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PROF. PATRICK C. IGBOJINWAEKWU

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EDITORIAL

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Editor-in-Chief

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EFFECT OF PROBLEM BASED LEARNING APPROACH ON ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN PHYSICS IN AWKA EDUCATION ZONE

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Abstract

This study investigated the effect of the Problem-Based Learning approach on students' academic achievement and retention in secondary senior school physics in Awka Education Zone. The study was guided by four research questions and six hypotheses tested at a 0.05 level of significance. The study adopted a quasi-experimental research design. The population of the study comprised 3777 SS2 physics students, which includes 1588 males and 2189 females in the 65 government-owned secondary schools in Awka Education Zone, Anambra State. A sample of A sample of 157 (90 males and 67 females) SSII physics students selected using multi-stage sampling procedures was used for the study. Data were collected using Physics Achievement Test (PAT), validated by three experts, one from the Department of Science Education, one from the Measurement and Evaluation unit of the Department of Educational Foundations, both from Nnamdi Azikiwe University, Awka, and one from an experienced Physics teacher. The reliability of the PAT was established using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.82. Data were gathered with the assistance of two trained research assistants. Descriptive statistics (mean and standard deviation) were used to answer the research questions, and ANCOVA was employed to test the hypotheses at the 0.05 alpha level. Findings revealed among others that; there was a significant difference in the mean achievement scores of students taught Physics using the Problem-Based Learning Approach (PBLA) and those taught using the Conventional Lecture Method (CLM), and Male and female students taught Physics under the PBLA, and CLM did not differ significantly in their academic achievement, with only a marginal difference in post-test mean scores between the genders in both groups. Based on the results, it is recommended that; Schools should incorporate the Problem-Based Learning Approach into their Physics curricula to enhance student achievement, effective training programmes should be developed for Physics teachers to facilitate the transition to PBLA methodologies and Policymakers and educational leaders must recognize the gender-neutral benefits of PBLA on Physics achievement and promote its use across all student demographics.

Keywords: Problem Based Learning Approach, Academic Achievement

Introduction

Education is broadly viewed as the process of facilitating learning or the acquisition of knowledge, skills, values, beliefs, and habits. Education is an instrument for national development and social change, emphasizing its role in equipping individuals with the knowledge and capacity to make meaningful societal contributions. According to Radu (2019), education refers to the comprehensive process of human development through which knowledge is transmitted, intellectual abilities are cultivated, and practical skills are acquired, ultimately influencing individuals' behaviour and ways of thinking within society. In a similar view, Dilbaz (2023) describes education as a systematic process designed to equip individuals to function effectively as productive members of society. In Nigeria, the educational system is organized into distinct levels, which include early childhood education, primary education, secondary education, and tertiary education.

Secondary education is a critical phase within the educational continuum, serving as the bridge between primary education and tertiary or vocational training. It typically encompasses students in their adolescent years and is structured to consolidate foundational knowledge while introducing more specialized subject areas. In Nigeria, secondary education is divided into junior secondary (JSS 1-3) and senior secondary (SSS 1-3) levels, covering six years of instruction. The National Policy on Education (Federal Republic of Nigeria, 2013) highlights secondary education as essential for producing individuals equipped with both academic competencies and practical skills necessary for higher learning, employment, and active citizenship. This level of education plays a crucial role in shaping students' intellectual growth, career choices,

and their ability to contribute meaningfully to national development. Within this stage, science occupies a central position as a key discipline that promotes scientific literacy, critical thinking, and problem-solving skills. It is often grouped under Science, Technology, Engineering, and Mathematics (STEM), reflecting its importance in driving innovation and national progress.

Science is man's best means of acquiring the necessary knowledge and skills for improving life and productivity. The United Nations Educational, Scientific, and Cultural Organization (2020) emphasises that science is essential in addressing global challenges and achieving sustainable development. Lederman and Lederman (2020) defined science as a body of knowledge resulting from the inquiry into natural phenomena and their applications in human life. Additionally, Da Silva (2022) stated that science involves the observation, identification, description, experimental investigation, and theoretical explanation of natural phenomena, making it both a product and a process. Core science subjects taught at the secondary school level in Nigeria are Chemistry, Physics, and Mathematics. Each of these subjects contributes to students' scientific literacy and understanding of the natural world.

Physics is a fundamental branch of science that plays a crucial role in explaining natural phenomena and driving technological advancement. Begaliyev, Nur, and Tursyn (2021) describe physics as the scientific discipline that studies the properties and interactions of matter and energy, governed by universal laws. In a broader sense, Prayogi and Verawati (2024) view physics as a foundational science that underpins innovation across various fields, including healthcare, energy, engineering, telecommunications, and information technology. Similarly, Okeke and Anyakoha

(2021) emphasize that physics is not only concerned with explaining the workings of the universe but also serves as a catalyst for developing technologies that address real-life challenges. The practical relevance of physics is evident in modern technological and scientific advancements. For instance, developments in medical physics have led to life-saving diagnostic tools such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) scans, while space exploration and satellite technology rely heavily on physics principles for navigation and system design. Okafor (2019) further asserts that knowledge of physics contributes to the development of a skilled workforce capable of addressing national challenges such as energy shortages, infrastructural development, and medical innovation. In addition, Verawati and Nisrina (2025) noted that physics equips learners with analytical thinking, logical reasoning, and problem-solving skills that are essential for careers in Science, Technology, Engineering, and Mathematics (STEM). Consequently, the Federal Republic of Nigeria (FRN, 2024) designates physics as a core and compulsory subject in secondary schools.

Despite its importance, students' performance in physics in Nigeria has remained consistently poor. Reports from the West African Examinations Council (WAEC) Chief Examiners have repeatedly highlighted this trend. For example, WAEC (2022) reported that candidates demonstrated weak understanding of basic concepts, poor problem-solving skills, and difficulty applying theoretical knowledge to practical situations. Similarly, WAEC (2021) noted that many students performed below the credit level due to weak mathematical foundations, poor interpretation of questions, and inadequate grasp of fundamental principles. The WAEC (2020) report further revealed persistent difficulties in numerical calculations, graphical analysis, and

application-based questions, indicating a continuing pattern of underachievement that undermines the goal of scientific literacy and technological development.

Several factors have been identified as contributing to this persistent poor performance. Nkechi and Nwanneka (2024) observed that inadequate resources, outdated teaching methods, and limited laboratory facilities negatively affect effective physics instruction in Nigeria. In the same vein, Jolaoluwa, Onifade, and Ojo (2024) noted that factors such as shortage of qualified teachers, lack of instructional materials, and ineffective pedagogical practices significantly contribute to students' underperformance. Furthermore, Ogundele, Adeniyi, and Olatunji (2020) highlighted that inadequate laboratory infrastructure often forces teachers to rely on traditional instructional methods, limiting students' opportunities for practical engagement with scientific concepts. Busari (2023) also argued that lecture-based teaching approaches tend to encourage passive learning, which results in poor understanding of physics concepts.

Lecture method, also known as the conventional lecture method, is a teacher-centred approach in which the teacher serves as the primary source of knowledge for students. A conventional lecture method, according to Jackson (2020), involves a one -way flow of information from the teacher or instructor to the students, with the instructor delivering a spoken presentation while the students passively listen and takes note on the material. Bligh, (2021) reported that it is typically structured and organized presentations that aim to cover specific topics or concepts in a comprehensive manner. The lecture method can be particularly useful when introducing new topics, presenting complex theories, or providing a broad overview

of a subject and it continues to be adopted by teachers for instructional purposes. This preference is often driven by its suitability for teaching large groups of students and its ability to cover a wide range of content areas. Good, Thomas and Yates (2019) suggested that lecture methods limit students' ability to apply theoretical knowledge to real-world situations, thereby reducing their problem-solving capabilities. Hence, Arsyad, Rahman and Yusuf (2024) reported that addressing these challenges through innovative instructional strategies, such as problem-based learning approach (PBLA), can significantly enhance students' comprehension, engagement, and long-term retention of physics concepts.

Problem-Based Learning Approach (PBLA) is an innovative and practical approach that emphasizes critical thinking, problem-solving, and teamwork. Unlike traditional teaching methods that rely heavily on lecture-style instruction (Widiastuti, Mantra, Utami, Sukanadi & Susrawan, 2023). PBLA places students at the centre of the learning process, challenging them to work collaboratively to solve real-world problems (Heong et al., 2020; Widya et al., 2021). This learning approach shifts the focus of teaching-learning process from teacher-centred instruction to student-driven exploration, and promotes stronger cognitive engagement and fosters critical thinking skills. Busari (2023) noted that this shift is significant given that traditional lecture-based approaches have been identified as contributing to passive learning and poor retention in science subjects. PBLA also requires students to actively construct knowledge through inquiry, discussion, and hands-on experimentation rather than passively receiving information. Furthermore, Tladi, (2018) reported that PBLA approach enhances independent learning by encouraging students to research, hypothesize, and test their ideas in a structured yet flexible learning environment.

Moreover, Esiobu and Soyibo (2022) maintained that PBLA emphasizes collaborative learning and addresses critical skill gaps beyond content knowledge. By working in groups, students develop communication and interpersonal skills that are essential for both academic and professional success in an increasingly collaborative scientific and technological workforce. The real-world application of knowledge inherent in PBL approach ensures that learners not only memorize concepts but also understand their relevance and utility, making knowledge retention more effective and durable. In the context of this study, the researcher sees PBLA as a pedagogical approach in which students work in small groups to solve ill-structured, real-world problems, thereby encouraging them to take ownership of their learning by engaging with complex, authentic scenarios that mirror actual physics applications.

Previous studies have shown that Problem Based Learning Approach improves students' academic achievement in science subjects. For instance, a study by Cosgun and Atay (2021) found that innovative pedagogical approaches, such as problem-based learning approach (PBLA), can improve students' comprehension and retention by fostering critical thinking and practical application of knowledge. Wilder (2025) reported that the PBL Approach enhances academic achievement and long-term retention by fostering active engagement, critical thinking, and problem-solving skills. Dole, Bloom, & Kowalske (2017) revealed that students exposed to PBL approach demonstrate higher motivation levels, increased participation, and deeper understanding of subject matter compared to those taught through conventional methods. Aksela and Haatainen (2019) reported that PBL approach improves academic achievement and conceptual understanding across various subjects, including physics. While international studies have established the effectiveness of

PBL, there remains limited empirical evidence examining its implementation and impact specifically within Nigerian secondary schools, where contextual factors such as large class sizes, limited resources, and diverse student preparedness levels may influence its effectiveness differently than in Western educational settings. In light of this, the study on the effect of Problem-Based Learning approach on students' academic achievement in secondary senior school physics is conceived by the researcher.

Academic achievement is an outcome-oriented construct that explains the extent to which a student or a programme has attained either short- or long-term learning goals or tasks. Academic achievement, according to Egwu and Okigbo (2021), refers to the level of attainment in a specific discipline, representing the degree of knowledge and skills a student acquires after a period of learning. Munir and Omotosho (2025) defined academic achievement as the overall accomplishment obtained by students from lessons, encompassing experiences, knowledge, and skills. Jacob et al. (2020) reported that academic achievement is referred to as the knowledge acquired or skills created in school subjects. It is expressed as a result given by the teacher. According to Santoveña-Casal (2019), academic achievement is often measured through examinations or continuous assessments and is communicated through descriptive grades, marks, results, and graduation rates. It is a measure of what an individual has accomplished after exposure to an educational programme, and academic achievement is highly associated with a student's ability to retain what they have learnt in school not minding the gender.

Gender is a concept that refers to the roles, behaviours, identities, and expectations that societies and cultures associate with individuals based on their perceived or assigned sex at birth. According to Oakley (2016), it is distinct from biological sex, which refers to physical and physiological differences like chromosomes and reproductive anatomy. In recent times, gender related issues in science education have generated serious concerns for science educators judging by the number of studies done to that effect. Akumah (2018) stressed that science, technology, and their related disciplines are male-reserved, while Art and Humanities are female-reserved. This belief makes boys appear to have a natural positive attitude towards science and technical subjects, while girls show more inclination to Arts and Humanities. The problem is even compounded by the fact that most science educators give a masculine outlook to science subjects such as chemistry and physics. This discrepancy was evident in the students' achievement in Chemistry (Ezeano, 2017), encouraging females to go for biology, agricultural science, and home economics, which they consider to be more female-friendly science subjects. Some other researchers (Orefor, 2016) opined that gender does not influence students' achievement in the sciences. All these and related treatments make girls have a phobia of science and science-related subjects, which may definitely affect their future career choices, achievement and retention.

From the forgoing, it becomes clear that inconclusive report exist on influence of gender on secondary school students' academic achievement and retention in sciences, physics inclusive. This therefore calls for further investigation to find out if gender has any influence on student academic achievement and retention in Physics when taught using Problem Based Learning Approach. In this study gender difference

in academic achievement and retention among secondary school students taught physics using Problem Based Learning Approach was also investigated. Also, the effect of the Problem-Based Learning approach on the academic achievement and retention of secondary school students in physics in Awka Education Zone has not been established, hence the need for this study in the area.

Statement of the Problem

Despite the importance of physics in one's day-to-day activities as well as its role in national development and wealth creation, the unsatisfactory performance of students in the subject in both internal and external examination over the years have been of serious concerns to all stakeholders in education sectors. Many researchers till today have attributed this unsatisfactory performance of students to several factors of which most emphasis has been placed on the conventional teaching methods that dominates the classrooms, which makes teaching and learning of physics uninteresting and students' retention and achievement in the subject unsatisfactory. In addition, there have been unsolved literature claims on the influence of gender on students' academic achievement in science subjects, physics inclusive.

To address this situation, efforts have been made in the past and present by researchers, federal and state governments as well as professional bodies (for example STAN) to improve male and female students' academic achievement and retention in physics through publications, organization of seminars, workshops, conferences and symposia for teachers but still little or inconsistent improvement has been recorded over the years. In light of the above statement, there is need to find instructional methods that will address the problem associated with the conventional

methods and making teaching and learning of physics student-centred. Based on this, the study sought to determine the effect of Problem-Based Learning Approach on the academic achievement of secondary school male and female students in physics in Awka Education Zone.

Purpose of the Study

The purpose of this study is to determine the effect of Problem-Based Learning approach on students' academic achievement in secondary senior school physics in Awka Education Zone. Specifically, the study sought to determine the:

1. Difference between the mean academic achievement scores of students taught physics using the PBL approach and those taught using Lecture method.
2. Difference between the mean academic achievement scores between male and female students taught physics using the PBL approach.
3. Interaction effect of teaching approaches and gender on students' academic achievement in physics.

Research Questions

The study was guided by the following research questions.

1. What is the difference between the mean academic achievement scores of students taught physics using the PBL approach and those taught using the lecture method?
2. What is the difference between the mean academic achievement score of male and female students taught physics using the PBL approach?

Hypotheses

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

1. There is no significant difference between the mean academic achievement scores of students taught physics using the PBL approach and those taught using the lecture method.
2. There is no significant difference between the mean academic achievement scores of male and female students taught physics using the PBL approach.

Methods

This study adopted a quasi-experimental research design. Specifically, the pre-test and post-test non-randomised control group designs were used. Quasi-experimental design, according to Nworgu (2015), is adopted where random assignment of subjects to experimental and control groups is not possible. Hence, intact groups were assigned to experimental and control groups. This research design was adopted for the study because the administrators of the schools under study may not permit the random assignment of participants to experimental and control groups, owing to the fact that it disrupts the school setting and timetable. The design was chosen because it aims to establish the effect of the Problem-Based Learning Approach (PBLA) on the students' academic achievement in senior secondary school physics.

The study was conducted in Awka Education Zone of Anambra State, Nigeria. Awka Education Zone comprises five local government areas: Anaocha, Awka-North, Awka-South, Dunukofia, and Njikoka. The zone has 62 State Government-owned secondary schools, out of which 49 are co-educational schools. Awka Education

Zone is the heart of Anambra State, as one of its towns - Awka - is the state capital, and located therein are the State Government house, State secretariat, Judiciary, and High courts. Nnamdi Azikiwe University, major campus and its school of Pharmacy, Anambra State University teaching hospital, Paul's University, located in the towns within this zone.

A good number of their population are civil servants, which is a result of the many government establishments situated within the zone. In some local governments within this zone, specifically Awka-North local government area, a good number of its population engage in profitable agricultural practices like the production of food and tree crops, livestock farming, and fishery. Also, some of the populations in this zone indulge in commercial activities, and this is as a result of the presence of big markets like Eke Awka, Nkwo Igboukwu, Nwagu market, AforAgulu, Oye Agu, Nkwo Enugwu-ukwu, Nkwo Agulu, and others. The people of this area are very rich in cultural heritage, and most of its population practices the Christian religion.

The researcher chose this zone for this study because most of the schools in the zone are adequately equipped with the resources needed to carry out the study properly. On the same note, co-educational secondary schools were used in the study in order to provide a learning environment where boys and girls can work together, since gender is considered an intervening variable in the study.

The total population of the study was 3777 SS2 physics students, and it comprised1588 males and 2189 females in the 65 government-owned secondary schools in Awka Education Zone, Anambra State (Post Primary School Service Commission Statistics Division Awka, 2025).Senior Secondary School Year two

(SSII) was used for the study because they are an intermediate class for the senior secondary and are not adjusting to senior secondary curriculum. Furthermore, they are not preparing for any external examination that interferes with the exercise. Coeducational schools were also used since gender was used as a moderating variable in the study. The sample for the study was157 (90 males and 67 females) SSII physics students. The multi-stage sampling procedures were adopted in the study. First, simple random sampling by balloting was used to select one local government in Awka, Education Zone of Anambra State. Next, purposive sampling technique was used (because of gender choice) to select one co-educational schools out of the six co-educational schools in Awka South LGA. Also, simple random sampling by tossing a coin was used to assign one school as the control and the other as the experimental group out of the two schools in Awka South LGA. The instrument for data collection was Physics Achievement Test (PAT). The PAT is made up of 50-item multiple choice objective questions. The item in the instrument was carefully selected and adapted from physics past West African Senior School Certificate Examinations (WASSCE), focusing on the topic of Electromagnetic Theory, which was taught during the intervention using the Problem-Based Learning (PBLA) approach. The instrument was used by the researchers for the purpose of data collection. The instrument is the Physics Achievement Test (PAT). The Physics Achievement Test (PAT) was developed to assess students' academic achievement in physics, specifically focusing on the topic of Electromagnetic Theory, which was taught during the intervention using the Problem-Based Learning (PBL) approach. Each question item is made up of four (4) options A-D. The PAT consists of two sections: A and B. Section A contains the personal data of respondents, such as

gender and class, and Section B has 50 multiple-choice questions. The test is designed to assess cognitive levels such as knowledge, comprehension, application, and analysis. Each correct answer attracts two (2) marks, while each incorrect or unanswered item scores zero (0). The highest possible score on the test is 100 marks, and the lowest is zero (0). This objective scoring system ensures consistency and allows for easy comparison of performance between the experimental and control groups. The PAT was administered in two phases; **Pre-test** – before the implementation of PBLA, to establish students' baseline knowledge. **Post-test** – immediately after the treatment, with items reshuffled to prevent recall bias. The instruments were validated by three experts, one from the Department of Science Education, one from the Measurement and Evaluation unit of the Department of Educational Foundations, both from Nnamdi Azikiwe University, Awka, and one from an experienced Physics teacher for face and content validity. The experts were given the lesson plans for the experimental and control groups, the Physics Achievement Test, and the table of specifications for the Test. They were requested to assess the face validity of the instruments, the clarity of the expressions used in the test, and the extent of the instruments' coverage of the topics under study. Corrections and suggestions given by the experts guided the production of the final instruments. To determine the reliability coefficient of the PAT, the instrument was administered to a complete class of 40 SSII students in one of the schools in Nnewi South Local Government Area (outside the LGA under study). Kuder-Richardson formula 20 (KR-20) was used to analyse the data collected. The choice of KR-20 was because of two reasons: The levels of difficulty in the question items are not equal, and the instrument is a multiple-choice question dichotomously scored. The reliability

coefficient for PAT was found to be 0.85. The value 0.85 for PAT was considered to be high enough for the instrument to be used for the study (Nworgu, 2015).

Before the commencement of the study, the researchers sought permission from the respective school principals to conduct the study within their schools. Upon receiving approval, the experimental procedure was carried out in four distinct stages; **Stage One: Briefing of Research Assistants (Classroom Physics Teachers)**, **Stage Two: Pretesting**, **Stage Three: Teaching of Students (Treatment Phase)** and **Stage Four: Post Testing.** Thus, at the end of the fourth week, a revision session was conducted for both the experimental and control groups. Following the revision, the PAT was reshuffled and administered as a post-test to assess the academic achievement of the students in both groups.

The post-test helped determine if there was any significant gain in academic achievement in electromagnetic theory concepts, as well as any change in students' achievement in the subject. The test scripts were collected, scored, and recorded by the researcher. The data obtained from the post-test served as the basis for evaluating the effectiveness of the Problem-Based Learning approach in enhancing students' understanding of electromagnetic theory in the subject.

In order to ensure the validity of the findings and mitigate any potential influence of extraneous variables on the dependent variables, several steps were taken to control these variables.

Before the treatment process commences, PAT was administered to all the students in the experimental group and control group as a pre-test. The purpose of this pre-test was to assess the students' baseline knowledge of electromagnetic theory before the

treatment began. The research assistants (classroom teachers) administered the test in the selected schools, and the scores from the pre-test were recorded for comparison after the treatment process. At the conclusion of the teaching process, the same instruments, the PAT, were administered again to both the experimental and control groups as a post-test. The post-test was identical to the pre-test, with the items reshuffled to avoid any influence from prior exposure to the pre-test. This reshuffling ensured that students were not able to recall the specific answers from the pre-test, providing a more accurate measure of the impact of the treatment. The scores obtained from the pre-test and post-test were recorded and analysed for further evaluation.

To address the research questions, mean and standard deviation were used to summarise the data collected from both the experimental and control groups. These descriptive statistics provided an overview of the central tendencies (average scores) and the spread of scores within each group. For hypothesis testing, Analysis of Covariance (ANCOVA**)** was used. This statistical technique was employed to test the hypotheses while controlling for any pre-existing differences between the groups. ANCOVA was particularly suitable for this study as it allowed the researcher to account for initial group differences (as measured by the pre-test scores) when comparing the academic achievement of the experimental and control groups after the treatment.

The significance level for the hypotheses was set at 0.05. If the p-value obtained from the ANCOVA is less than or equal to 0.05 ($P \leq 0.05$), the null hypothesis is rejected, suggesting that the Problem-Based Learning approach has had a significant effect on

the students' academic achievement . On the other hand, if the p-value is greater than 0.05, the null hypothesis will not be rejected, indicating that there is no statistically significant difference between the two groups in terms of academic achievement after the treatment.

Results

Research Question 1: What is the difference between the mean achievement scores of students taught Physics using the Problem-Based Learning Approach (PBLA) and those taught using the Conventional Lecture Method (CLM)?

Table 1: Difference between the mean achievement scores of students taught Physics using PBLA and those taught using CLM

Variable	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gain
PBL (Experimental)	79	43.27	4.72	70.15	3.57	26.88
Lecture (Control)	78	42.27	2.72	56.72	3.48	14.45
Mean Difference		1.00		13.43		12.43

The result presented in Table 1 shows that the students under the Problem-Based Learning Approach (PBLA) had a pretest achievement mean score of 43.27 with a standard deviation of 4.72 and a post-test mean score of 70.15 with a standard deviation of 3.57. The difference between the pre-achievement and post-achievement mean for the PBLA group was 26.88. The Conventional Lecture Method (CLM) group had a pre-achievement mean of 42.27 with a standard deviation of 2.72 and a post-achievement mean of 56.72 with a standard deviation of 3.48. The difference

between the pre-achievement and post-achievement mean for the CLM group was 14.45. However, for each of the groups, the post-achievement mean was greater than the pretest mean, with the students taught Physics under the PBLA having the highest mean gain of 26.88 compared to 14.45 for the CLM group. The mean difference in post-test scores between the two groups was 13.43, and the mean gain difference was 12.43. This result shows that the PBLA leads to higher achievement in Physics than the CLM. This is an indication that PBLA has a positive effect on students' academic achievement in Physics.

Research Question 2: What is the difference between the mean achievement scores of male and female students taught Physics using the PBLA

Table 2: Mean and Standard Deviation of achievement test scores of male and female students' taught physics using PBLA

Variable	Gender	N	Pretest Mean	SD	Posttest Mean	SD	Mean Gain
PBL (Experimental)	Male	47	43.62	5.61	70.83	3.42	27.21
	Female	32	42.75	2.98	69.16	3.60	26.41
	Mean Difference		0.87		1.67		0.80

The result presented in Table 2 shows that the male students had a pre-test achievement mean score of 43.62 with a standard deviation of 5.61 and a post-test achievement mean score of 70.83 with a standard deviation of 3.42. The mean gain score for the male group was 27.21. For the females, the pre-test achievement mean

score was 42.75 with a standard deviation of 2.98, and the post-test mean was 69.16 with a standard deviation of 3.60; however, the mean gain score was 26.41. The mean difference in post-test achievement between males and females was 1.67, in favour of the males. Nevertheless, the margin of difference between male and female achievement scores was relatively small within each group. This result suggested that gender may have minimal effects on students' academic achievement in Physics when taught using PBLA.

$H0_1$: There is no significant difference in the mean achievement scores of students taught Physics using the Problem-Based Learning Approach (PBLA) and those taught using the Conventional Lecture Method (CLM).

Table 3: Analysis of Covariance (ANCOVA) of Students' Achievement in Physics

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	7422.724a	4	1855.681	177.796	.000
Intercept	2933.581	1	2933.581	281.071	.000
Pretest Scores	270.999	1	270.999	25.965	.000
Instruction	37.399	1	37.399	3.583	.060
Gender	6371.738	1	6371.738	610.486	.000
Instruction* GENDER	5.571	1	5.571	0.534	.466
Error	1586.448	152	10.437		
Total	641628.000	157			
Corrected Total	9009.172	156			
R Squared = .824 (Adjusted R Squared = .819)					

Table 3 shows that with respect to the achievement m8ean scores of students taught Physics under PBLA and CLM, an F-ratio 3.583 was obtained with an associated exact probability value of .060. Since the associated probability (.060) is greater than .05 set as the level of significance, the null hypothesis (H_{01}) which stated that there is no significant difference in the mean achievement scores of students taught Physics using the PBLA and those taught using the CLM is not rejected. Hence, there is no significant difference in the mean achievement scores of students taught Physics using the Problem-Based Learning Approach (PBLA) and those taught using the Conventional Lecture Method (CLM).

$H0_2$: There is no significant difference in the mean achievement scores of male and female students taught Physics using PBLA.

Tables 3 showed that with respect to the achievement mean scores of male and female students taught Physics using PBLA, an F-ratio of 610.486 was obtained with an associated probability value of .000. Since the associated probability value (.000) was less than .05 set as a benchmark, the null hypothesis (H_{02}) which stated that there is no significant difference in the mean achievement of male and female students taught physics using PBLA is rejected. This showed that there is a significant difference in the mean achievement scores of male and female students taught Physics using PBLA in favour of male students.

Table 4: Adjusted Achievement Mean Scores of Male and Female Students (ANCOVA Estimated Marginal Means)

Gender	N	Adjusted Mean	Std. Error	95% CI Lower Bound	95% CI Upper Bound
Male	90	63.852	.342	63.177	64.527
Female	67	62.858	.396	62.075	63.642

Note. Adjusted means are estimated marginal means from ANCOVA with Pretest as covariate (Pretest = 42.77). N = number of students per gender group.

$H0_3$: There is no significant interaction effect of teaching method and gender on students' achievement in Physics.

The result in Table 3 shows that an F-ratio of 0.534 with an associated probability value of .466 was obtained for the interaction between teaching method and gender on students' achievement when taught Physics under PBLA and CLM. Since the associated probability (.466) is greater than .05, the null hypothesis (H_{03}) is not rejected. Thus, there is no significant interaction effect of teaching method and gender on students' mean achievement when taught Physics under PBLA and CLM.

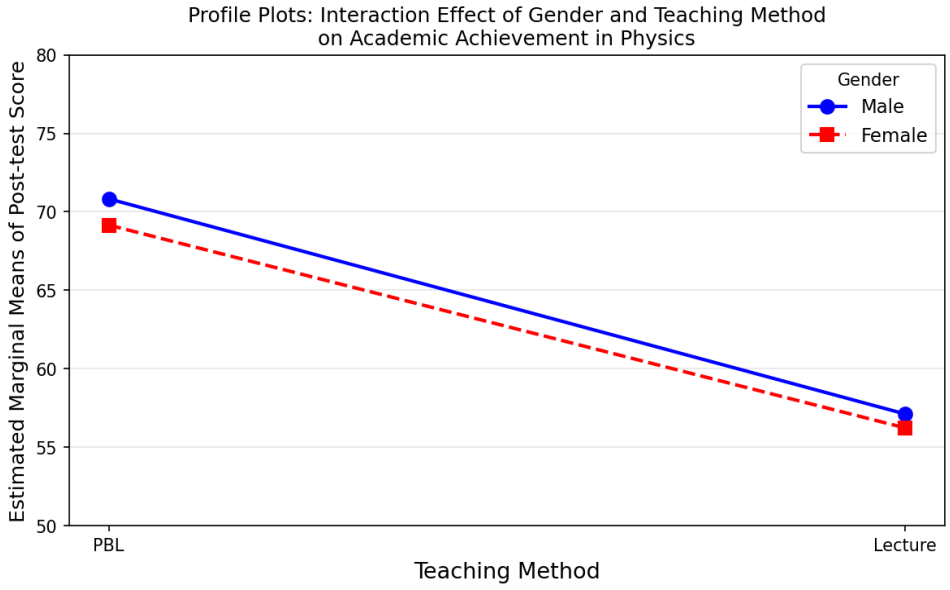

Figure 1.1: Profile plots of the interaction effect of gender and teaching method (PBLA and CLM) on academic achievement of students in Physics

The profile plots of the two teaching methods on male and female students' achievement scores are parallel to each other without any intersection. Hence, there is no interaction effect of gender and teaching method on academic achievement of students in Physics. By implication, the effect of the two methods of teaching on the mean achievement scores of students in Physics does not depend on their gender. This implies that the treatment affected the mean achievement scores of male and female students in Physics in the same way.

Discussion

The findings of the study indicate that students taught Physics using the Problem-Based Learning Approach (PBLA) recorded higher mean achievement scores compared to those taught using the Conventional Lecture Method (CLM). However, this difference was not statistically significant, implying that although PBLA produced better performance outcomes, the improvement was not strong enough to establish a significant difference in achievement between the two groups. This finding aligns with the work of Achor, Smith, and Brown (2018), who reported that students exposed to problem-based instructional strategies in Physics demonstrated improved performance due to active engagement in learning tasks. It also supports the view that learner-centred instructional approaches enhance understanding by involving students in knowledge construction rather than passive reception. Furthermore, this result is consistent with Kolb's (1984) Experiential Learning Theory (ELT), which posits that learning is most effective when students engage actively with real-world problems, reflect on their experiences, form conceptual understanding, and test that understanding through further experimentation. In PBLA environments, students are guided through precisely this cycle, constructing meaningful understanding of Physics concepts through inquiry and collaborative problem-solving. This active engagement explains why PBLA students outperformed their CLM counterparts in academic achievement. Empirical support is further provided by Udo and Udofia (2020), who found that PBLA improves both achievement and understanding in Physics among secondary school students in Nigeria. Okonkwo et al. (2021) also reported higher performance among students taught using PBLA compared to those taught using conventional lecture methods.

Hence, the present finding is consistent with Ibeh and Okigbo (2024), who reported that although cooperative learning strategies may produce higher mean scores than conventional methods, such differences are not always statistically significant. This suggests that while PBLA enhances engagement and understanding, its impact on achievement may depend on implementation quality and classroom context.

The impact of gender on students' academic achievement in Physics, when taught through the Problem-Based Learning Approach (PBLA) and Conventional Lecture Method (CLM), presents a significant area of inquiry. The data in Table 2 provides an understanding of the relationship between gender, instructional method, and academic achievement in Physics. In the PBLA group, both male and female students exhibited substantial improvement from pre-test to post-test scores. Male students demonstrated a mean gain score of 27.21, while female students attained a closely comparable mean gain score of 26.41. On testing the null hypothesis (H_{02}), which stated that gender does not have a significant influence on students' achievement under PBLA and CLM, it was not rejected. Thus, the inference drawn is that male and female students taught Physics under PBLA and CLM did not differ significantly in their academic achievement. This finding aligns with the results of Afolabi and Akinbobola (2019), who observed no significant gender differences in the performance of students taught with the PBLA te2chnique in Physics in Nigerian secondary schools. Similarly, Ibrahim and Dazi (2023) found that gender-neutral instructional strategies enhance academic achievement across both male and female learners. Notably, Ibeh and Okigbo (2024) also reported no significant gender differences in students' performance, indicating that cooperative learning approaches generally promote equity in learning outcomes across genders. This outcome is

consistent with the Experiential Learning Theory (ELT) underpinning this study. Kolb (1984) posits that the experiential, collaborative nature of PBLA creates an inclusive learning environment that benefits all learners regardless of gender. By engaging both male and female students in shared problem-solving experiences, PBLA reduces the gender-based disparities that are often reinforced by teacher-centred instruction. The collaborative group inquiry that characterises PBLA allows students of all genders to contribute meaningfully, ask questions, and support each other's learning, processes that benefit all learners equally. This finding reinforces ELT's position that the method of instruction, rather than the learner's gender, is the primary determinant of achievement outcomes. Furthermore, the findings of Ajai and Imoko (2025) revealed no significant difference between male and female students in both achievement and retention scores when taught using PBLA, suggesting that both genders are equally capable of excelling when exposed to effective teaching methods. Akpan and Akanwa (2024) equally found no significant gender difference in mean achievement scores of Physics students taught using problem-solving instructional strategies in Akwa Ibom State. These findings corroborate the present study's result and reinforce the growing body of evidence that PBLA functions as an equitable pedagogical approach, conferring comparable academic benefits to both male and female Physics learners. In addition, the CLM group also showed no significant gender difference, although both male and female students recorded more modest gains, with males achieving a mean gain of 14.49 and females 14.40. This minimal difference further confirms that gender differences in Physics achievement are not inherent to learners but are largely influenced by the instructional method employed. Finally, as asserted by Fadeyi and Owoyele (2019), PBLA fosters a more inclusive

learning environment by shifting the focus from teacher-centred instruction to learner-driven exploration, thereby benefiting students of all genders equally.

The findings on the interaction effect of teaching method and gender on students' achievement in Physics are both instructive and consistent with a growing body of literature emphasizing the effectiveness of learner-centred instructional approaches in science education (Eze et al., 2022; Okonkwo et al., 2021). The result of the analysis revealed that there was no significant interaction effect between teaching method and gender on students' mean achievement in Physics when taught using PBLA and CLM ($F = 0.534$, $p = .466$). This finding implies that the effect of the Problem-Based Learning Approach (PBLA) on students' academic achievement is not dependent on gender. In other words, PBLA improved achievement equally for both male and female students, indicating that gender did not moderate the effectiveness of the instructional method. This result aligns with the findings of Owolabi et al. (2021) and Ogunsola et al. (2021), who both reported no significant interaction effect between PBLA and gender on students' academic performance in Mathematics. Their studies demonstrate that learner-centred instructional approaches tend to produce similar learning outcomes across gender groups. Similarly, Hmelo-Silver (2024) observed that the open-ended nature of Problem-Based Learning allows learners to engage with content at their own pace and contribute meaningfully to group discussions based on their individual strengths. This inclusive structure naturally minimizes gender-based differences in learning outcomes. In addition, Deci and Ryan (2025) noted that when learners perceive learning activities as meaningful and connected to real-life situations, they are more likely to develop intrinsic motivation and persistence, a motivational factor that operates independently of gender. This finding is further

supported by Mbacho (2022), who reported no significant interaction between cooperative learning strategies and gender in determining students' academic achievement. It also aligns with Ibrahim and Dazi (2023), who found that effective instructional strategies tend to produce similar academic outcomes across male and female students. In the same vein, Ibeh and Okigbo (2024) established that there was no significant interaction effect of instructional strategy and gender on students' achievement, reinforcing the position that learner-centred approaches function independently of gender differences. Furthermore, the profile plots presented in Figure 1 visually confirm the absence of interaction, as the lines representing male and female achievement scores across the two instructional methods are approximately parallel and do not intersect. This indicates that the effect of the teaching methods on students' achievement is consistent across gender groups. By implication, the influence of PBLA and CLM on students' achievement in Physics does not depend on gender, meaning that both male and female students benefit equally from the instructional approaches employed. This finding is consistent with the conclusions of Agu and Iyamu (2020) and Obidile (2024), who both reported that gender does not significantly influence academic achievement when effective student-centred instructional strategies are used. These findings reinforce the position that the quality of instructional method, rather than gender, is the primary determinant of students' academic outcomes in Physics.

Conclusion

The study concluded that Problem Based Learning Approach is an effective learning approach for improving students' achievement in Physics. Through this learning approach, students will understand the learning materials more irrespective of their gender.

Recommendations

Based on the research findings, the following recommendations are made:

1. Schools should incorporate the Problem-Based Learning Approach into their Physics curricula to enhance student achievement. Given the clear evidence of a higher mean achievement gain under PBLA, educators should prioritize developing and implementing problem-centred, inquiry-based learning activities in Physics classes at the secondary school level.
2. Effective training programmes should be developed for Physics teachers to facilitate the transition to PBLA methodologies. This will ensure that problem-based learning is designed and employed optimally; enabling teachers to scaffold students' inquiry processes effectively and manage the logistical demands of collaborative, group-based problem-solving sessions.
3. Policymakers and educational leaders must recognize the gender-neutral benefits of PBLA on Physics achievement and promote its use across all student demographics. Given that PBLA does not favour one gender over another in improving academic achievement, it should be adopted as a standard instructional practice in mixed-gender secondary school Physics classrooms.

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