Kontagora Journal of Science and Technology (KONJOST)
2025, Vol. 18, No. 1-2, pp. 65–72 | ISSN:1118-9673 (print)
https://doi.org/10.5281/zenodo.17887536

Research Article

Physics teachers' challenges of integrating Artificial Intelligence technology as predictor of students' academic performance in secondary schools in Plateau state

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Abstract

This study examined Physics teachers' challenges of integrating Artificial Intelligence (AI) technology as predictor of students' academic performance in secondary schools in Plateau State, adopting a predictive correlational survey design. The population comprised 311 Physics teachers and 22,985 SSIII students, from which 36 teachers and 393 students were sampled through random sampling. Instruments used were the Physics Teachers' Level of Understanding Artificial Intelligence Questionnaire (PTLUAIQ, r=0.78) and the Physics Students' Academic Performance Proforma (PSAPP). Data were analyzed using descriptive statistics and inferential statistic (linear and multiple regression). Findings revealed a high level of challenges (M=3.64) of integrating AI technology among Physics teachers, with inadequate training, poor internet access, and insufficient infrastructure as major barriers. Gender did not significantly predict students' academic performance, as mean scores were similar for both male (M=56.23) and female (M=56.37) teachers' students' academic performance. The study concludes that improving AI literacy, rather than focusing on gender differences, is vital for enhancing student academic achievement. Recommendations include AI-focused teacher training, embedding AI in teacher education programs, equitable gender policies, and strengthening school digital infrastructure.

Keywords: *Artificial Intelligence, AI literacy and gender, Physics performance, Plateau State.*

1. Introduction

Artificial Intelligence (AI) is reshaping modern educational practices by introducing intelligent tools that support and enhance teaching and learning. As this technological wave spreads, educators are increasingly expected to be proficient in AI applications. In science education, especially Physics, the role of teachers in effectively applying AI tools may significantly influence students' academic performance (Lawrence, Macmillan, & Mankilik, 2025). This study investigates the extent to which Physics teachers' challenges of integrating AI technology into teaching and gender as predictor of physics academic outcomes of students in senior secondary schools in Plateau State, Nigeria.

Across the globe, AI is transforming how educators deliver content and how students engage with learning materials. Tools like AI-powered tutors, automated assessment systems, and adaptive learning environments are becoming more common in advanced education systems (Holmes, Bialik, & Fadel, 2019). In countries like Nigeria, where digital integration is still emerging due to being a developing nation, Physics remains a complex subject requiring innovative strategies for active instruction in other for students' to fully grasps the understanding of the subject without abstraction (Fwangle, Mankilik, & Usman, 2025). Teachers' familiarity and confidence in using AI tools may affect how these technologies are integrated into lessons (Luckin, Holmes, Griffiths, & Forcier 2016). Additionally, factors such as gender may influence AI adoption rates among physics teachers, with prior studies indicating possible disparities in technological competence (Buabeng-Andoh, 2012). Therefore, understanding the challenges faced by Physics teachers in integrating this artificial intelligence technology into teaching and gender (Sunday et al. 2025), how they collectively influence students' academic performance in senior secondary schools in Plateau State, Nigeria is critical in guiding educational policy and teacher training.

Sunday et al. (2025) carried out a study in Akwa Ibom

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Received: 30/08/2025; **Accepted:** 23/11/2025; **Published:** 30/11/2025

State on teachers' perceptions of the integration of artificial intelligence tools in classroom instruction and academic performance in secondary schools in Akwa Ibom State, Nigeria. The results showed that teachers encounter considerable difficulties in applying these tools in classroom teaching, as all the mean values were above the criterion mean of 2.50, indicating strong agreement among respondents. The highest mean value of 3.83 (S.D. = 2.51) was recorded for limited technical support, reflecting that many teachers feel neglected when technical problems arise. Other notable challenges identified were inadequate training (mean = 3.32) and poor access to technological resources (mean = 3.49), which remain major obstacles to effective classroom integration of technology. These findings highlight the urgent need for better training opportunities, adequate resources, and improved infrastructure to enhance the successful utilization of modern instructional technologies in schools (Crompton & Burke, 2023; Ren & Wu, 2025; Okeke & Ochuba, 2020).

Notwithstanding the growing relevance of Artificial Intelligence (AI) in education, limited empirical evidence exists on how Nigerian Physics teachers apply these technologies in senior secondary schools. Preliminary observations in Plateau State show varying levels of student performance in Physics in national examinations such as the Senior School Certificate Examinations (SSCE) conducted by WAEC and NECO (Usman & Jilang, 2018; Lawrence, Macmillan & Mankilik, 2025), which may be potentially linked to differences in their teachers' technological preparedness. The influence of teacher gender when combined with challenges faced in integrating AI technology as predictor of student academic performance remains underexplored in the study region.

The research is grounded in the Technological Pedagogical Content Knowledge (TPACK) framework by Mishra and Koehler (2006), which highlights the interconnectedness of technological, pedagogical, and content expertise in effective teaching. A teacher's Artificial Intelligence (AI) proficiency represents the technological domain and contributes to the delivery of subject content for subjects like Physics. The study also draws on Bandura's Social Cognitive Theory (SCT) (1986), which emphasizes the role of self-efficacy, influenced by gender and experience, in technology adoption. AI literacy involves understanding and effectively applying AI tools in educational settings. Teachers proficient in AI are better positioned to personalize learning and improve student participation and academic achievement (Zawacki-Richter et al., 2019). There is evidence suggesting gender gaps in the use of educational technology, often rooted in confidence and access. Although the gap is narrowing, male teachers have historically shown higher engagement with complex technological tools (Volman & van Eck, 2001).

Academic performance in Physics among Nigerian students is often rated low in average, attributed to insufficient instructional innovation and poor integration of supportive technologies (Okeke & Ochuba, 2020; Lawrence et al. 2025). AI applications offer promising solutions for delivering abstract Physics concepts more proficiently, provided teachers are competent in their use (Fwangle, Mankilik, & Usman, 2025). Thus, the necessity to conduct this research on Physics teachers challenges of integrating artificial intelligence technology as predictor of students' academic performance in secondary schools in Plateau State. This study addresses this gap by examining whether Physics teachers' challenges of integrating AI technology and gender are associated with students' academic outcomes in senior secondary schools in Plateau State, Nigeria. Hence, from the above discourse on artificial intelligence technology and its integration into teaching, it is necessary to conduct this research titled 'Physics teachers artificial intelligence technology as predictor of students' academic performance in secondary schools in Plateau State'.

The study aims to determine 'Physics teachers' challenges of integrating AI technology as predictor of students' academic performance in secondary schools of Plateau State'. Specifically, the study intends to:

(i) Examine the challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching in senior secondary schools in Plateau State.

(ii) Determine the mean students' academic achievement based on Physics teachers' gender in senior secondary schools in Plateau State

The following questions were raised and guided the study:

1. What level of challenges do Physics teachers face in integrating AI-powered tools into teaching in secondary schools in Plateau State?

2. What are the mean students' academic achievement based on Physics teachers' gender in secondary schools in Plateau State?

The study tested the following null hypotheses at 0.05 significance level:

H_{01}: There is no significant predictive correlation between the level of challenges Physics teachers faced in integrating AI tools on students' academic performance among secondary schools in Plateau State.

H_{02}: There is no significant interactive predictive correlation between gender and level of challenges physics teachers faced in integrating AI tools on students' academic performance among secondary schools in Plateau State.

2. Methods

The study employed a predictive correlational research design, as the researchers did not manipulate any variables but examined existing conditions (teachers' level of challenges in integrating artificial intelligence technology and gender) and their predictive relationship with students' academic performance. The target population included 311 Physics teachers and 22,985 SSIII senior secondary school students in Plateau State for 2024/2025 academic session as obtained from the Plateau State Ministry of Education (2024). Using random sampling, thirty-six Physics teachers (27 males, 9 females) and 393 SSIII students from thirty-six randomly selected schools. Physics Teachers Level of Understanding Artificial Intelligence Questionnaire (PTLUAIQ) which had ten items: Measured Physics teachers' familiarity, challenges and competence with AI tools and Physics Students' Academic Performance Proforma (PSAPP): Assessed students' academic performance in Physics. Both instruments were validated by experts. Reliability coefficient was 0.88 for PTLUAIQ using Cronbach's Alpha. Descriptive statistics (mean and standard deviation) addressed research questions. Hypotheses were tested at 0.05 level of significance using simple linear and multiple regression to control for potential confounding variables and assess predictive relationships.

3. Results

The results are presented in tables and discussion follow after each table presented.

3.1. Answer to Research Question 1

Research Question 1: *What level of challenges do Physics teachers face in integrating AI-powered tools into teaching in secondary schools in Plateau State?*

Table 1. Responses on Challenges Physics Teachers Face in Integrating AI-Powered Tools into Teaching Among Secondary Schools in Plateau State

S/N	Statement n=36	Mean	S.D	REMARK
1	I lack access to internet connectivity necessary for AI-powered tools.	4.06	1.09	HL
2	I report insufficient training for using AI-powered tools.	3.64	1.05	HL
3	I am concerned about the potential for AI to replace human teachers.	3.33	0.99	ML
4	I am worry about data privacy when using AI-powered tools.	3.42	1.05	ML
5	I report difficulty in finding AI-powered tools relevant to physics education.	3.67	1.20	HL
6	I often lack administrative support with resources for integrating AI-powered tools.	4.11	0.95	HL
7	I am concerned about the potential for AI to worsen existing educational inequalities.	3.31	1.23	ML
8	I have difficulty in evaluating the effectiveness of AI-powered tools.	3.33	0.83	ML
9	I often lack the technical expertise to troubleshoot issues with AI-powered tools.	3.39	1.04	ML
10	Integration of AI-powered tools in physics education is hindered by inadequate infrastructural resources.	4.19	1.12	HL
	Grand total	**3.64**	**1.06**	**HL**

Source: (Field work, 2025)

Table 1 data reported the level of challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching physics. The overall mean score is 3.64 with a standard deviation of 1.06, indicating a high level (HL) of challenges in integrating AI tools. Some items reflect high levels (HL) of challenges in integrating AI tools in teaching physics, such as I lack access to internet connectivity necessary for AI-powered tools. (Mean = 4.06, S.D = 1.09). Other items, like Integration of AI-powered tools in physics education is hindered by inadequate infrastructural resources (mean=4.19, S.D = 1.12), I report insufficient training for using AI-powered tools (Mean = 3.64, S.D = 1.05, other five fall into the medium level category. The overall result implies that challenges in integrating AI tools in teaching physics is an issue among Physics teachers in senior secondary schools in Plateau State. Teachers demonstrate high level of challenge in integrating AI powered tools in teaching physics.

3.2. Test of Hypothesis 1

Hypothesis 1: Challenges faced by Physics teachers in integrating Artificial Intelligence (AI) tools do not significantly predict students' academic performance.

Table 2a: Summary of ANOVA from Linear Regression Analysis of Correlation between Challenges Physics Teachers Faced in Integrating AI Tools on Students' Academic Performance Among Secondary School in Plateau State.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	186.632	1	186.632	1.783	.191[b]
	Residual	3559.590	34	104.694		
	Total	3746.222	35			

Source: (Field work, 2025)

a. Dependent Variable: students' academic achievement in physics

b. Predictors: (Constant), challenges faced by physics teachers in integrating AI-powered tools into teaching.

The result of analysis in Table 2a provides a summary of ANOVA-based linear regression analysis, which was employed to investigate whether there is a significant predictive correlation between challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching and students' academic achievement in physics. The results reveal that there is nonsignificant predictive correlation between challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching on students' academic achievement in physics, $F(1, 34) = 1.783$, $p = 0.191 > 0.05$. Since the p-value (0.191^{b}) is higher than the predefined significance level of 0.05, the null hypothesis is not rejected

Table 2b: Model Summary from Linear Regression Analysis of Correlation between Challenges Physics Teachers Faced in Integrating AI Tools on Students Academic Performance Among Secondary School in Plateau State.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.223[a]	.050	.022	10.23200

Source: (Field work, 2025)

a. Predictors: (Constant), challenges faced by second ary school physics teachers in integrating AI-powered tools into teaching). Table 2b information shows a model summary that demonstrates how the independent variable accounts for the variance in the dependent variable. The results reveal that 2.2% of the variation in the academic performance could be attributed to challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching. The r-value of 0.223^{a} reveals that there is a weak insignificant positive predictive correlation between challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching on students' academic performance in Plateau State.

Table 2c: Coefficients of Beta from Linear Regression Analysis of Correlation between Challenges Physics Teachers Faced in Integrating AI Tools on Students' Academic Performance Among Secondary School in Plateau State.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	43.350	10.200		4.250	.000
	Challenges of AI	.368	.276	.223	1.335	.191

Source: (Field work,2025)

a. Dependent variable: students' academic performance in physics

The result in Table 2c indicates the beta coefficient of the regression analysis of correlation between Physics teachers AI literacy level and students' academic performance in physics. The result shows a beta coefficient of $\beta = 0.223$, $t = 1.335$, $p = 0.191 > 0.05$. This indicates that there is insignificant weak positive predictive correlation between challenges faced by physics teachers in integrating AI-powered tools into teaching and students' academic achievement in physics in senior secondary schools Plateau State.

3.3. Answer to Research Question 2

Research Question 2: *What are the mean students' academic achievement based on Physics teachers' gender in senior secondary schools in Plateau State*?

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Table 3. Mean and Standard Deviation for Students Academic Achievement Scores of Based on Physics Teachers Gender in Senior Secondary Schools in Plateau State.

Physics teachers' gender	Mean n=387	S. D n=387	n
Male	56.23	13.45	27
Female	56.37	13.15	9
Total	56.30	13.30	36

Source: (Field work, 2025)

Table 3 reports the mean academic achievement score of students offering Physics in senior secondary schools in Plateau State based on their teachers' gender. With a sample size of 393 students and 36 teachers, the mean academic performance score is 56.23 and 56.37, with a standard deviation of 13.45 and 13.15 respectively. This suggests that on average, students' academic performance in Physics is moderate for both students taught by male or female teachers, showing that gender and AI literacy makes no difference in academic achievement but there is a considerable variation in their academic achievement levels. The standard deviation indicates a wide dispersion of scores around the mean, highlighting differences in students' individual academic achievement in Physics in Plateau State. Male teachers: ML=56.23 (SD=13.45), Female teachers: ML=56.37 (SD=13.15) This suggests minimal difference between genders, confirming that gender alone may not significantly impact academic outcomes.

3.4. Test of Hypothesis 2

Hypothesis 2: Gender and challenges faced by Physics teachers in integrating Artificial Intelligence (AI) tools do not significantly predict students' academic performance.

Table 4a: Summary of ANOVA from Multiple-Linear Regression Analysis of Correlation between Gender and Challenges Physics Teachers Faced in Integrating AI Tools on Students' Academic Performance in Physics Among Secondary Schools in Plateau State.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	188.767	2	94.384	.876	.426[b]
	Residual	3557.455	33	107.802		
	Total	3746.222	35			

Source: (Field work,2025)

a. Dependent Variable: students' academic achievement in physics

b. Predictors: (Constant), Gender; challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching.

The result of analysis in Table 4a provides a summary of ANOVA-based linear regression analysis, which was employed to investigate whether there is a significant correlation between challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching, gender and students' academic performance in physics. The results reveal that there is significant correlation between gender; challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching and students' academic achievement in physics, $F(2, .33) = 0.876$, $p>0.05$. Since the p-value (0.426^{b}) is higher than the predefined significance level of 0.05, the null hypothesis is not rejected

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Received: 30/08/2025; **Accepted:** 23/11/2025; **Published:** 30/11/2025

Table 4b: Model Summary from Multiple-Linear Regression Analysis of Correlation between Gender and Challenges Physics Teachers Faced in Integrating AI Tools on Students' Academic Performance in Physics Among Secondary School in Plateau State.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.224[a]	.050	-.007	10.38276

Source: (Field work, 2025)

a. Predictors: (Constant), Gender; challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching.

b. Table 4b shows a model summary that demonstrates how the independent variable accounts for the variance in the dependent variable. The results reveal that 0.7% of the variation in the academic achievement could be attributed to gender; challenges faced by secondary school physics teachers in integrating AI-powered tools into teaching. The r-value of 0.224[a] reveals that there is a weak positive relationship between challenges faced by physics teachers in integrating AI-powered tools into teaching and students' academic achievement in senior secondary schools in Plateau State.

Table 4c: Coefficients of Beta Multiple-Linear Regression Analysis of Correlation between Gender and Challenges Physics Teachers Faced in Integrating AI Tools on Students' Academic Performance in Physics Among Secondary School in Plateau State.

Model		Unstandardized Coefficients		Standardized Coefficients	Coef-T	Sig.
		B	Std. Error	Beta		
1	(Constant)	42.894	10.848		3.954	.000
	Challenges of AI	.361	.284	.219	1.270	.213
	Gender	.571	4.060	.024	.141	.889

Source: (Field work, 2025)

a. Dependent Variable: students' academic achievement in physics

The result in Table 4b indicates the beta coefficient of the regression analysis of correlation between gender; challenges faced by physics teachers in integrating AI-powered tools into teaching and students' academic achievement in physics. The result shows a beta coefficient of β=0.219, t =1.270, p=0.213> 0.05 for challenges faced by Physics teachers in integrating AI. This indicates that there is no significant positive weak correlation between challenges faced by physics teachers in integrating AI-powered tools into teaching and students' academic achievement in physics in senior secondary schools in Plateau State. For gender, the beta coefficient is β=0.024, t=0.141, at p=0.889>0.05 which indicates that there is no predictive relationship.

It can be deduced that the interactive predictive correlation between gender and challenges faced by secondary school Physics teachers in integrating AI-powered tools into teaching, challenges faced by Physics teachers made the unique contribution to explaining academic performance, when the variance explained by all other variables in the model are controlled since it has the largest beta coefficient of 0..219

4. Discussion

Findings indicate that Physics teachers in secondary schools in Plateau State encounter substantial challenges in integrating Artificial Intelligence (AI) technology into teaching, primarily infrastructural and training-related, consistent with Okeke and Ochuba (2020); Sunday et al. (2025). However, these challenges showed no statistically significant predictive correlation on students' academic performance. While AI competence holds potential for enhancing learning (Zawacki-Richter et al., 2019), its limited application in secondary schools in Plateau State may explain the weak predictive correlations observed (Crompton & Burke, 2023; Ren & Wu, 2025; Okeke & Ochuba, 2020).

Gender did not significantly influence students' academic performance, reinforcing Volman & van Eck (2001) that competence rather than gender is the determining factor in technology use. The slight edge in performance of students taught by female teachers suggests that training and confidence in AI use, not gender identity, are central to improved student outcomes.

5. Conclusion

Physics teachers among secondary schools in Plateau State face high barriers to AI integration, yet these challenges do not significantly predict students' academic achievement. Teacher gender is also not a determinant of student outcomes. Instead, competence and access to AI resources

remain key drivers of effective teaching and learning.

Recommendations:

- Provide targeted AI-focused training to build teachers' digital competence.
- Improve school infrastructure and internet connectivity.
- Future research to explore other science subjects and regions for broader insights

Abbreviations

PTLUAIQ	Physics Teachers' Level of Understanding Artificial Intelligence Questionnaire
AI	Artificial Intelligence
PSAPP	Physics Students' Academic Performance Proforma
SD	Standard Deviation
TPACK	Technological Pedagogical Content Knowledge
WAEC	West African Examination Council
NECO	National Examination Council
SSCE	Senior School Certificate Examinations
SCT	Social Cognitive Theory

Acknowledgments

The author sincerely acknowledge the contribution of Prof. A.U Okoronka my mentor and motivator into academic research and writings. He is from Department of Physical Sciences Education, Modibbo Adama University, Yola. God bless you for stirring the writing attitude in me.

Author Contributions

I. I Fwangle: Conceptualization, methodology, writing-original draft, Methodology , Analysis of result**,** Writing-Review and Editing.

Conflicts of Interest

The author(s) declare that they have no known competing financial interests, professional affiliations or personal relationships that could have appeared to influence the work reported in this paper,

Funding

None

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