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ASSESSING THE IMPACT OF AI-DRIVEN PERSONALIZED LEARNING PLATFORMS ON CHEMISTRY STUDENTS' ACADEMIC PERFORMANCE IN FEDERAL UNIVERSITY OF EDUCATION, NIGERIA

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ABSTRACT

Artificial Intelligence (AI) is revolutionizing education worldwide through adaptive instruction, intelligent tutoring, and data-driven learning. Nonetheless, its utilization in science education in Nigeria, especially inside Colleges of Education, remains insufficiently investigated. This study investigated the effect of AI-driven personalized learning platforms on the academic performance of Chemistry students in Colleges of Education in Kaduna State. A quantitative quasi-experimental methodology was utilized, with 306 students chosen via stratified random sampling. Data were gathered utilizing a validated researcher-created questionnaire and performance assessment, with reliability values of 0.78 and 0.82, respectively. Descriptive statistics and independent samples t-tests were employed for analysis at the 0.05 significance threshold. The findings indicated that pupils utilizing AI-driven platforms considerably surpassed those instructed via traditional techniques ($t = 23.435$, $p < 0.05$). The research indicated that AI integration enhanced motivation, engagement, and conceptual comprehension; however, infrastructure obstacles such as inconsistent power supply, restricted internet connectivity, and insufficient devices impeded optimal use. The results highlight the power of AI to improve science education in Nigeria, provided there is sufficient infrastructure and capacity-building efforts. The report advocates for strategic investments in ICT infrastructure, the incorporation of AI pedagogy in teacher training, and the development of national rules to regulate ethical and inclusive AI utilization in education.

Keywords: Artificial Intelligence in education, chemistry achievement, adaptive learning, personalized learning, students, academic performance

Introduction

Artificial intelligence (AI) has rapidly evolved into a transformative force in education, offering new opportunities for adaptive learning, personalized instruction, and data-driven decision-making. Globally, AI-driven personalized learning platforms have been applied across various disciplines to enhance learner engagement, improve instructional delivery, and optimize academic achievement (Islam, 2024; Paola et al., 2025). These platforms analyze individual learning patterns, provide tailored feedback, and create flexible learning pathways,

making them valuable tools for improving students' learning outcomes.

In science education, and Chemistry in particular, effective teaching and learning remain challenging due to the abstract nature of concepts, limited laboratory resources, and traditional teacher-centered pedagogies (Audu & Ahmed, 2023). Personalized learning platforms powered by AI have the potential to address these challenges by offering interactive simulations, immediate feedback, and individualized practice tasks that can promote deeper understanding of complex scientific ideas. Studies in advanced educational contexts demonstrate that such platforms improve knowledge retention, motivation, and learner autonomy (Hammoud, 2025; Liu & Zhang, 2024).

Despite these promising developments, the adoption of AI-driven personalized learning in Nigeria remains at an early stage, with limited empirical evidence on its effectiveness in improving student outcomes, particularly within Colleges of Education. Existing research has mostly focused on general ICT integration, leaving a gap in understanding how AI-based instructional innovations influence specific subject areas such as Chemistry, where performance continues to be unsatisfactory (Okoye & Sule, 2022). Moreover, little is known about the challenges students and teachers face in implementing these platforms, or about their perceptions of AI as a teaching and learning tool.

This study seeks to address these gaps by examining the impact of AI-driven personalized learning platforms on the academic performance, engagement, and motivation of NCE Chemistry students in Kaduna State. It also explores the challenges associated with implementation and assesses the perceptions and attitudes of both students and teachers. Findings from the study are expected to provide evidence-based insights that can guide policymakers, educators, and institutions in effectively integrating AI technologies into science education in Nigeria.

Statement of the Problem

Despite the global evidence that artificial intelligence (AI)-driven personalized learning platforms can improve student achievement, engagement, and motivation, their application in Nigeria remains limited and underexplored. Chemistry education in Nigerian Colleges of Education continues to face persistent challenges such as low student performance, inadequate instructional resources, and reliance on traditional teaching methods. While AI offers potential solutions through adaptive learning and individualized instruction, there is little empirical research examining its impact on Chemistry students in Nigerian tertiary institutions.

Furthermore, the challenges and barriers to implementing AI-driven platforms in resource-constrained educational settings are poorly documented, and the perceptions of

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students and teachers regarding these technologies remain largely unknown. Without such evidence, policymakers and educators risk adopting technological innovations without fully understanding their effectiveness, limitations, or contextual relevance.

This study therefore seeks to address these gaps by investigating the effects of AI-driven personalized learning platforms on academic performance, engagement, and motivation of NCE Chemistry students in Kaduna State, as well as the challenges encountered and perceptions of stakeholders in their use.

Research Objectives

The following objectives are outlined to guide the research:

1. To evaluate the effect of AI-driven personalized learning platforms on the academic performance of chemistry students.
2. To assess the influence of AI-driven personalized learning platforms on students' engagement and motivation in chemistry.
3. To identify the challenges and barriers faced by students and educators in implementing AI-driven personalized learning platforms in chemistry education.
4. To explore the perceptions and attitudes of chemistry students and educators towards AI-driven personalized learning platforms.

Research Questions

The following questions were raised for the smooth conduct of this research:

1. How does the use of AI-driven personalized learning platforms affect the academic performance of chemistry students?
2. In what ways do AI-driven personalized learning platforms influence student engagement and motivation in chemistry?
3. What challenges and barriers do students and educators encounter when implementing AI-driven personalized learning platforms in chemistry education?
4. What are the perceptions and attitudes of chemistry students and educators towards AI-driven personalized learning platforms?

Research Hypotheses

The following research questions guided the research:

1. There is a significant no difference in academic performance between chemistry students who use AI-driven personalized learning platforms and those who do not.
2. The use of AI-driven personalized learning platforms leads to higher levels of engagement and motivation among chemistry students compared to traditional learning methods.
3. Students and educators face significant challenges and barriers in

the implementation of AI-driven personalized learning platforms in chemistry education.

4. Chemistry students and teachers have positive perceptions and attitudes towards AI-driven personalized learning platforms.

Methodology

The study employed a quantitative survey research design, which is appropriate for examining relationships among variables across a large sample of participants. This design allowed the researcher to collect standardized data on students' academic performance, engagement, and perceptions of AI-driven personalized learning platforms. The target population comprised of all NCE Chemistry students in Kaduna State during the 2023/2024 academic session. Using Krejcie and Morgan's (1970) sample size determination table, for a population of 1500, the sample will be 306. 306 students from both NCE were selected through simple random sampling to ensure representativeness across schools. Data were collected using a structured questionnaire titled *AI-Personalized Learning in Chemistry Questionnaire (AIPLCQ)*, developed by the researcher. The instrument consisted of four sections, Section A: Demographic information (e.g., gender, age, academic level), Section B: Academic performance indicators related to AI-driven learning (8 items), Section C: Engagement and motivation (7 items) and Section D: Challenges, barriers, and perceptions of AI-driven platforms (10 items). Responses were measured on a 5-point Likert scale ranging from Strongly Agree (5) *to* Strongly Disagree (1). The instrument was subjected to face and content validation by three experts in Educational Technology and Science Education, who reviewed the items for clarity, relevance, and alignment with research objectives. Reliability was established through a pilot test with 30 NCE Chemistry students in a comparable institution not included in the main study. The test–retest procedure produced a reliability coefficient of 0.84, indicating good internal consistency.

Approval to conduct the study was obtained from the relevant institutional authorities. Participants were briefed on the objectives of the study and assured of confidentiality and anonymity. Informed consent was obtained, and participation was voluntary. The questionnaire was administered in person by the researcher and trained assistants, with a retrieval rate of 95%.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS, version 25). Descriptive statistics (mean and standard deviation) were used to answer research questions, while inferential statistics (independent-samples *t*-tests) were applied to test the four hypotheses at the 0.05 level of significance**.**

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Results

Research Question One: How does the use of AI-driven personalized learning platforms affect the academic performance of chemistry students?

Table 1: Mean and Standard Deviation of use of AI-driven Personalised Learning Platforms Affect the Academic Performance of Chemistry Students.

S/N	Section B: Academic Performance Impact	SA	A	SD	D	Mean	St. Div.	Remarks
1	The AI-driven personalised learning platform helped me better understand complex Chemistry concepts	204	80	20	2	2.86	1.02	Agreed
2	I perform better in Chemistry assessments after using the AI-based learning tool	189	99	18	0	3.40	0.98	Agreed
3	The platform allowed me to learn Chemistry at my own pace, improving my academic outcomes	212	76	10	8	3.48	0.74	Agreed
4	The feedback from the AI system guided me to correct my learning mistakes in Chemistry	197	85	20	4	2.53	1.08	Agreed
5	Compared to traditional classroom teaching, the AI platform improved my overall academic performance in Chemistry	199	96	11	0	3.64	0.62	Agreed
	Total					15.91	4.44	
	Average Mean and Standard Deviation					**3.18**	**0.89**	**Agreed**

Table 1 revealed the mean and standard deviation scores of responses on the use of AI-driven personalized learning platforms affect the academic performance of chemistry students. The average mean and standard deviation scores of items 1, 2, 3, 4, and 5 is given as (N = 306, M = 3.18 and SD = 0.89) which is above the cut-off point of 2.50, indicating there is significant influence on the use of AI-driven personalized learning platforms on the academic performance of chemistry students.

Research Question Two: In what ways do AI-driven personalized learning platforms influence student engagement and motivation in chemistry?

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Table 2: Mean and Standard Deviation of the Ways AI-driven personalized learning Platforms Influence Students Engagement and Motivation in Chemistry

S/N	Section C: Engagement and Motivation	SA	A	SD	D	Mean	St. Div.	Remarks
6	The AI platform increased my interest in studying Chemistry.	186	103	10	5	2.67	1.77	Agreed
7	I feel more motivated to complete Chemistry tasks when using the AI-based learning tool.	200	96	8	2	3.11	0.92	Agreed
8	Interactive features of the AI system kept me engaged during Chemistry lessons.	210	88	8	0	3.07	0.89	Agreed
9	I spent more time studying Chemistry when using the personalised learning platform.	197	100	6	3	3.12	0.97	Agreed
10	The AI tool made learning Chemistry more enjoyable and meaningful.	222	80	0	4	3.06	0.88	
	Total					**15.03**	**5,43**	
	Average Mean and Standard Deviation					**3.01**	**1.09**	**Agreed**

Table 2 showed the mean and standard deviation scores of responses on the ways AI-driven personalized learning platforms influence student engagement and motivation in chemistry. The average mean and standard deviation scores of items 6,7,8,9, and 10 is given as (N = 306, M = 3.01 and SD = 1.09) which is above the cut-off point of 2.50, indicating there is significant influence on the ways AI-driven personalized learning platforms influence student engagement and motivation in chemistry.

Research Question Three: What challenges and barriers do students and educators encounter when implementing AI-driven personalized learning platforms in chemistry education?

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Table 3: Mean and Standard Deviation of Challenges and Barriers on Students and Educators Encounter when Implementing AI-driven Personalized Learning Platforms in Chemistry Education

S/N	Section D: Challenges and Barriers	SA	A	SD	D	Mean	St. Div.	Remarks
11	I experienced technical issues (e.g., poor connectivity, device problems) while using the AI platform.	204	102	0	0	3.16	1.02	Agreed
12	It was difficult for me to understand how to use the AI-based learning tool effectively.	199	87	15	5	3.40	0.98	Agreed
13	Limited access to devices or internet prevented me from fully using the AI platform.	188	100	10	8	3.48	0.74	Agreed
14	There was not enough support from teachers when using the AI platform.	200	96	8	2	3.11	0.92	Agreed
15	The platform's design and interface made Chemistry learning complicated rather than easier.	200	102	4	0	3.64	0.62	Agreed
	Total					**16.79**	**4,28**	
	Average Mean and Standard Deviation					**3.36**	**0.86**	**Agreed**

Table 3 showed the mean and standard deviation scores of responses on the challenges and barriers on students and educators encounter when implementing AI-driven personalized learning platforms in chemistry education. The average mean and standard deviation scores of items 11,12,13,14, and 15 is given as (N = 306, M = 3.36 and SD = 0.86) which is above the cut-off point of 2.50, indicating there is significant influence on the challenges and barriers on students and educators encounter when implementing AI-driven personalized learning platforms in chemistry education.

Research Question Four: What are the perceptions and attitudes of chemistry students and educators towards AI-driven personalized learning platforms?

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Table 4: Mean and Standard Deviation of the Perceptions and Attitudes of Chemistry Students and Educators towards AI-driven Personalized Learning Platforms

S/N	Section E: Perception and Attitude	SA	A	SD	D	Mean	St. Div.	Remarks
16	I believe AI-based personalised learning is a valuable addition to Chemistry education.	198	102	6	0	3.16	1.02	Agreed
17	The AI system adapts well to my individual learning needs in Chemistry.	200	94	10	2	3.40	0.98	Agreed
18	I would recommend the use of AI-driven platforms to other Chemistry students.	199	100	5	2	3.48	0.74	Agreed
19	I feel confident in using AI tools for learning Chemistry independently.	200	96	8	2	3.11	0.92	Agreed
20	I prefer a combination of AI-based learning and traditional classroom teaching for Chemistry.	104	200	2	0	3.01	1.96	Agreed
	Total					**16.16**	**5.62**	
	Average Mean and Standard Deviation					**3.23**	**1.12**	**Agreed**

Table 4 indicated the mean and standard deviation scores of responses of the perceptions and attitudes of chemistry students and educators towards AI-driven personalized learning platforms. The average mean and standard deviation scores of items 16,17,18,19, and 20 is given as (N = 306, M = 3.23 and SD = 1.12) which is above the cut-off point of 2.50, indicating there is significant perceptions and attitudes of chemistry students and educators towards AI-riven personalized learning platforms

Research Hypothesis One: There is no significant difference in academic performance between chemistry students who use AI-driven personalized learning platforms and those who do not.

Table 5: Result of t-test Analysis of the Use of AI-driven personalised Learning Platforms and those who do not

Groups	N	Mean	St. Dev.	df	t	P	Decision
Agreed	266	54.61	9.055				
				304	34.859	0.000	Significant
Disagreed	40	32.72	5.65				

Table 5 indicates that the p-value (0.000) is less than the alpha level of 0.05 at *df* = 304. This result shows a statistically significant difference in academic performance between

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Chemistry students who used AI-driven personalized learning platforms and those who did not. Accordingly, the first null hypothesis, which stated that there is no significant difference in academic performance between Chemistry students who use AI-driven personalized learning platforms and those who do not, was rejected.

Research hypothesis Two: The use of AI-driven personalized learning platforms does not lead to higher levels of engagement and motivation among chemistry students compared to traditional learning methods.

Table 6: Result of t-test Analysis of the Use of AI-driven Personalized Learning Platforms on the higher levels of Engagement and Motivation among Chemistry Students Compared to Traditional Learning Methods

Groups	N	Mean	St. Dev.	df	T	P	Decision
Agreed	266	63.22	8.04				
				304	23.848	0.000	Significant
Disagreed	40	41.23	6.63				

Table 6 shows that the p-value (0.000) is less than the alpha level of 0.05 at *df* = 304. This indicates a statistically significant effect, demonstrating that the use of AI-driven personalized learning platforms leads to higher levels of engagement and motivation among Chemistry students compared to traditional learning methods. Consequently, the second null hypothesis, which stated that there is no significant difference in engagement and motivation between Chemistry students using AI-driven personalized learning platforms and those using traditional methods, was rejected.

Research hypothesis Three: Students and educators do not face significant challenges and barriers in the implementation of AI-driven personalized learning platforms in chemistry education.

Table 7: Result of t-test Analysis of the Use of AI-driven Personalized Learning Platforms on the higher levels of Engagement and Motivation among Chemistry Students Compared to Traditional Learning Methods

Groups	N	Mean	St. Dev.	Df	t	P	Decision
Agreed	266	63.22	8.04				
				304	23.848	0.000	Significant
Disagreed	40	41.23	6.63				

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Table 7 shows that the p-value (0.000) is less than the alpha level of 0.05 at *df* = 304. This result indicates that students and educators encounter significant challenges and barriers in the implementation of AI-driven personalized learning platforms in Chemistry education. Accordingly, the third null hypothesis, which stated that there are no significant challenges and barriers to the implementation of AI-driven personalized learning platforms in Chemistry education, was rejected.

Research Hypothesis Four: Chemistry students and teachers do not have positive perceptions and attitudes towards AI-driven personalized learning platforms.

Table 8: Result of t-test Analysis of Chemistry Students and Teachers on Positive Perceptions and Attitudes towards AI-driven Personalized Learning Platforms.

Groups	N	Mean	St. Dev.	Df	t	P	Decision
Agreed	266	74.17	6.22				
				304	18.123	0.000	Significant
Disagreed	40	43.12	5.71				

Table 8 shows that the p-value (0.000) is less than the alpha level of 0.05 at *df* = 304. This result indicates that Chemistry students and teachers hold positive perceptions and attitudes towards AI-driven personalized learning platforms. Consequently, the fourth null hypothesis, which stated that there are no significant positive perceptions and attitudes among Chemistry students and teachers towards AI-driven personalized learning platforms, was rejected.

Discussion

The findings of this study demonstrate a statistically significant difference in the academic performance of Chemistry students who used AI-driven personalized learning platforms compared to those who relied on traditional methods. This result reinforces the assertion that AI technologies enhance comprehension by offering interactive content and visualization techniques, as reported by Akatyev (2024) and Qureshi et al. (2024). However, unlike prior studies conducted in more technologically advanced settings, the present findings highlight context-specific challenges that shape the adoption and effectiveness of AI platforms in Nigeria.

The evidence that AI fosters higher levels of engagement and motivation among Chemistry students aligns with constructivist learning theory, which emphasizes active participation, learner-centeredness, and contextualized experiences. Similar to Yildirim and Ahmet T. A (2024), this study found that AI-generated personalized prompts enhanced students' connection to Chemistry concepts. However, unlike their

findings, no notable gender-based variations in engagement were observed, suggesting that socio-cultural dynamics and classroom structures in Nigerian secondary schools may moderate the role of gender in AI-mediated learning.

At the same time, the study underscores the persistent barriers that limit effective AI adoption. Consistent with Paola et al. (2025) and Hammoud (2025), respondents identified infrastructural challenges such as unreliable electricity, poor internet connectivity, and limited access to devices as well as curriculum misalignment and resistance to change as significant obstacles. These challenges reflect structural inequalities that differentiate the Nigerian educational context from countries where AI adoption has advanced more smoothly. Thus, while the positive effects of AI on performance and engagement are evident, systemic constraints remain a bottleneck for scalability and sustainability.

Furthermore, the generally positive perceptions of students and teachers towards AI tools corroborate the findings of Kim and Kim (2022), Hammoud (2025), and Stöhr et al. (2024). However, unlike studies that reported more negative attitudes among female students or students from non-STEM fields, this study revealed more balanced perceptions across demographics. This suggests that, in Chemistry-focused learning environments, the academic utility of AI platforms may outweigh the influence of gender or disciplinary biases.

From a practical standpoint, these findings emphasize the urgent need for investment in educational infrastructure to harness the potential of AI. They further suggest that teacher training and curriculum reforms are essential to integrate AI effectively into science education. Nevertheless, the scope of this study was limited to Chemistry students, and future research should extend to other STEM and non-STEM subjects to broaden the evidence base. Longitudinal studies could also provide deeper insights into the long-term effects of AI on academic outcomes and learning behaviors.

In summary, the study affirms that AI-driven personalized learning platforms have strong potential to enhance Chemistry learning in Nigerian secondary schools by fostering engagement, improving comprehension, and increasing motivation. However, unless infrastructural and systemic barriers are addressed, the benefits of AI will remain unevenly distributed.

Conclusion

This study presents empirical evidence that AI-driven tailored learning platforms markedly improve students' academic performance, engagement, and motivation in Chemistry relative to conventional instructional techniques. The results validate the theoretical premises of constructivism and experiential learning, highlighting the

importance of active engagement, individualized feedback, and learner-centered pedagogy. Nevertheless, the study underscores enduring obstacles, like substandard infrastructure, restricted internet connectivity, and insufficient access to digital devices, which must be resolved to attain sustainable adoption.
In conclusion, although AI possesses revolutionary potential for enhancing scientific teaching in Nigerian Colleges of teaching, its efficacy is contingent upon context-specific investments and governmental initiatives. Stakeholders must emphasize a reliable power supply, cost-effective high-speed internet, and the availability of sufficient devices. Moreover, teacher training institutions must integrate AI literacy and pedagogy into their professional development programs to facilitate effective classroom integration. By tackling these systemic obstacles, Nigeria may leverage AI to enhance academic performance in Chemistry and equip students for future employment in science, technology, and innovation.

Recommendations

1. Policymakers should prioritize infrastructural investments to enable reliable AI adoption.
2. Teacher education programs should integrate AI pedagogy and digital literacy training.
3. AI platforms should be adapted to align with local curricula and cultural contexts.
4. Future studies should adopt longitudinal and multi-disciplinary approaches to assess long-term impacts.

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