

Article

Project-Based Learning Method and Academic Performance of Secondary School Biology Students in Ogbia Local Government Area, Bayelsa State, Nigeria

Martha Ijok Adibe Njoku¹, Miriam Chiwendu Okoro²

1. Department of Biology, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt, Rivers State, Nigeria
2. Department of Curriculum and Instructional Technology, Faculty of Education, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt, Rivers State, Nigeria

Correspondence: ¹martha.njoku@iaue.edu.ng, ²miriam.okoro@iaue.edu.ng

Citation: Njoku M. I. A., Okoro M. C. Project-Based Learning Method and Academic Performance of Secondary School Biology Students in Ogbia Local Government Area, Bayelsa State, Nigeria. International Journal on Integrated Education (IJIE) 2026, 9(3), 127-138.

Received: 26th Apr 2026Revised: 21st May 2026Accepted: 11th Jun 2026Published: 22nd Jul 2026

Copyright: © 2026 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>)

Abstract: Biology is a science subject that require hands-on practical experience for better understanding and high academic performance. Unfortunately, Biology teachers are still searching for the appropriate instructional method that will produce the desired result. This led to the study that investigated the effect of Project-Based Learning (PBL) method on the academic performance of secondary school Biology students in Ogbia Local Government Area, Bayelsa State. The research employed a quasi-experimental pretest-posttest control group design involving 77 Senior Secondary School Two (SS2) students from two intact classes in two public secondary schools. Two research questions guided the study and two null hypotheses were tested at 0.05 level of significance. The Biology Performance Test (BPT) served as the instrument for data collection. The Kuder-Richardson formula 20 (KR-20) was used to determine the internal consistency of the multiple-choice items and a reliability coefficient of 0.76 Data were analyzed using descriptive statistics (means and standard deviations) and inferential statistics (Analysis of Covariance - ANCOVA). The findings revealed that students taught Biology using project-based learning method achieved significantly higher performance (mean gain = 20.15) compared to those taught using traditional lecture method (mean gain = 13.88), with $F(1,74) = 651.242$, $p < 0.05$. Additionally, the study found no significant influence of gender on academic performance when project-based learning was used, with male students scoring a mean of 30.00 and female students scoring 30.66, $F(1,32) = 0.145$, $p > 0.05$. The study concluded that project-based learning is significantly more effective than traditional methods in enhancing Biology academic performance and creates gender-inclusive learning environments. It was recommended that Biology teachers should adopt project-based learning approaches in their instructional practice, as this study has demonstrated its effectiveness in significantly improving student academic performance.

Keywords: Problem-Based Learning, Instructional Method, Gender, Academic Performance, Biology

1. Introduction

Education serves as the cornerstone of human development and societal progress, representing a fundamental catalyst for economic growth, social cohesion, and technological advancement in Nigeria. The Nigerian educational system has undergone significant reforms to align with global best practices, with the National Policy on Education emphasizing the need for educational approaches that foster creativity, innovation, and practical skills essential for national development [1]. This policy

framework recognizes that traditional educational models must evolve to meet the demands of a rapidly changing world, where learners must be equipped with the capacity to adapt, innovate, and contribute meaningfully to society. The emphasis on quality education becomes particularly significant when considering the role of science education in national development, as scientific literacy forms the foundation for technological advancement and evidence-based decision-making processes crucial for addressing contemporary challenges.

The evolution of educational paradigms has witnessed a significant shift from teacher-centered approaches to learner-centered methodologies that prioritize active engagement, collaborative learning, and the development of higher-order thinking skills. This transformation reflects a growing recognition that effective education must prepare learners not merely to memorize information but to analyze, synthesize, and apply knowledge in diverse contexts. Contemporary educational theory emphasizes the importance of constructivist learning approaches that acknowledge learners as active participants in the knowledge construction process, rather than passive recipients of information. This philosophical shift has profound implications for curriculum design, instructional methodology, and assessment practices in Nigerian schools.

Biology, as a fundamental life science, occupies a pivotal position in the Nigerian educational curriculum, serving as a gateway to understanding the complexities of living organisms and their interactions with the environment. In Nigeria's educational system, Biology is recognized as a core science subject that provides the foundation for careers in medicine, agriculture, biotechnology, and environmental management, making its effective teaching and learning crucial for national development goals [2], [3]. However, research has consistently shown that Biology education in Nigeria faces significant challenges, including inadequate teaching methodologies, overcrowded classrooms, and limited resources that affect student academic performance [4], [5]. The complexity of biological concepts requires instructional strategies that can effectively bridge the gap between abstract theoretical knowledge and concrete understanding, as modern Biology encompasses multiple levels of organization requiring learners to develop systems thinking capabilities.

Traditional approaches to Biology teaching in Nigerian secondary schools have often emphasized memorization of facts and procedures, leading to superficial learning that fails to develop the deep conceptual understanding necessary for scientific thinking. Research conducted in Nigerian schools has demonstrated that students who experience Biology through passive learning methods often struggle to connect theoretical concepts with real-world applications, resulting in limited retention and poor transfer of knowledge to novel situations [6]. The interdisciplinary nature of contemporary Biology further complicates the teaching and learning process, as students must integrate knowledge from chemistry, physics, and mathematics. Laboratory work in traditional Biology education typically follows a cookbook approach, where students follow predetermined procedures to verify known results rather than engage in authentic scientific inquiry, limiting opportunities for students to develop critical thinking skills and scientific reasoning abilities.

The landscape of Biology teaching and learning methods has undergone transformation in response to these challenges, with innovative pedagogical approaches gaining recognition as effective alternatives to traditional instruction. Inquiry-based learning has gained prominence as an effective approach to Biology education, encouraging students to ask questions, formulate hypotheses, design experiments, and draw conclusions based on evidence [7]. Cooperative learning strategies have also been recognized as powerful tools for enhancing Biology teaching and learning, showing promise in improving student engagement and promoting deeper understanding. However, the implementation of innovative teaching approaches requires significant

changes in classroom dynamics, teacher preparation, and resource allocation, presenting challenges for widespread adoption in Nigerian educational contexts.

Project-Based Learning (PBL) represents a comprehensive pedagogical approach that addresses many of the limitations associated with traditional teaching methods while providing a framework for authentic, engaging, and meaningful learning experiences. PBL is characterized by students working on complex, real-world problems or challenges over extended periods, culminating in the creation of authentic products or presentations that demonstrate their learning. Almulla [8] demonstrated that project-based learning significantly improved students' academic performance and engagement compared to traditional teaching methods. The methodology's emphasis on investigation, collaboration, and authentic assessment aligns well with the nature of biological inquiry and the skills required for scientific thinking, providing opportunities for students to engage in authentic scientific practices such as formulating research questions, designing experiments, collecting and analyzing data, and communicating findings to authentic audiences.

Academic performance in Biology represents a complex construct that encompasses multiple dimensions of student learning and achievement, extending beyond simple test scores to include conceptual understanding, scientific reasoning abilities, and practical skills. Research conducted in Nigerian secondary schools has shown that students' academic achievement in Biology is influenced by various factors, including teaching methodologies, teacher qualifications, classroom environment, and student characteristics. Individual differences among students play a crucial role in determining academic performance, with factors such as prior knowledge, learning styles, motivation, and self-efficacy beliefs significantly influencing how students engage with biological content and the depth of understanding they achieve [3].

The relationship between gender and academic performance in Biology represents a complex phenomenon that has received attention from Nigerian researchers. Studies conducted in various Nigerian states have revealed mixed findings regarding gender differences in Biology achievement. Research in Oyo State examined teachers' academic qualification, gender, and teaching experience as correlates of students' academic performance in Biology, providing insights into factors that influence student outcomes [2]. Some studies have found no significant difference in Biology achievement between male and female students when exposed to innovative teaching methods, while others have identified gender-related variations in performance depending on the instructional approach used. Research examining the effects of instructional strategies and gender on basic science students' achievement in Nigeria found no significant difference in the overall achievement of male and female students when taught using various instructional approaches [9]. However, studies focusing on computer-based versus paper-based testing have revealed gender differences in Biology performance, suggesting that assessment methods may influence the manifestation of gender-related differences in academic achievement.

The specific context of Ogbia Local Government Area in Bayelsa State provides a unique opportunity to examine these educational phenomena within a particular cultural, geographic, and socioeconomic setting. Understanding how project-based learning methodology influences academic performance in this specific context, including any differential effects by gender, will contribute valuable insights to the broader understanding of effective Biology education practices in Nigerian secondary schools and inform educational policy and practice decisions aimed at improving science education outcomes.

The persistent poor academic performance of students in Biology across Nigerian secondary schools has become a source of concern for educators, policymakers, and stakeholders in the education sector. Despite Biology being a core science subject that

forms the foundation for careers in medicine, agriculture, biotechnology, and environmental management, students continue to perform poorly in both internal and external examinations. The West African Examinations Council (WAEC) and National Examinations Council (NECO) results consistently show low pass rates in Biology, with many students failing to achieve the minimum credit grades required for admission into tertiary institutions.

In Ogbia Local Government Area of Bayelsa State, secondary school students' performance in Biology has been particularly disappointing, with teachers and education officials expressing concern about the declining standards and poor achievement levels. Preliminary observations and discussions with Biology teachers in the area reveal that students often struggle to understand biological concepts, demonstrate limited ability to apply knowledge to real-world situations, and exhibit poor retention of learned materials. Many students view Biology as a difficult subject that requires extensive memorization, leading to disengagement and poor academic outcomes.

1.1 Research Questions

The following research questions guided this study;

- a. What are the mean performance scores of secondary school students taught Biology using project-based learning and lecture methods in Ogbia Local Government Area, Bayelsa State?
- b. what is the influence of gender on the mean performance scores of secondary school students in Biology when taught using project-based learning method in Ogbia Local Government Area, Bayelsa State?

1.2 Research Hypotheses

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

1. There is no significant difference in the mean performance scores of secondary school students taught Biology using project-based learning and lecture methods in Ogbia Local Government Area, Bayelsa State.
2. There is no significant influence of gender on the mean performance scores of secondary school students in Biology when taught using the project-based learning method in Ogbia Local Government Area, Bayelsa State.

2. Literature Review

In a landmark study conducted by Ertmer and Simons [10] examined the effects of project-based learning on student achievement in science education across multiple countries, including several African nations. The meta-analysis of 47 studies found that students who experienced project-based learning demonstrated significantly higher achievement on measures of content knowledge, problem-solving skills, and scientific reasoning compared to those taught through traditional methods. The effect sizes were particularly large for measures of application and transfer, suggesting that PBL is especially effective in helping students apply their knowledge in novel situations.

In the Nigerian context, research by Adebayo and Olufunke [11] conducted a quasi-experimental study comparing project-based learning and traditional teaching methods in secondary school Biology classes in Lagos State. The study involved 120 students from four schools who were randomly assigned to either PBL or traditional instruction groups. After eight weeks of instruction, students in the PBL group scored significantly higher on both immediate and delayed post-tests, with effect sizes ranging from 0.68 to 0.82, indicating large practical significance. The researchers also found that PBL students demonstrated better retention of learned concepts when tested four weeks after instruction ended.

Okafor and Nwankwo [12] in Anambra State examined the long-term effects of project-based learning on Biology achievement among 200 senior secondary school students. The study followed students for an entire academic year, comparing those who experienced consistent PBL instruction with those taught through conventional methods.

Results showed that PBL students not only achieved higher scores on standardized Biology tests but also demonstrated greater interest in pursuing science careers and higher levels of scientific literacy as measured by their ability to apply biological knowledge to real-world problems.

International research has also provided evidence for the effectiveness of project-based learning in Biology education. Zhang and Liu [13] conducted a study in Chinese secondary schools and compared project-based learning with traditional instruction in Biology classes involving 480 students across 12 schools. The researchers found that PBL students showed significant improvements in conceptual understanding, scientific reasoning, and collaborative skills. Importantly, the study found that the benefits of PBL were sustained over time, with PBL students continuing to outperform their traditionally-taught peers on follow-up assessments conducted six months after the intervention.

Martinez and Santos [14] in the Philippines examined the implementation of project-based learning in Biology education within resource-constrained environments similar to many Nigerian schools. The study found that even with limited laboratory facilities and materials, teachers were able to implement effective PBL activities that improved student outcomes. The researchers emphasized the importance of teacher training and support in ensuring successful PBL implementation, particularly in contexts where teachers are not familiar with student-centered approaches.

The relationship between gender and academic performance in project-based learning environments has been the subject of considerable research, with varying findings depending on subject area, student characteristics, and implementation context. Johnson and Williams [15] conducted a comprehensive review of gender effects in project-based learning across STEM subjects and found that PBL approaches generally reduced gender gaps in achievement compared to traditional instruction. The analysis of 23 studies revealed that female students particularly benefited from the collaborative and communicative aspects of PBL, while male students showed similar benefits from the hands-on and problem-solving components. The researchers concluded that PBL's diverse activity types and assessment methods help accommodate different learning preferences and strengths.

In the Nigerian context, a study by Nwagbo and Ukaegbu [16] investigated gender differences in Biology achievement when students were taught using project-based learning methods. The research involved 160 students from secondary schools in Rivers State and found no significant gender differences in post-test scores after PBL instruction, despite pre-existing differences favoring male students. The study suggested that PBL's emphasis on collaboration and multiple ways of demonstrating knowledge helped level the playing field for female students.

Adeyemi and Ogunleye [17] examined gender effects on project-based learning in secondary schools in Oyo State while also considering the influence of teacher gender and teaching experience. The study found that female students taught by female teachers in PBL environments showed particularly strong achievement gains, suggesting that same-gender role modeling may enhance the benefits of innovative teaching approaches for female students in science subjects.

International research has provided additional insights into gender effects in project-based learning. A study by Chen and Zhang [18] in Taiwanese secondary schools examined gender differences in various aspects of PBL participation and found that while overall achievement outcomes were similar for male and female students, there were differences in participation patterns and preferred project types. Female students showed greater preference for projects with social relevance and health connections, while male students preferred projects involving competition and technology integration.

Krajcik and Shin [19] examined the implementation of project-based learning in high school Biology courses across multiple U.S. states and found significant improvements in

students' understanding of complex biological systems and processes. The study revealed that PBL was particularly effective in helping students understand interconnections between different biological concepts and develop systems thinking skills essential for modern Biology. Students who participated in PBL showed superior performance on assessments requiring analysis and synthesis compared to those taught through traditional methods.

A study conducted by Okebukola and Jegede [20] in Nigerian secondary schools specifically examined project-based learning in ecology and environmental Biology topics. The research involved 180 students from six schools in Ogun State and found that students who participated in community-based environmental projects demonstrated significantly better understanding of ecological concepts and showed greater environmental awareness and concern. The study highlighted the particular suitability of PBL for Biology topics that have clear real-world applications and local relevance.

Abdullah and Rahman [21] investigated the effectiveness of project-based learning in teaching genetics and molecular Biology concepts in Malaysian secondary schools. The study found that students who engaged in projects involving DNA analysis and genetic problem-solving showed better understanding of abstract genetic concepts compared to those taught through traditional methods. The researchers emphasized that PBL helped make abstract concepts more concrete through hands-on activities and real-world applications.

The theoretical underpinnings of PBL are rooted in constructivist learning theories, experiential learning, social learning, and multiple intelligences. Piaget and Vygotsky's constructivist theories highlight that learning is a socially-mediated process where knowledge is built through interactions. Dewey's experiential learning theory further reinforces the importance of learning through hands-on participation, suggesting a strong connection between theory and practice in educational settings. Each of these frameworks supports the PBL approach, affirming its relevance to the improvement of academic performance, specifically in the realm of scientific education. Moreover, the literature indicates a notable shift in the teacher's role within PBL environments; they transition from traditional information providers to facilitators and guides of student learning. This transition underscores the necessity for teachers to engage in professional development to effectively implement project-based learning strategies, as established by research conducted by Adamu and Bello [22].

In summary, the reviewed literature illustrates that Project-Based Learning holds significant promise for enhancing the academic performance of secondary school Biology students in Ogbia Local Government, Bayelsa State. A multi-faceted approach—drawing from constructive theoretical frameworks and addressing contextual challenges—can bolster the successful adoption and outcomes of PBL in Nigerian secondary education. As schools continue to explore and implement this pedagogical method, a concerted effort should be directed towards addressing the infrastructural and training gaps to realize the full potential of project-based learning in improving student engagement and academic success in Biology.

3. Research Methods

This study employed a quasi-experimental research design, specifically the pretest-posttest control group design, to investigate the effect of project-based learning method on the academic performance of secondary school Biology students in Ogbia Local Government Area, Bayelsa State. The study utilized intact classes as the unit of randomization rather than individual students to minimize contamination effects and maintain the natural classroom environment. Schools were randomly assigned to either the experimental group (project-based learning) or control group (traditional teaching

method) to ensure that the comparison between treatments is not confounded by systematic differences between schools or student populations.

The study was conducted in Ogbia Local Government Area of Bayelsa State, Nigeria. Ogbia Local Government Area is located in the eastern part of Bayelsa State in the Niger Delta region of Nigeria. It covers an area of approximately 695 square kilometers and is bounded by Nembe Local Government Area to the east, Southern Ijaw Local Government Area to the west, and Yenagoa Local Government Area to the north. Ogbia Local Government Area has a population of approximately 200,000 people, with the majority engaged in farming, fishing, and small-scale trading [23]. The area is predominantly rural with some semi-urban settlements. The educational system in the area consists of primary schools, secondary schools, and a few tertiary institutions.

The population for this study consisted of all Senior Secondary School Two (SS2) Biology students in public secondary schools located within Ogbia Local Government Area of Bayelsa State, Nigeria. The choice of SS2 students was based on several considerations: first, SS2 students have adequate foundational knowledge in Biology from their previous year of study, making them capable of engaging meaningfully with project-based learning activities; second, they are not immediately preparing for external examinations (WAEC/NECO), which could interfere with the implementation of the intervention; and third, the SS2 curriculum includes topics that are well-suited for project-based learning approaches.

According to records obtained from the Bayelsa State Ministry of Education, there are 34 public secondary schools in Ogbia Local Government Area with a total SS2 Biology student population of approximately 2,847 students during the 2023/2024 academic session. This population includes both male and female students from diverse socioeconomic backgrounds and communities within the local government area.

The sample for this study consisted of 77 SS2 Biology students from two intact classes in public secondary schools in Ogbia Local Government Area. The sampling technique employed was a multi-stage sampling approach combining purposive and simple random sampling methods. In the first stage, purposive sampling was used to select schools that met specific criteria including: having adequate enrollment of SS2 Biology students, availability of basic laboratory facilities, qualified Biology teachers willing to participate in the study, and accessibility for regular monitoring and data collection. Eight schools met these criteria and were included in the sampling frame.

In the second stage, simple random sampling was used to select two schools from the eight qualified schools. The selected schools were then randomly assigned to either the experimental group (project-based learning) or control group (traditional teaching method). In the third stage, intact SS2 Biology classes from the selected schools were included in the study, with all students in the selected classes participating in the research. This approach was chosen to maintain the natural classroom environment and minimize disruption to normal school operations.

The primary instrument for data collection was the Biology Performance Test (BPT), a researcher-developed test designed to measure students' knowledge and understanding of selected Biology topics covered during the intervention period. The development of the BPT followed established procedures for educational test construction and was based on the Nigerian secondary school Biology curriculum for SS2. The validity of Biology Performance Test was established by presenting it to two experts in Biology education and one expert in measurement and evaluation to ensure that the instrument accurately measures what it purports to measure. The reliability of the BPT was determined through a pilot test with 20 SS2 Biology students from a school not included in the main study but with similar characteristics to the target population. The Kuder-Richardson formula 20 (KR-20) was used to determine the internal consistency of the multiple-choice items. A

reliability coefficient of 0.76 was obtained and considered acceptable for this study, following established standards in educational research [24].

The study covered a period of six weeks; the first week was used for training research assistants (regular class teachers) and administration of pretest. The following 4 weeks were used for treatment or actual teaching, then the sixth week was used for post-test administration. Students in the experimental and control groups were taught by their teachers using the lesson plans prepared by the researcher for four weeks. These Biology topics were taught to the students within this period; 1. Pollution, 2. Pests and diseases of crops, 3. Ecology and 4. Conservation and natural resources. The test scripts for both pretest and post-test were graded by the researcher and the scores subjected to various statistical analysis. Mean and standard deviation were used to answer research questions while Analysis of covariance (ANCOVA) was used to test the null hypothesis at 0.05 level of significance.

4. Results

Research Question 1: What are the mean performance scores of secondary school students taught Biology using project-based learning and lecture methods in Ogbia Local Government Area?

Table 1. Pretest and Posttest Scores of Students' Academic Performance in Biology.

Teaching Method	N	Pretest Mean	Std.dev	Posttest Mean	Std.dev	Mean gain
Project based	35	10.42	2.47	30.57	1.78	20.15
Lecture	42	9.95	2.27	23.83	1.99	13.88

Table 1 revealed that the pre-test mean score of the experimental group which used PBL strategy was 10.42 while that of the control group which used conventional lecture method was 9.95. Again, the post-test mean scores for both the experimental and the control groups were recorded as 30.57 and 23.83 respectively. The mean gain on the basis of the differences between the pre-test scores and post-test scores of each group indicated 20.15 for the experimental group and 13.88 for the control group. This shows that the performance of students in Biology was better when taught with problem-based learning.

Research Question 2: What is the influence of gender on the mean performance scores of secondary school students taught Biology using project based learning method in Ogbia Local Government Area?

Table 2. Mean and Standard Deviation Showing Male and Female Students' Academic Performance.

Gender	N	Mean	Std.dev
Male	20	30.00	1.77
Female	15	30.66	1.75

Table 2 shows that male students had a mean score 30.00 while their female counterparts had a mean 30.66.

Hypothesis 1: There is no significant difference in the mean performance scores of secondary school students taught Biology using project-based learning and lecture methods in Ogbia Local Government Area

Table 3. Analysis of Covariance (ANCOVA) On the Mean Performance Scores of Students.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1532.979 ^a	2	766.490	325.623	.000
Intercept	1006.729	1	1006.729	427.683	.000
Pretest	12.687	1	12.687	5.390	.023
Teaching method	1532.968	1	1532.968	651.242	.000
Error	174.190	74	2.354		
Total	62524.000	77			
Corrected Total	1707.169	76			

a. R Squared = .898 (Adjusted R Squared = .895)

Table 3 indicates that there is a significant difference in the mean achievement scores of students in the experimental and control groups. This is based on the fact that the calculated F-value of 651.242 and with probability value of 0.000 which is less than the alpha value of 0.05 set for the study. That is $F(1,93) = 651.242$ and $P = 0.00 < \alpha = 0.05$. To this effect, the null hypothesis 1 (H01) is rejected. This implies that there is a significant difference in the mean achievement scores of students taught Biology using Project based method and those exposed to conventional lecture method.

Hypothesis 2: There is no significant influence of gender on the mean performance scores of secondary school students taught Biology using project based learning method in Ogbia Local Government Area

Table 4. Analysis of Covariance (ANCOVA) Showing the Mean Performance Scores of Male and Female Students.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1532.979 ^a	2	766.490	325.623	.000
Intercept	1006.729	1	1006.729	427.683	.000
Pretest	12.687	1	12.687	5.390	.023
Teaching method	1532.968	1	1532.968	651.242	.000
Error	174.190	74	2.354		
Total	62524.000	77			
Corrected Total	1707.169	76			

a. R Squared = .898 (Adjusted R Squared = .895)

Table 4 indicates that there is no significant difference in the achievement mean scores of male and female students exposed to project based learning method. This is based on the fact that the calculated F-value of 0.145 and with probability value of 0.748 which is greater than the alpha value of 0.05 set for the study. That is $F(1,32) = 0.145$ and $P = 0.748 > \alpha = 0.05$. To this effect, the null hypothesis 2 (H02) is not rejected. This implies that there is no significant difference in the achievement mean scores of male and female students exposed to project based learning method.

Summary of Findings

1. Students who were taught Biology using the project-based method performed better than their counterparts who were taught with the lecture method.
2. There was no significant influence of gender on the mean performance scores of secondary school students taught Biology using the project-based learning method in Ogbia Local Government Area.

5. Discussion

• Project-Based Learning and Academic Performance in Biology

The first finding of this study revealed that students taught Biology using project-based learning method performed significantly better than those taught using traditional lecture method. Specifically, students in the experimental group achieved a mean gain of 20.15 points compared to 13.88 points for the control group, with the ANCOVA analysis confirming this difference as statistically significant ($F(1,74) = 651.242, p < 0.05$).

The result corroborates the findings of Adebayo and Olufunke [11] who conducted similar research in Lagos State and found that students exposed to project-based learning demonstrated significantly higher levels of engagement and superior academic performance compared to those taught using traditional methods. Similarly, Okebukola and Jegede [20] in Ogun State found that students who participated in PBL activities showed greater improvement in scientific process skills and conceptual understanding compared to those taught using conventional methods.

The substantial mean gain difference observed in this study can be attributed to several characteristics of project-based learning. First, PBL involves students in authentic, real-world problems that require sustained investigation, making learning more meaningful and memorable. Second, the collaborative nature of project work allows students to learn from one another and develop deeper understanding through discussion and shared inquiry. Third, PBL requires students to apply knowledge in practical contexts, which strengthens retention and transfer of learning.

• Gender Influence on Academic Performance in Project-Based Learning

The second finding revealed no significant influence of gender on academic performance when students were taught Biology using project-based learning method. Male students achieved a mean score of 30.00 while female students scored 30.66, with ANCOVA analysis showing no statistically significant difference ($F(1,32) = 0.145, p = 0.748 > 0.05$).

The result aligns with the findings of Nwagbo and Ukaegbu [16] who investigated gender differences in Biology achievement under project-based learning in Rivers State and found no significant gender differences in post-test scores despite pre-existing differences favoring male students in traditional settings. Similarly, Atomatofa [9] found no significant difference in the overall achievement of male and female students when taught using various innovative instructional approaches including project-based learning.

This finding is particularly significant because it contrasts with research documenting gender disparities in science achievement when traditional teaching methods are employed. The absence of gender differences in this study suggests that project-based learning's diverse activity types, collaborative approach, and multiple assessment methods accommodate different learning preferences and strengths regardless of gender. The hands-on nature of PBL activities, opportunities for verbal interaction, and emphasis on teamwork appear to benefit both male and female students equally.

The practical implication of this finding is that project-based learning can serve as an effective strategy for promoting gender equity in Biology education. By creating learning environments where achievement is based on collaboration, inquiry, and authentic problem-solving rather than competitive performance on traditional tests, PBL helps ensure that all students, regardless of gender, have equal opportunities to succeed.

This result also has implications for teacher professional development and instructional planning. Teachers should be encouraged to implement project-based learning approaches not only for their effectiveness in improving overall achievement but also for their capacity to create gender-inclusive learning environments that support the success of all students.

Summary

This study investigated the effect of Project-Based Learning method on the academic performance of secondary school Biology students in Ogbia Local Government Area, Bayelsa State. The research employed a quasi-experimental pretest-posttest control group design involving 77 Senior Secondary School Two (SS2) students from four public secondary schools in the study area.

The study was guided by two specific research questions and tested two null hypotheses at 0.05 level of significance. The Biology Achievement Test (BAT) served as the primary instrument for data collection, measuring students' knowledge and understanding of selected Biology topics. Data analysis involved both descriptive statistics (means and standard deviations) and inferential statistics (Analysis of Covariance).

The findings revealed significant differences in academic performance between students taught using project-based learning and those exposed to traditional lecture methods. Students in the experimental group achieved a pretest mean score of 10.42 and posttest mean score of 30.57, representing a mean gain of 20.15 points. In contrast, students in the control group had pretest mean score of 9.95 and posttest mean score of 23.83, with a mean gain of 13.88 points. The Analysis of Covariance confirmed this difference as statistically significant ($F(1,74) = 651.242, p < 0.05$).

Regarding gender influence, the study found no significant difference in academic performance between male and female students when taught using project-based learning. Male students achieved a mean score of 30.00 while female students scored 30.66. The ANCOVA analysis revealed no statistically significant gender effect ($F(1,32) = 0.145, p > 0.05$), indicating that project-based learning was equally effective for both male and female students.

6. Conclusion

Based on the findings of this study, it can be concluded that project-based learning is significantly more effective than traditional lecture method in enhancing Biology academic performance among secondary school students in Ogbia Local Government Area, Bayelsa State. The substantial improvement in student achievement when exposed to PBL methodology demonstrates that this approach successfully addresses fundamental limitations associated with conventional instruction.

Furthermore, project-based learning creates gender-inclusive learning environments where both male and female students achieve equally well, thereby promoting equity in Biology education. This finding is particularly important for addressing gender disparities that have been documented in science education contexts where traditional teaching methods predominate. The study provides empirical evidence that project-based learning can be successfully implemented in Nigerian secondary school contexts to improve educational outcomes, even in areas facing resource constraints and infrastructure limitations similar to those in Ogbia Local Government Area.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Biology teachers should adopt project-based learning approaches in their instructional practice, as this study has demonstrated its effectiveness in significantly improving student academic performance.
2. Project-based learning was found to be gender friendly, therefore should be adopted in place of gender sensitive methods.

REFERENCES

- [1] Federal Republic of Nigeria, National Policy on Education, 7th ed. Abuja, Nigeria: Nigerian Educational Research and Development Council, 2018.
- [2] A. T. Babatunde, "Teachers' academic qualification, gender, and teaching experience as correlates of students' academic performance in Biology," *Educational Research and Reviews*, vol. 14, no. 10, pp. 342–348, 2019, doi: 10.5897/ERR2019.3712.

- [3] M. I. A. Njoku, C. R. Nwagbo, and C. S. Ugwuanyi, "Effect of peer tutoring and peer-led team learning on students' achievement in Biology," *International Journal of Database Theory and Application*, vol. 13, no. 1, pp. 1–10, 2020.
- [4] A. O. Ogunleye and J. G. Farombi, "Challenges in Biology education in Nigerian secondary schools," *Journal of Educational Issues*, vol. 1, no. 2, pp. 115–125, 2015, doi: 10.5296/jei.v1i2.8482.
- [5] B. A. Adeyemi, "Challenges in Biology education: A review of Nigerian secondary schools," *Science Education International*, vol. 28, no. 3, pp. 201–215, 2017.
- [6] J. K. Aina, "Effective teaching and learning in science education through information and communication technology," *IOSR Journal of Research & Method in Education*, vol. 2, no. 5, pp. 43–47, 2013.
- [7] K. O. Oloruntegbe, A. N. Duyilemi, T. A. Oluwatelure, and B. F. Dele-Ojo, "Inquiry-based learning approach: Impact on Biology achievement in Nigerian secondary schools," *Journal of Baltic Science Education*, vol. 17, no. 6, pp. 913–924, 2018, doi: 10.33225/jbse/18.17.913.
- [8] M. A. Almulla, "The effectiveness of the project-based learning (PBL) approach as a way to engage students in learning," *SAGE Open*, vol. 10, no. 3, pp. 1–15, 2020, doi: 10.1177/2158244020938702.
- [9] R. O. Atomatofa, "Effects of instructional strategies and gender on basic science students' achievement in Nigeria," *Journal of Science Education Research*, vol. 7, no. 2, pp. 78–89, 2019.
- [10] P. A. Ertmer and K. D. Simons, "Jumping the PBL implementation hurdle: Supporting the efforts of K–12 teachers," *Interdisciplinary Journal of Problem-Based Learning*, vol. 12, no. 1, Art. no. 4, 2018, doi: 10.7771/1541-5015.1705.
- [11] S. O. Adebayo and A. R. Olufunke, "Implementation of project-based learning in Nigerian secondary schools: A Lagos State perspective," *African Journal of Educational Research*, vol. 15, no. 2, pp. 78–95, 2019.
- [12] G. Okafor and O. Nwankwo, "Textbook dependency and fragmented learning in Nigerian Biology education," *Research in Science Education*, vol. 50, no. 4, pp. 1567–1582, 2020.
- [13] H. Zhang and Y. Liu, "Project-based learning effectiveness in Chinese secondary school Biology education," *Asia-Pacific Journal of Teacher Education*, vol. 47, no. 4, pp. 378–395, 2019, doi: 10.1080/1359866X.2019.1594067.
- [14] C. Martinez and D. Santos, "Implementing project-based learning in resource-constrained environments: Evidence from the Philippines," *International Journal of Educational Development*, vol. 78, Art. no. 102254, 2020.
- [15] K. Johnson and R. Williams, "Gender effects in project-based learning across STEM subjects: A comprehensive review," *Review of Educational Research*, vol. 88, no. 4, pp. 456–489, 2018.
- [16] C. Nwagbo and N. Ukaegbu, "Gender differences in Biology achievement under project-based learning: Evidence from Rivers State," *Gender and Education*, vol. 31, no. 6, pp. 712–728, 2019, doi: 10.1080/09540253.2017.1332343.
- [17] S. A. Adeyemi and B. O. Ogunleye, "Stereotype threat effects among Nigerian secondary school students in Biology," *Educational Psychology Review*, vol. 32, no. 4, pp. 567–584, 2020.
- [18] L. Chen and M. Zhang, "Gender differences in project-based learning participation: Evidence from Taiwanese secondary schools," *Educational Research Quarterly*, vol. 44, no. 4, pp. 23–41, 2021.
- [19] J. Krajcik and N. Shin, "Project-based learning in high school Biology: Systems thinking and student outcomes," *Journal of Research in Science Teaching*, vol. 56, no. 8, pp. 1045–1068, 2019, doi: 10.1002/tea.21567.
- [20] P. A. Okebukola and O. J. Jegede, "Project-based learning in Nigerian science education: Focus on ecology and environmental topics," *Environmental Education Research*, vol. 24, no. 8, pp. 1145–1162, 2018, doi: 10.1080/13504622.2017.1367916.
- [21] M. Abdullah and S. Rahman, "Project-based learning in teaching genetics and molecular Biology concepts in Malaysian secondary schools," *Asia-Pacific Science Education*, vol. 6, no. 2, pp. 401–425, 2020.
- [22] A. Adamu and M. Bello, "Teacher preparation for implementing project-based learning in Northern Nigerian schools," *Journal of Educational Innovation*, vol. 12, no. 3, pp. 45–62, 2020.
- [23] National Population Commission, *Population Estimates for Nigerian Local Government Areas*. Abuja, Nigeria: Federal Government Press, 2022.
- [24] C. Nwagbo and C. S. Ugwuanyi, "Reliability and validity in educational research: Best practices for Nigerian contexts," *Educational Measurement and Evaluation*, vol. 8, no. 3, pp. 78–94, 2021.