



**STUDENTS' PERCEPTIONS OF AI-BASED CHEMISTRY LEARNING
PLATFORMS AND THEIR RELATIONSHIP WITH SELF-EFFICACY AND
ACADEMIC ENGAGEMENT AMONG SECONDARY SCHOOL STUDENTS IN
ZARIA, NIGERIA**

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ABSTRACT

The present study examined the perceptions of the secondary school students on artificial intelligence (AI) based chemistry learning platform, and the relationship between the perceptions and students' self-efficacy and academic engagement in Zaria education zone, Kaduna state, Nigeria. A mixed-research design (descriptive and correlational survey design) was used. A purposive sampling technique was employed in selecting 103 Senior Secondary School students (62 males and 41 females) from two public schools namely Government Secondary School (GSS) Dakace and Government Secondary School (GSS) Gyallesu. Three four-point scales were used to gather data, with reliability coefficients ranging from .85 to .89 and were expert-validated. Mean, standard deviation, simple linear regression and Pearson product-moment correlation were used to analyse the data at .05 level of significance. The students had positive attitudes towards chemistry learning platforms that use AI ($M = 3.00$, $SD = 0.44$). Perceptions were highly and positively associated with self-efficacy ($\beta = 0.52$, $p < 0.001$), academic engagement ($\beta = 0.52$, $p < 0.001$), and highly and positively correlated with both of those outcomes together ($r = 0.58$, $p < 0.001$). A positive correlation was found between favorable attitudes toward AI-based platforms, students' confidence and engagement in chemistry, but no causal inference could be made due to the cross-sectional design. Schools be given guidance on access to AI platforms; teachers be trained to use them in lessons; and data-cost issues be resolved.

Keywords: Artificial Intelligence, Chemistry Education, Perception, Self-Efficacy, Academic Engagement, Secondary School

Introduction

Artificial intelligence (AI) is one of the most influential technologies to have emerged in teaching and learning. The study also shows that intelligent tutoring, adaptive feedback, and automated assessment are among the key applications of AI in STEM education that have been systematically studied (Xu & Ouyang, 2022). With the advent of generative technology like ChatGPT, students have opportunities to get explanations, worked examples, and feedback whenever they need it, without having to wait for a teacher (Baidoo-Anu & Ansah, 2023; Kasneci et al., 2023). Previous works on research about AI in science education have resulted in positive findings on learning and motivation, with most studies focusing on achievement rather than affective aspects (Almasri, 2024), and preliminary research indicates that ChatGPT can aid science education tasks (Cooper, 2023). Students are also using these tools



independently, even if they are not formally part of the curriculum in the school (Naumann et al., 2025). As these developments emerge, there are important questions to consider regarding learners' perceptions of the AI-based platforms and whether there is any connection between perception and confidence and learner engagement in learning, especially in subjects like Chemistry that require demonstration of abstract concepts, the sooner the better.

Questions such as these are particularly pertinent in chemistry. Chemistry is a complicated subject to learn, according to Johnstone (1991), because it is necessary that students understand it at the same time at three different levels of representation: macroscopic, submicroscopic, and symbolic. Many students, therefore, are having difficulty connecting observed phenomena, particles, equations and calculations. AI learning platforms can be used to aid this process by providing immediate feedback, worked examples, and visual or interactive explanations – elements that align with the principles of multimedia learning (Mayer, 2009).

This is a need in Nigeria. The results of the Senior School Certificate Examination in Physics and Chemistry over the years 1999 to 2019 were analysed and it was concluded that a lot of the problem of the inconsistent performance of examinees was due to the reported weaknesses by the chief examiners, out of which the poor understanding of concepts ranked highest (Obafemi & Ugonwa, 2025). Meanwhile, students are already using AI to learn concepts and to access information, even when AI is not formally introduced in schools (Naumann et al., 2025). The attitude students have towards these tools is, therefore, significant as it affects the acceptance and use of a technology (Davis, 1989).

Perceptions can also be significant to what happens within the learner. Self-efficacy is the confidence in one's ability to organize and perform the actions needed to achieve a desired goal, and this impacts effort, persistence and task selection (Bandura, 1997). A key link between academic engagement and achievement is the behavioral, emotional, and cognitive effort students put forth in learning (Fredricks et al., 2004). There might be a higher rate of success with solving chemistry problems by students who consider AI-based platforms useful and user-friendly, which could relate to increased self-confidence and engagement. There is very little documentation of this type in Northern Nigeria. The primary goal of this study was to investigate the relationship between AI based chemistry learning platforms, students' perception and self-efficacy in secondary schools in Zaria. This study, therefore, investigated the relationship between AI based chemistry learning platforms, students' perception, and self-efficacy among secondary school students in Zaria.

Statement of the Problem

AI's application in education has led to the creation of educational platforms that provide customized learning experiences, adaptive feedback, and interactive content, especially in science disciplines like chemistry. These platforms can help to enhance students' comprehension of complex concepts and to promote deeper engagement with learning. The use of AI-powered chemistry learning platforms in secondary school in developing contexts like Zaria was still unclear even though it offered potential benefits. Limited digital infrastructure, lack of support from teachers and a different understanding of digital literacy are common issues in many schools. Moreover, students' positive or negative perceptions of these platforms



are of great importance in influencing their acceptance, engagement, and consequently, their outcomes of learning. The research conducted so far regarding technology integration in science education has concentrated on the general information and communication technology (ICT) and not enough attention has been paid to the AI based technology platforms and the psychological and behavioural factors, including self-efficacy and academic engagement. The perception of AI learning tools in secondary school students' learning of chemistry in Nigeria was also lacking. This study thus focused on the lack of understanding for students' perception of the AI-based chemistry learning platform and the relationship between students' perception and self-efficacy in learning chemistry in secondary schools in Zaria.

Objectives of the Study

The objectives of the study were to:

1. examine students' perceptions of AI-based chemistry learning platforms in secondary schools in Zaria;
2. determine the extent to which students' perceptions of AI-based chemistry learning platforms predict their self-efficacy in learning chemistry; and
3. determine the extent to which students' perceptions of AI-based chemistry learning platforms predict their academic engagement in chemistry.

Research Questions

1. What are students' perceptions of AI-based chemistry learning platforms in secondary schools in Zaria?
2. To what extent do students' perceptions of AI-based chemistry learning platforms predict their self-efficacy in learning chemistry?
3. To what extent do students' perceptions of AI-based chemistry learning platforms predict their academic engagement in chemistry?

Null Hypotheses

The following null hypotheses were tested at the .05 level of significance:

- H0₁: Students' perceptions of AI-based chemistry learning platforms do not significantly predict their self-efficacy in learning chemistry.
- H0₂: Students' perceptions of AI-based chemistry learning platforms do not significantly predict their academic engagement in chemistry.
- H0₃: There is no significant relationship between students' perceptions of AI-based chemistry learning platforms and their combined self-efficacy and academic engagement in chemistry.

Theoretical Framework and Literature Review

Theoretical Framework

The study was based on three complementary viewpoints. Bandura's (1997) social cognitive theory states that self-efficacy is largely acquired through mastery experiences, vicarious experience, social persuasion and physiological states. AI-based platforms can provide mastery experiences if they provide learners with timely and specific feedback so they can achieve increasing challenges in chemistry.



The second one was the technology acceptance model (TAM) by Davis (1989) that argues that perceived usefulness and perceived ease of use are what influences the attitude of users towards a technology and their use of it. In this research, students' perception of the AI platform for chemistry was captured as such and together with the perception of access and trust. The third point of view is the cognitive theory of multimedia learning (Mayer, 2009), which argues that providing words and pictures, animation and interaction can minimize unnecessary cognitive load in the learning process and facilitate meaningful learning of abstract materials like chemical bonding and chemical reaction mechanisms.

The views combined give a simple conceptual roadmap. Theoretically, a positive attitude toward AI platforms should lead to increased usage of the platforms, repeated successful use should increase self-efficacy, and greater self-efficacy should increase academic engagement. In the present study, the association was tested between these variables, but not the proposed sequence. Engagement was considered as a multi-dimensional phenomenon, which includes behavioral, emotional, and cognitive dimensions (Ben-Eliyahu et al., 2018; Fredricks et al., 2004).

Literature Review

As reported in reviews of research on AI in science teaching and STEM education, positive results for learning, motivation, and feedback have been found; most of the studies conducted to date have been in high-resource settings, and most focus on achievement rather than affective variables (Almasri, 2024; Xu & Ouyang, 2022), and preliminary research indicates that ChatGPT can assist teachers with science education tasks (Cooper, 2023). Research targeted at chemistry has begun to fill this void. Jere and Mpeta (2025) interviewed 240 learners from South Africa after the introduction of ChatGPT into teaching and learning about intermolecular forces. They concluded that satisfaction led to both increased engagement and perceived conceptual understanding, while self-efficacy only led to an increase in perceived conceptual understanding, and that motivation only led to increased engagement. Naumann et al. (2025) concluded that real-world experience with AI tools in secondary chemistry enhanced students' self-efficacy and engagement, but the confidence in being able to produce their own AI-based solutions was still lower, and that students preferred to use a combination of teacher-led and AI-supported learning.

Other work points concur. Iyamuremye and Ndiokubwayo (2024) investigated the interest and mastery of atomic structure and chemical bonding by secondary school students using ChatGPT, and Kolil et al. (2020) looked into the impact of the virtual experimental platforms in chemistry laboratory education on experimental self-efficacy. Chiu et al. (2024) demonstrated the correlation between teacher support and students' learning motivation through an AI-based chatbot, while Jia and Tu (2024) created a model that connects the teachers' own self-efficacy, skills for using AI, students' learning motivation, and awareness of critical thinking. Measurement is now available in this area with Scales for AI self-efficacy (Wang & Chuang, 2024). This literature provides two observations. First, most of it is not from outside West Africa, and the results on the relationship between affective variables and engagement are not always consistent. Second, there remains a lack of understanding on the part of students in public secondary schools in Northern Nigeria with regards to the perception



of AI-based chemistry platforms or its connection to self-efficacy and engagement. The present study sought to tackle these gaps.

Methodology

The study was a mixed-research design involving descriptive survey and correlational type and, data were collected in one point of time so that the analysed relationships and association were only estimated as predictive relation and not causing. The population was the 10,966 Senior Secondary School students in the 31 public senior secondary schools of Zaria Education Zone, Kaduna State. The two schools (Government Secondary School Dakace, and Government Secondary School Gyallesu) were purposively selected since students at these schools had used AI tools for chemistry for at least one term. This resulted in a sample size of 103 (62 male and 41 female), which was larger than the 55 required to achieve a medium effect with $\alpha = 0.05$ and power = 0.80 (Cohen, 1988). AI chemistry learning platform was identified as a software that provides explanations, worked examples, or feedback based on a student's chemistry question by applying artificial intelligence. Most respondents used ChatGPT or Google Gemini via personal phones and school computers and for free plus with purchased mobile data from students or their families. Use was independent without researcher-designed use or instruction.

Three researchers developed four-point scales to measure perception of AI platforms (10 items), chemistry self-efficacy (10 items), and academic engagement (12 items) were used to collect data, followed by the platform screening section, length of time using the platform, and device. The instruments were validated by four experts and Cronbach's alpha values of 0.85, 0.87, and 0.89 were obtained in a pilot test involving 30 students from a school that was not included in the sample. On the spot, with permission granted by the principals, the researcher, along with two research assistants, administered the questionnaires in classrooms and collected all 103 copies of the questionnaires. The answers were eliminated if no AI platform was used. Means and standard deviations were calculated in SPSS for Research Question 1, simple linear regression was used for Research Questions 2 and 3 (H_{01} and H_{02}) and Pearson correlation was used for H_{03} at 0.05 level of significance.

Results

Of the 103 respondents, 71 (68.9%) rated ChatGPT, 22 (21.4%) rated Google Gemini, and 10 (9.7%) rated other platforms.

Research Question One:

Table 2: Students' Perceptions of AI-Based Chemistry Learning Platforms

S/N	Item	M	SD	Decision
1	They help me understand hard concepts.	2.82	0.61	Favourable
2	They give me quick feedback.	2.96	0.73	Favourable
3	They are easy to use.	3.18	0.59	Favourable
4	They make chemistry more interesting.	2.97	0.65	Favourable
5	They explain topics clearly to me.	3.05	0.65	Favourable
6	They let me practise at my own pace.	3.05	0.72	Favourable
7	They prepare me for WAEC and NECO.	3.00	0.61	Favourable
8	I can use them outside school hours.	3.20	0.57	Favourable
9	Data cost does not discourage my use.	2.74	0.64	Favourable
10	I trust the answers they provide.	3.07	0.61	Favourable
Overall		3.00	0.44	Favourable



The means for all ten items exceeded the criterion of 2.50; and the overall mean was 3.00 ($SD = 0.44$) as displayed in Table 2. The top-rated items were the use of outside school hours ($M = 3.20$) and ease of use ($M = 3.18$); the lowest rated items were data cost ($M = 2.74$) and help with hard concepts ($M = 2.82$). In all, 91 of the 103 students (88.3%) had individual mean scores of 2.50 or higher. Therefore, students formed positive attitudes towards AI-driven chemistry learning platforms.

Research Question 2 and Hypothesis H0₁

Table 3 presents the descriptive statistics for the three variables, and Table 4 presents the regression results for Hypotheses H0₁ and H0₂.

Table 3: Descriptive Statistics of the Study Variables

Variable	<i>M</i>	<i>SD</i>	Minimum	Maximum
Perception of AI platforms	3.00	0.44	2.00	3.90
Chemistry self-efficacy	2.87	0.48	1.80	3.70
Academic engagement	2.89	0.48	1.42	3.92

Table 4: Simple Linear Regression of Self-Efficacy and Academic Engagement on Perception

Outcome	<i>R</i>	<i>R</i> ²	Adj. <i>R</i> ²	<i>B</i>	β	<i>t</i>	<i>F</i>	<i>p</i>
Self-efficacy	0.52	0.270	0.266	0.56	0.52	6.05	36.66	< 0.001
Engagement	0.52	0.270	0.266	0.57	0.52	6.12	37.43	< 0.001

Note. $df = 1, 101$ for all models.

According to Table 3, students' scores were higher than the mid-point, 2.50, for all factors of the perception, self-efficacy and engagement. Table 4 shows that perception significantly predicted self-efficacy, $F(1, 101) = 36.66$, $p < 0.001$, accounting for 26.6% of its variance ($R^2 = .270$). Perception was linked positively with self-efficacy ($\beta = 0.52$, $t = 6.05$) and the increase in self-efficacy was 0.56 per unit of change in perception. The p -value was < 0.05 so that H0₁ was rejected. Students' perceptions of AI-based chemistry learning platforms had a positive association with their chemistry learning self-efficacy, as measured by the students' self-efficacy scale. The relationship between students' perceptions of AI-based chemistry learning platforms and their chemistry learning self-efficacy was positive and significant, as indicated by the self-efficacy scale.

Research Question 3 and Hypothesis H0₂

As Table 4 also shows, perception significantly predicted academic engagement, $F(1, 101) = 37.43$, $p < 0.001$, explaining 27.0% of the variance ($R^2 = .270$). Perception and engagement were positively correlated with each other and were related at the 0.57-unit level ($\beta = 0.52$, $t = 6.12$). It was then rejected that H0₂ should be rejected. There was a strong positive association between students' perceptions of AI-based chemistry learning platforms and academic engagement in chemistry, with this being a significant predictor.



Hypothesis H0₃

Table 5 presents the Pearson correlation coefficients among the variables.

Table 5: Pearson Correlation Matrix of Perception, Self-Efficacy, and Academic Engagement

Variable	1	2	3
1. Perception of AI platforms	—		
2. Chemistry self-efficacy	0.52*	—	
3. Academic engagement	0.52*	0.61*	—

Note. $p^* < 0.001$ (two-tailed).

The combined self-efficacy and engagement score was correlated with perception and was positive and significant, $r(101) = 0.58$, $p < 0.001$, and explained 33.4% of the variance in the combined score ($R^2 = 0.33$). According to Cohen's (1988) benchmarks, all of the relationships presented in Table 5 are large. The overall self-efficacy and academic engagement of students in chemistry learning showed a significant positive correlation with their perceptions of AI-based chemistry learning platforms, which was the reason it was rejected: $H0_3$ was therefore rejected: there was a significant positive relationship between students' perceptions of AI-based chemistry learning platforms and their combined self-efficacy and academic engagement in chemistry.

Discussion of Findings

One of the conclusions drawn was students' positive attitudes towards learning platforms based on AI in the field of chemistry. One of the conclusions obtained was that students had positive attitudes towards learning platforms based on AI in the field of Chemistry. The ease of use and the opportunity for study outside school hours were rated highest reflecting the emphasis on ease of use and usefulness as outlined in the technology acceptance model (TAM) (Davis, 1989). This result was consistent with Naumann et al. (2025), who reported positive attitudes of secondary school students towards the use of AI tools in chemistry, but with caution. The lower scores for data cost and support for challenging concepts suggest that access cost is a legitimate problem, and that students are not seeing the platforms as a suitable substitute for teacher explanations, which corresponds with the preference for blended approaches in the same study.

The second finding was that there was a strong linkage between the perceptions and self-efficacy. If these interactions with the AI tools are successful, then this may boost efficacy beliefs, as students could receive timely feedback and have the ability to verify their work, leading to greater confidence in using the tool. The result is consistent with the findings of Naumann et al. (2025) who found that practical experience with AI tools resulted in an increase in self-efficacy and with the model proposed by Jia and Tu (2024). However, the data were cross-sectional and it was not possible to determine the direction of the association.

The third finding was that perceptions also had significant predictive power for academic engagement. Attentive, interested and hard work in Chemistry were reported by students who saw the platforms as favourable. This is consistent with the findings of Jere and Mpeta (2025) who found that satisfaction leads to engagement, and Chiu et al. (2024) who found that supportive conditions lead to students' motivation to learn when interacting with an AI based



chatbot. Within the framework of Fredricks et al., (2004), interactive and responsive platforms might be associated with either behaviour participation or emotional interest and/or cognitive effort.

The fourth finding was that combined score for self-efficacy and engagement was significantly positively related to perceptions. This was a correlational design so these findings indicate association and prediction, but not causation (Zimmerman, 2008). The platforms may have been perceived more positively by students who were already confident and engaged, while other factors (not measured here) including prior achievement and/or school resources and/or prior use of AI might have played a role in all three variables.

Conclusion

The study found that the students' perceptions to the AI learning platforms in Zaria secondary schools were favourable, as well as the positive relationship between perceived attitude and self-efficacy and academic engagement in chemistry learning. Data cost and the need for teacher explanation were the main reservations.

Recommendations

Based on the findings, the following recommendations were made:

1. Chemistry teachers should integrate guided use of AI-based platforms into lessons, treating them as a supplement to, not a replacement for, teacher explanation.
2. School administrators and education authorities in Kaduna State should improve internet access and provide offline or low-data options so that cost does not limit use.
3. Teachers should be trained in AI literacy and in verifying AI-generated chemistry content.



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