation of 4.229, The mean pre-test score of female in Moodle was 17.35 with a standard deviation of 2.366 while, the mean post-test score of male in Moodle was 37.79 with a standard deviation of 3.773 the mean post-test scores of female in Moodle was 37.58 with a standard deviation of 2.469.

Null Hypothesis One

Table 3: Results of Analysis of Covariance on Pre-service Achievement in Vertebrate Physiology Using VPAT

Source	Type III Squares	Sum of df	Mean Square	F	Sig.
Corrected Model	19414.643[a]	3	6471.548	538.713	.000
Intercept	12153.624	1	12153.624	1011.708	.000
Pre-test	5.756	1	5.756	.479	.489
*Method	18926.182	2	9463.091	787.739	.000
Error	3051.295	254	12.013		
Total	244226.000	258			
Corrected Total	22465.938	257			

Table 3 revealed a significant difference in the achievement of pre-service teachers taught vertebrate physiology exposed to Moodle, F= ratio of 787.739 was obtained with an associated exact probability value of 0.000. Since the associated probability (0.000) is less than 0.05 set as the level of significance, the null hypothesis was rejected. The result implies that Moodle Instruction improved and facilitated pre-service teachers' achievement in vertebrate physiology more than the conventional method.

Null Hypothesis Two

Table 4: Result of Analysis of Covariance of Pre-service Teachers' Achievement in Vertebrate Physiology Using VPAT Based on Gender and Moodle

Source	Type III Sum Squares	of df	Mean Square	F	Sig.
Corrected Model	.865[a]	2	.432	.072	.930
Intercept	4413.684	1	4413.684	738.470	.000
Pretest	.065	1	.065	.011	.917
*Gender M	.857	1	.857	.143	.706
Error	394.469	66	5.977		
Total	98291.000	69			
Corrected Total	395.333	68			

Table 4 revealed the ANCOVA table on male and female pre-service teachers' achievement in VPAT. F= ratio of .143 with an associated probability of .706 which is greater than the benchmark probability value of 0.05. There was no significant difference in the mean achievement scores of male and female pre-service teachers taught vertebrate physiology using MOODLE instruction method and the null hypothesis was accepted.

3. Discussion of Findings

The findings of this study indicate that the use of Moodle as an instructional platform significantly enhanced the achievement of pre-service NCE teachers in vertebrate physiology. Pre-service teachers who were taught using Moodle-based instructions demonstrated significantly higher mean achievement scores compared to their counterparts who received instruction through conventional teaching methods. This suggests that the integration of Moodle into biology instruction offers an effective approach to improving student learning outcomes. The observed improvement can be attributed to the interactive and flexible nature of Moodle, which allows learners to access course materials at their convenience, engage in self-paced learning, and participate in interactive activities that reinforce understanding.

These findings align with the study conducted by Plasencia (2021), who reported that students who utilized Moodle for solving practice tests in molecular biology achieved significantly higher scores compared to their initial attempts, indicating improved comprehension and retention. Similarly, Olmos, Sanches, Mena, and Rodriguez (2015) found that Moodle enhanced the academic achievement of undergraduate students by promoting content management and interactivity within ICT courses. The flexibility and accessibility of online learning platforms like Moodle empower students to engage with learning materials beyond traditional classroom settings, leading to improved academic performance. This aligns with the

study of Alameri, Masadeh, Hamadallah, Ismail, and Fakhouri (2020), who found that the use of Moodle, Microsoft Teams, and Zoom during the COVID-19 pandemic had a positive impact on students' academic achievement, as it allowed them to learn at their own pace and in a more comfortable learning environment.

Furthermore, findings from the hypothesis testing revealed no significant difference in the mean achievement scores of male and female pre-service teachers taught vertebrate physiology using the Moodle instructional method. This suggests that Moodle is an equitable instructional tool that benefits both genders equally in terms of learning outcomes. These results are in agreement with the study conducted by Ramon, Bello, and Bauchi (2019), who found that the use of computer animation instructional packages in teaching cell division significantly improved pre-service Biology teachers' achievement, irrespective of gender. Similarly, Olmos et al. (2015) reported no noticeable difference between male and female students in their academic performance when taught using Moodle-based instruction.

However, the present study's findings contrast with those of Raman, Don, Khalid, and Rizuan (2014), who found that gender played a role in students' performance expectancy and behavioral intention in the use of Moodle, with male students showing a stronger correlation between these factors. Additionally, Etim, Etim, Heilman, Mathiyalakan, and Ntukidem (2016) observed that female students outperformed their male counterparts in subjects such as English Language, Mathematics, and Biology. Despite these contrasting findings, the results of this study suggest that Moodle-based instruction is an effective and gender-neutral tool for improving academic achievement in vertebrate physiology.

The overall trend of improved achievement in the Moodle group reinforces the significance of digital learning platforms in modern education. By enabling flexible, interactive, and student-centered learning, Moodle provides an opportunity to enhance science education at the tertiary level, particularly in a post-pandemic era where technology-driven learning continues to evolve.

4. Conclusion

The findings of this study demonstrate that pre-service teachers exposed to Moodle-based instruction showed significant improvement in their achievement in vertebrate physiology compared to those taught using conventional methods. This suggests that Moodle is an effective instructional tool for enhancing learning outcomes in biology education at the tertiary level. The study further revealed no significant difference in the achievement of male and female pre-service teachers taught using Moodle, indicating that the platform provides an equitable learning experience for all students regardless of gender.

The results highlight the limitations of conventional instructional strategies commonly used by biology lecturers in colleges of education, which may have contributed to the persistent low achievement in vertebrate physiology. The study underscores the need for adopting innovative, technology-driven instructional approaches, such as Moodle, which provide flexible, student-centered, and interactive learning experiences. Given the growing integration of digital learning in education, it is essential to develop and implement more modular, synchronous, and asynchronous online teaching methods to enhance science education.

5. Recommendations

Based on the study's findings, the following recommendations are proposed:

Integration of Online Teaching Tools – Biology lecturers should adopt the use of online learning platforms, such as Moodle, incorporating multimedia tools to enhance the teaching and learning process. This will provide a more engaging and effective instructional approach, leading to improved student achievement in vertebrate physiology.

Early Implementation of Digital Instructional Strategies – At the pre-service level, there should be an emphasis on integrating online instructional methods with various multimedia components. Introducing these strategies early will help pre-service teachers develop digital teaching competencies and discourage reliance on conventional teaching methods.

Curriculum Enhancement – Curriculum planners should incorporate various forms of online teaching and learning strategies into the Biology curriculum of colleges of education. This will ensure that pre-service Biology teachers are adequately prepared to use digital instructional tools, ultimately improving their achievement and effectiveness as future educators.

By implementing these recommendations, stakeholders in teacher education can foster a more effective, inclusive, and technologically advanced learning environment for pre-service biology teachers.

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