

Students' Academic Performance in Physics: The Impact of Practical on Theoretical Comprehension in Nigerian Colleges of Education

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Abstract

This research explores the relationship between students' performance in both practical and theoretical physics at three colleges of education in Kwara State. Using a correlational research framework, the study analyzed three consecutive years of official examination results recorded in departmental ledgers, presented as percentage scores. The data were evaluated through descriptive statistics, linear regression, and the t-test. The results revealed a moderate positive correlation between practical and theoretical performance, with achievements in practical work acting as a significant indicator of theoretical comprehension. Furthermore, there were no notable differences in practical physics performance based on gender. Informed by the theory of multiple intelligences, the study emphasizes the need for instructional strategies that balance conceptual knowledge with practical laboratory experiences. The results stress the significance of having well-equipped laboratories, providing sufficient practical resources, and employing qualified physics instructors to enhance the outcomes of physics education in Nigeria.

Keywords: Academic Performance, Practical Physics, Theoretical Physics, Intelligence, Laboratory, Physics Apparatus.

Introduction

Students' academic performance in science is a serious concern for all stakeholders in Nigeria, particularly in physics, a core subject in science and technology. According to Abuh (2021), a significant number of students fail this subject at the Senior Secondary School Certificate level. No nation should be satisfied with poor academic performance in physics because, according to Oluwadamilare and Adekunle (2021), it plays a central role in the actualization of the Fourth Industrial Revolution. Physics is a science subject comprising theoretical and laboratory work. Practical physics, also called laboratory physics, engages students in enhancing their comprehension and refining problem-solving skills, allowing them to actively participate in the exploration of the natural world (Ilomuanya, Ikusika, & Aramide, 2024). Experiences in practical physics can bridge physics and scientific competencies with other academic disciplines and real-life applications (Rosen & Kelly,

2020). It comprises a series of experiments that illustrate a diverse array of physical principles and phenomena (Institute of Physics, 2019).

The two aspects are critical to student learning, which requires that both teachers and students take them seriously to gain complete knowledge of the subject. However, it is believed that students' understanding of laboratory work should support their theoretical comprehension. Amusa (2022) asserted that practical physics enhances students' academic performance in physics. Students' scientific skills are enhanced through practical physics. Walsh et al. (2022) observed that laboratory work is importantly beneficial for students' better academic performance in physics. Antwi Sakyi-Hagan, Addo-Wuwer, and Asare (2021) asserted that practical work enhances students' understanding of science. Basagre (2020) discovered that hands-on inquiry enhances conceptual understanding of grade 9 physics students in mechanics and advocated for its use by teachers. Abidoye et al. (2022) asserted that students taking part in laboratory work in physics significantly impact their academic performance.

The debate on academic performance in physics has no consensus based on gender. Gender inequality in academic performance is a global issue (Valero-Ancco, Gutierrez, Lujano-Ortega, and Calderón-Quino, 2025). Sagala, Umam, Thahir, Saregar, and Wardani (2019) observed that male students achieved higher scores in physics than their female counterparts. Similarly, Achor and Abuh (2020) said there are significant gender differences in physics academic performance when the traditional teaching method is not adopted. Radulović et al. (2022) looked beyond academic performance to say male students are more aware of developments in physics and physics careers than female students. Rosen and Kelly (2020) observed gender gaps in physics practical work in schools.

There is a lack of consensus in the existing literature on gender disparities in academic performance in physics among students. While a significant amount of research has been conducted on physics achievement at the senior secondary school level, there are relatively few studies that specifically target Colleges of Education. Additionally, studies have not definitively determined whether theoretical or laboratory physics has a greater impact on students' overall performance in the subject. This gap in the literature highlights the necessity for further research, especially within the context of Colleges of Education.

Building on this background, the present study investigated the impact of students' performance in practical physics on their performance in theoretical physics. Accordingly, the research objectives, questions, and guiding theoretical framework are outlined below.

Problem Statement

Physics plays a crucial role in national development and the Fourth Industrial Revolution. Nevertheless, Nigerian students often perform poorly in this subject. Although laboratory activities are designed to connect theoretical concepts with practical applications, research on the strength of the relationship between practical skills and theoretical understanding is inconsistent. Moreover, a significant debate persists about gender differences in physics, with mixed results on whether male or female students excel more in practical and

theoretical contexts. Most existing research centers on secondary education, leaving a significant gap in studies regarding Colleges of Education. This gap is concerning because these institutions prepare future teachers whose content knowledge (CK) and hands-on skills are essential for the advancement of physics education in Nigeria.

Objective of the study

The objective of the study is to compare students' scores in practical and theoretical physics to identify how students perform in each. Specifically, the study investigated:

1. The relationship between students' academic performance in practical and theoretical physics.
2. Whether practical physics influences students' academic performance in theoretical physics.
3. Gender differences in students' academic performance in practical physics

Research questions

1. What is the relationship between students' academic performance in practical physics and theoretical physics?
2. Can practical physics influence students' performance in theoretical physics?
3. Is there a gender difference in academic performance in practical physics?

This study does not require hypotheses because the research questions are sufficient to address the study's objectives.

Theoretical Framework

The study adopted the philosophy of Multiple Intelligences as a theoretical lens. This theory, introduced by Gardner (1993), posits that students exhibit diverse cognitive styles, influencing their learning approaches, memory retention, comprehension, and academic performance. According to the theory, classrooms consist of students with varying types of intelligence, with logical-mathematical and bodily-kinesthetic intelligence being particularly relevant in this research.

Logical-mathematical intelligence encompasses the ability to solve mathematical problems, think conceptually, and reason abstractly (Aina, 2018; Gardner, 1993). In contrast, bodily-kinesthetic intelligence involves using physical movement and sensory engagement, such as hands, eyes, and other body parts, to facilitate learning (Herr, 2007). In practical physics, students rely heavily on bodily-kinesthetic intelligence as they conduct experiments and engage physically with equipment and materials. However, not all students possess a natural aptitude for this form of intelligence, which can impact their academic performance in such settings. Conversely, students with strong logical-mathematical intelligence tend to excel in theoretical physics, as they can conceptualize and reason abstractly without needing physical demonstrations of physics concepts. Given this, the current study examined the relationship between students' academic performance

across two learning styles. Achieving this involved reviewing relevant previous studies published in various reputable academic sources.

Literature Review

Physics is an experimental science in which laboratory work is fundamental to students' education (Rosen & Kelly, 2020). It is a fundamental science subject with applications in everyday human activities, requiring students' comprehension for meaningful learning (Aderonmu & Adolphus, 2021). The significance of physics to national development is profound, as its principles are foundational to fields such as medicine, architecture, and engineering (Wesonga & Aurah, 2019). Physics education is critical for equipping students with 21st-century skills, as noted by Simangunsong, Uskenat, Damanik, Simangunsong, and Purba (2024).

Zhanatbekova, Andasbayev, Khaimuldanov, Abdulayeva, and Boribekova (2024) highlight the critical role of laboratory experiments in enhancing physics education. In Ghana, Asamoah and Aboagye (2019) emphasized that practical physics is an essential component of physics learning, which is expected to enhance students' understanding of the subject. Shana and Abulibdeh (2020) demonstrated a positive correlation between practical work and students' academic performance in science. Similarly, Nwafor et al. (2024) argued that when students exhibit a positive attitude toward practical work in science, it positively impacts their academic performance. There are debates about the impact of laboratory-based instruction. For example, Walsh et al. (2022) found no significant improvement in students' understanding of introductory physics concepts through laboratory work. However, Ketonen, Lehtinen, and Koskinen (2023) argue that teaching physics without laboratory activities undermines the learning process.

However, concerns persist about poor academic performance in physics, as noted by Abuh (2021), who observed gender disparities in Nigeria, with male students outperforming their female counterparts. In Nigeria, the challenge of poor academic performance may persist unless there is significant progress in science, technology, and innovation (Oluwadamilare & Ayanwale, 2021).

Physics explores the physical properties of matter through careful observation, measurement, and experimentation (Hoehn & Lewandowski, 2022). Dupe (2019) describes it as the study of interactions between matter and energy. Although many students struggle with physics, the way teachers present the subject is crucial to improving understanding (Oluwaseyi, 2023). Poor academic performance in physics is a global issue. For instance, Lukita and Jayanagara (2023) report similar challenges among students in the Philippines.

Gender and instructional methods also play a significant role in physics learning outcomes (Wesonga & Aurah, 2019). Studies indicate a global decline in students' interest in physics and related careers (Morgan & Aboagye, 2022). In some countries, such as Rwanda, physics is a compulsory subject, yet students' academic performance and interest remain discouraging (Mbonyiriyivuze, Yadav, and Amadalo, 2019). Teaching abstract concepts in

physics presents additional challenges, as these topics are often difficult for students to grasp (Musfiroh et al., 2024).

Assem, Nartey, Appiah, and Aidoo (2023) argued that globally, the attitudes of teachers and students significantly contribute to poor academic performance in physics. Similarly, Radulović et al. (2022) observed a significant gender difference in students' academic performance in challenging physics concepts. Istiyono et al. (2020) also reported gender differences in creative thinking skills related to physics. Physics is often perceived as a challenging subject and remains unattractive to many students (Mbonyirivuze, Yadav, & Amadalo, 2021).

Agbele, Oyelade, and Oluwatuyi (2020), in their study on students' academic performance in physics using two teaching methods, found that male students outperformed their female counterparts. However, Olusola, Popoola, and Omonijo (2020) contradicted these findings, reporting no gender bias in students' academic performance in senior secondary school physics results. Research indicates that gender differences exist in various aspects of physics education. For example, Bottomley, et al. (2022) found significant disparities in physics identity and self-efficacy, with men exhibiting higher levels than women. Doucette et al. (2020) argued that laboratory work remains an integral part of physics education and highlighted the existence of gender disparities in this area. Despite the reviewed relevant literature, achieving the stated objectives largely depends on the robust methodology adopted by the researcher.

Material and Method

This research adopts a correlational design, utilizing three consecutive years of student grades in practical and theoretical physics from three colleges of education. The primary research instrument consists of result ledgers from the physics department, containing the official results of the sampled students over the three years. These ledgers document the students' performance in practical and theoretical physics, recorded as percentages.

The study sampled only 110 students who have complete records of three years of results in practical and theoretical physics. The sample consists of 50 male students and 60 female students across the three schools. The sample size of 110 comprised only students with complete graduation records over the three years.

The choice of colleges of education was based on the fact that they are teacher-training tertiary institutions mandated to train pre-service physics teachers. Knowing teachers' subject content knowledge is crucial for a subject like physics, which is considered difficult for students in schools. Descriptive statistics, linear regression, and the t-test were used to analyse the data and answer the researcher's questions.

Permission was obtained from the appropriate authorities of each college before the release of the documents. Physics course question papers, both practical and theoretical, were moderated by senior physics education lecturers from other public colleges of education before each examination and after grading, before the release of results. Additionally, the Academic Board of each college convenes to approve the results, ensuring

the data's credibility without requiring further validation. The reliability of the data was assessed using SPSS software, and the Cronbach's alpha coefficient was calculated to be 0.80. The outcome of the analysis is presented below as the results.

Results

This section presents the details of the data analysis. It includes five tables: Tables 1–4 provide the results of the linear regression analyses addressing research questions 1 and 2, while Table 5 summarizes the t-test analysis for research question 3. Each table is followed by a detailed interpretation.

Table 1: Correlations between Laboratory and Theoretical Physics

		Theoretical	Laboratory
Pearson Correlation	Theoretical	1.000	.614
	Laboratory	.614	1.000
Sig. (1-tailed)	Theoretical	.	.000
	Laboratory	.000	.
N	Theoretical	110	110
	Laboratory	110	110

Table 1 shows there is a moderate correlation between practical physics and theoretical physics with a coefficient of 0.614, and the correlation is significant with a p-value of .000 < .005.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.614	.377	.371	8.991

Table 2 indicates that the linear regression analysis showed a moderate positive correlation between practical physics and theoretical physics, with $R = 0.614$. The coefficient of determination ($R^2 = 0.377$) indicates that approximately 37.7% of the variance in theoretical physics is explained by the model. This suggests that practical physics accounts for a significant portion of the variability in theoretical physics performance, though other factors may also contribute.

Table 3: ANOVA

Model		Sum Squares	df	Mean Square	F	Sig.	
1	Regression	5281.557	1	5281.557	65.330	.000	
	Residual	8731.216	108	80.845			
	Total	14012.773	109				

Table 3 shows the regression model is statistically significant ($F(1,108) = 65.330, p < 0.001$).

Table 4: Coefficients

Model		Unstandardized coefficients		Standardize coefficients			95.0% Confidence Interval for B	
		B	Std Error	Beta	t	sig	Lower Bound	Upper Bound
1	(Constant)	16.533	4.102		4.031	.000	8.402	24.663
	Laboratory	.604	.075	.614	8.083	.000	.456	.752

Table 4 indicates that practical physics has a significant positive effect on theoretical knowledge ($B=0.604$, $\beta=0.614$, $t=8.083$, $p<0.001$)

The findings suggest that practical knowledge is a significant and moderately strong predictor of theoretical knowledge. Approximately 37.7% of the variability in theoretical scores can be explained by laboratory engagement, underscoring the importance of practical learning in enhancing theoretical understanding.

Table 5: T-test Analysis of gender difference in students' academic performance in practical physics

		Levene's Test for Equality of Variances						t-test for Equality of Means			
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Diff	Std. Error Diff	95% confidence interval of the difference		
									Lower	Upper	
Score	Equal variances assumed	.001	.978	1.32	108	.191	2.81	2.12	-1.42	7.04	
	Equal variances not assumed			1.33	106.75	.188	2.81	2.12	-1.39	7.01	

Table 5 demonstrates that the assumption of equal variance is not violated, as the significance value (0.978) exceeds the threshold probability value (0.05). Additionally, the t-test for equality of means yields a two-tailed significance value of 0.191, which is also greater than 0.05, indicating no significant difference between the groups. The discussion of the findings is presented to analyse the results in relation to previous studies and the adopted theoretical framework.

Discussion

The findings of this study indicate a moderate correlation between practical physics and theoretical physics. Furthermore, practical physics is shown to be a predictor of theoretical physics performance, suggesting that students' academic achievements in practical physics significantly influence their performance in theoretical physics. This finding highlights the

importance of balancing problem-solving and conceptual understanding with hands-on manipulation of physics instruments, as emphasized by the theoretical framework of multiple intelligences. According to this framework, students exhibit diverse cognitive styles that affect their learning approaches, memory retention, comprehension, and academic performance. Therefore, according to this finding, the cognitive ability of students in practical physics affects students' understanding of the theoretical concepts, reflected in academic performance.

Given the moderate correlation, students struggling in theoretical physics are likely to encounter challenges in practical physics as well. These findings align with previous studies in physics education. For instance, Antwi et al. (2021) demonstrated that appropriate practical work enhances students' understanding of physics in Ghanaian high schools. Similarly, Usman and Yakubu (2020) asserted that practical physics fosters students' academic performance in physics. Shana and Abulibdeh (2020) also confirmed a correlation between practical physics experiences and students' academic achievements. However, Olufisayo (2024) highlighted that a lack of laboratory equipment adversely affects students' ability to learn physics effectively.

The study also found no significant gender differences in students' performance in practical physics. This aligns with some studies but contradicts others, reflecting ongoing debates in gender disparities in science education, particularly in physics. Holmes et al. (2022) observed differences in how male and female students share laboratory equipment, while Doucette and Singh (2024) reported gender disparities in practical physics, albeit not necessarily in academic performance but in activities such as equipment handling, measurement, and observation. On the other hand, the findings of this study corroborate those of Shawai et al. (2022), who reported no significant gender differences in the academic performance of senior secondary school science students in Kano, Nigeria. The study has several implications for physics education in Nigeria.

Conclusion and Implications

This study examined the relationship between practical and theoretical physics performance among students in three public Colleges of Education. The findings revealed a moderate correlation between practical and theoretical physics, with practical physics performance predicting success in theoretical physics. No significant gender differences were found in students' academic performance.

Using the lens of multiple intelligences theory, the study highlighted the need for balanced emphasis on both conceptual understanding and hands-on manipulation of physics apparatus. The findings point to three critical areas for improvement in physics education in Nigeria: the provision of standard laboratories, availability of practical equipment, and employment of qualified physics teachers. Addressing these areas will significantly enhance the quality of physics education in Nigerian Colleges of Education.

The findings of this study have significant implications for physics education in the country. While the Nigerian government has demonstrated some commitment to advancing science

education, initiatives like the Nigerian Integrated Science Project (NISP) and the National Primary Science and Mathematics Project (NPSMP) represent notable efforts. Similarly, Ojimba (2023) highlighted the Basic Science for Nigerian Secondary Schools (BSNSS) program as another developmental stride. However, further efforts are required, particularly in providing standard science laboratories, laboratory equipment, and qualified teachers.

The study emphasizes the need for the government to equip all Colleges of Education in Nigeria with standard physics laboratories and adequate laboratory equipment. Standard laboratories are vital for training physics teachers effectively. Shahzadi et al. (2023) noted that laboratories are critical for science education globally. Papalazarou, Lefkos, and Fachantidis (2024) also argued that laboratory experiences significantly enhance students' understanding of scientific concepts. Oguiche (2025) further emphasized the importance of laboratory resources in improving students' academic performance in physics. A focus solely on classroom teaching, without adequate laboratory facilities, will hinder students' performance. Inadequate preparation in laboratory work inevitably impacts students' theoretical knowledge.

In addition to laboratories, modern physics apparatus is essential for effective learning. Tamunoiyowuna and Doris (2022) highlighted the limited presence and utilization of practical physics equipment in Nigerian schools. Babalola and Ojobola (2022) identified similar challenges in sub-Saharan Africa, including insufficient resources, poorly trained teachers, and a lack of enthusiasm for practical work. The problem is not unique to Nigeria; Niyitanga et al. (2021) reported that inadequate facilities are a significant obstacle to physics education in Rwanda.

Qualified physics teachers with comprehensive knowledge of both theoretical and practical aspects of the subject are crucial. According to Aliu et al. (2024), one of the significant challenges in Nigerian physics education is teachers' inadequate content knowledge (CK). Many physics teachers lack sufficient practical knowledge, which often leads them to limit the types of experiments they conduct with students. Onuegbu (2023) confirmed that students taught by qualified teachers perform better than their peers taught by less qualified instructors.

A qualified physics teacher should also be capable of managing a classroom with students exhibiting diverse learning styles and intelligences. This aligns with the study's theoretical framework of multiple intelligences, which posits that students possess varying forms of intelligence. The study highlights the relevance of logical-mathematical intelligence, associated with solving mathematical problems and abstract reasoning, and bodily-kinesthetic intelligence, which involves hands-on manipulation of instruments. Teachers with a well-rounded understanding of these aspects are essential for effective physics instruction in Colleges of Education.

This study underscores the need for increased government investment in physics education. This includes:

1. Allocating funds for the establishment of standard physics laboratories and the procurement of modern laboratory equipment in Colleges of Education.
2. Employing qualified physics teachers with strong knowledge of both theoretical and practical physics.

By addressing these needs, Nigeria has the potential to significantly enhance the quality of physics education, thereby contributing to the nation's broader developmental goals. Since the study was conducted in colleges of education, the findings may not be generalizable to all educational institutions; however, several actionable suggestions have been provided.

Recommendations

Based on the outcome of this study, the following recommendations are suggested:

1. The Nigerian government should pay adequate attention to physics education in Colleges of Education by providing standard laboratories with modern apparatus.
2. Qualified teachers who have strong physics Content Knowledge (CK) and Pedagogical Content Knowledge (PCK) should be employed to teach at Colleges of Education. CK and PCK are important to enable the teachers to have a proper understanding of practical physics and to instruct students adequately.
3. Further research is required to ascertain gender gaps for inclusive physics learning in Nigerian Colleges of Education.

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