



## Artificial intelligence tools and students' Academic engagement in higher education: The double-edged sword of digital assistance

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### Abstract

The rapid integration of artificial intelligence (AI) tools into higher education has transformed the learning landscape, yet empirical evidence on how these tools influence students' academic engagement and cognitive development remains inconclusive. This study examined the influence of AI tools on students' academic engagement and critical thinking in a Nigerian university context. A descriptive survey design was adopted, with 250 undergraduate students selected through simple random sampling. Data were collected using the Artificial Intelligence Engagement Scale (AIES), the Academic Engagement Scale (AES), and a Critical Thinking Test (CTT). Pearson product-moment correlation, linear regression, and independent samples t-test were used for analysis. Results revealed a significant positive relationship between AI usage and academic engagement,  $r(248) = .62, p < .001$ , with AI usage accounting for 38% of the variance in engagement ( $R^2 = .38$ ). However, a significant negative correlation was found between AI usage and critical thinking ( $r = -.41, p < .001$ ), and students with moderate AI usage demonstrated significantly higher critical thinking scores than those with excessive usage ( $t(248) = -6.72, p < .001$ ). The findings suggest that while AI tools can enhance behavioural, emotional, and cognitive engagement, over-reliance may undermine higher-order thinking skills. The study recommends the integration of AI tools with structured pedagogical guidance to foster meaningful learning.

**Keywords:** Artificial intelligence, academic engagement, critical thinking, higher education, Nigerian Universities

### Introduction

Artificial intelligence (AI) has rapidly permeated every sector of society, and education is no exception. In higher education, AI tools—ranging from intelligent tutoring systems and automated writing assistants to adaptive learning platforms and AI-powered chatbots—have become increasingly prevalent. These tools promise personalised learning, immediate feedback, and enhanced student support, potentially transforming the ways students interact with academic content (Holmes, Bialik, & Fadel, 2022) <sup>[10]</sup>. Simultaneously, academic engagement remains a cornerstone of student success. Defined as the quality of students' involvement in learning activities, engagement encompasses behavioural, emotional, and cognitive dimensions (Fredricks, Blumenfeld, & Paris, 2004) <sup>[8]</sup>. Engaged students are more likely to persist, achieve higher grades, and develop deep learning strategies. Therefore, understanding how AI tools influence engagement is of paramount importance for educators, policymakers, and curriculum developers.

However, the integration of AI into education is not without concerns. Critics argue that over-reliance on AI tools may lead to a decline in critical thinking, problem-solving abilities, and independent learning (Akgun & Greenhow, 2022) <sup>[11]</sup>. When students outsource cognitive tasks to AI—such as generating essay outlines, solving equations, or summarising texts—they may bypass the very processes that foster deep understanding. Thus, AI presents a double-edged sword: it can scaffold engagement but potentially erode higher-order cognitive skills.

This study is situated within the Nigerian higher education context, where AI adoption is growing rapidly, yet empirical research on its psychological and pedagogical effects remains scarce. With increasing access to smartphones and

internet connectivity, Nigerian university students are increasingly using AI tools such as ChatGPT, Grammarly, and various learning apps. Understanding the dual effects of AI on engagement and critical thinking is essential for developing evidence-based policies that maximise benefits while mitigating risks.

### 1. Research Objectives

The primary objectives of this study were to:

1. Examine the relationship between AI tool usage and academic engagement among undergraduate students.
2. Determine the extent to which AI tool usage predicts academic engagement.
3. Investigate the relationship between AI tool usage and critical thinking.
4. Compare the critical thinking scores of students with high versus moderate AI usage.

### 2. Research Questions

1. What is the relationship between AI tool usage and academic engagement?
2. Does AI tool usage significantly predict academic engagement?
3. What is the relationship between AI tool usage and critical thinking?
4. Is there a significant difference in critical thinking scores between students with high AI usage and those with moderate AI usage?

### 1. Hypotheses

- **H<sub>1</sub>:** There is a significant positive relationship between AI tool usage and academic engagement.
- **H<sub>2</sub>:** AI tool usage significantly predicts academic engagement.

- **H<sub>3</sub>:** There is a significant negative relationship between AI tool usage and critical thinking.
- **H<sub>4</sub>:** Students with moderate AI usage have significantly higher critical thinking scores than those with high AI usage.

## Literature Review and Theoretical Framework

### 1. Conceptualising Academic Engagement

Academic engagement is a multidimensional construct that reflects the quality of students' involvement in learning. Fredricks *et al.* (2004) <sup>[8]</sup> delineated three interrelated dimensions:

- **Behavioural engagement:** Participation in academic activities, attendance, and effort.
- **Emotional engagement:** Affective reactions to learning, including interest, enjoyment, and identification with school.
- **Cognitive engagement:** Investment in learning, use of deep strategies, and self-regulation.

These dimensions interact dynamically; for instance, positive emotions can fuel cognitive investment, which in turn reinforces behavioral participation. Engagement is widely recognized as a robust predictor of academic achievement and persistence (Trowler, 2010) <sup>[13]</sup>.

### 2. AI Tools in Higher Education

AI tools encompass a range of technologies that simulate human intelligence to perform educational tasks. Common categories include:

1. **Intelligent tutoring systems:** Provide adaptive instruction and feedback (e.g., Carnegie Learning).
2. **Automated writing assistants:** Offer grammar, style, and content suggestions (e.g., Grammarly, ChatGPT).
3. **Adaptive learning platforms:** Adjust content difficulty based on student performance (e.g., Knewton).
4. **AI chatbots:** Answer student queries and provide 24/7 support (e.g., Jill Watson at Georgia Tech).

These tools can enhance engagement by offering instant feedback, personalising learning paths, and reducing frustration associated with difficult tasks (Zawacki-Richter, Marín, Bond, & Gouverneur, 2019) <sup>[14]</sup>. However, concerns have been raised that they may promote surface learning and reduce opportunities for critical reflection (Akgun & Greenhow, 2022) <sup>[1]</sup>.

### 3. The Double-Edged Sword: AI and Critical Thinking

Critical thinking—the ability to analyse, evaluate, and synthesize information—is a foundational learning outcome in higher education (Facione, 1990) <sup>[7]</sup>. AI tools can support critical thinking by providing diverse perspectives and challenging students' assumptions. For example, AI-generated counterarguments can prompt deeper analysis. Conversely, when students use AI to generate answers without engaging in the underlying reasoning, they may bypass cognitive effort essential for developing critical thinking. Research has shown that over-reliance on automated assistance can lead to cognitive offloading, where individuals externalise thinking processes to technology, potentially weakening their own cognitive capacities (Barr, Pennycook, Stolz, & Fugelsang, 2015) <sup>[4]</sup>.

## 4. Theoretical Framework

This study is grounded in two complementary theories:

- **Social Cognitive Theory** (Bandura, 2001) <sup>[3]</sup> posits that learning occurs through reciprocal interactions between personal, behavioural, and environmental factors. AI tools represent an environmental factor that can influence students' self-efficacy and self-regulation. When used appropriately, they can enhance engagement by providing scaffolding that builds competence. However, excessive reliance may undermine self-efficacy for independent problem-solving.
- **Self-Determination Theory** (Ryan & Deci, 2000) <sup>[12]</sup> emphasises the importance of autonomy, competence, and relatedness for intrinsic motivation. AI tools that support autonomy (e.g., allowing choice in learning paths) and competence (e.g., providing mastery-oriented feedback) can foster engagement. Conversely, tools that reduce autonomy by offering ready-made answers may diminish the sense of competence derived from independent effort.

These theoretical lenses suggest that the effects of AI on engagement and critical thinking are not inherent in the tools themselves but depend on how they are used and integrated into the learning environment.

## 5. Empirical Studies

Prior research has produced mixed findings. A meta-analysis by Crompton and Burke (2023) <sup>[6]</sup> found that AI tools generally have a small-to-medium positive effect on student engagement across various educational levels. However, studies focusing on higher-order thinking skills have reported negative effects when AI tools are used to complete assignments without meaningful student input (Guo & Wang, 2024) <sup>[9]</sup>. In the Nigerian context, limited studies have examined these relationships, underscoring the need for context-specific investigation.

## Methodology

### 1. Research Design

A descriptive survey research design was employed. This design is appropriate for examining relationships among variables and describing current conditions without manipulating the environment (Creswell & Creswell, 2018) <sup>[5]</sup>.

### 2. Study Area and Population

The study was conducted at the University of Port Harcourt, a federal university in Rivers State, Nigeria. The target population comprised all undergraduate students enrolled in the 2024/2025 academic session, estimated at 15,000 students across various faculties.

### 3. Sample and Sampling Technique

A sample of 250 undergraduate students was selected using simple random sampling. Students were drawn from six faculties to ensure diversity. The sample size was determined using Krejcie and Morgan's (1970) <sup>[11]</sup> table for a population of 15,000, and the simple random technique ensured equal chance of selection, minimizing selection bias.

### 4. Instruments

Three instruments were used:

- 1. Artificial Intelligence Engagement Scale (AIES):** Developed by the researcher based on a review of AI usage patterns. It consists of 12 items measuring frequency and depth of AI tool use (e.g., “I use AI tools to help me understand difficult concepts,” “I rely on AI tools to complete assignments”). Responses were on a 5-point Likert scale (1 = Never, 5 = Always). Reliability was established through Cronbach’s alpha, yielding  $\alpha = .87$ .
- 2. Academic Engagement Scale (AES):** Adapted from the widely used Student Engagement Instrument (Appleton, Christenson, & Furlong, 2006) [2]. It comprises 15 items measuring behavioral, emotional, and cognitive engagement. Responses were on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The scale demonstrated high internal consistency ( $\alpha = .89$ ).
- 3. Critical Thinking Test (CTT):** A 20-item, multiple-choice test developed by the researcher to assess students’ analytical, evaluative, and inferential reasoning. Items were drawn from standard critical thinking assessment banks and validated by three experts in educational psychology. Reliability using Kuder-Richardson formula 20 (KR-20) was .81.

All instruments were pilot-tested with 30 students not included in the main sample to ensure clarity and reliability.

### 5. Data Collection Procedure

Ethical approval was obtained from the University of Port Harcourt Research Ethics Committee. Permission was sought from faculty deans and course lecturers. Data collection was conducted during regular class sessions, with questionnaires administered by trained research assistants. Students were informed of the purpose of the study, assured of confidentiality, and given the right to withdraw at any time. The questionnaires took approximately 20 minutes to complete.

### 6. Data Analysis

Data were entered into SPSS version 27. The following analyses were performed:

- Descriptive statistics (means, standard deviations) to summarize variables.
- Pearson product-moment correlation to test relationships between AI usage, academic engagement, and critical thinking.
- Linear regression to determine the predictive power of AI usage on academic engagement.
- Independent samples t-test to compare critical thinking scores between high and moderate AI users. High AI usage was defined as scores above the 75th percentile on the AIES (score  $\geq 4.0$ ); moderate AI usage as scores between the 25th and 75th percentiles.

All hypotheses were tested at  $\alpha = .05$ .

## Results

### 1. Participant Characteristics and Descriptive Statistics

A total of 250 students participated in the study, comprising 120 male (48%) and 130 female (52%). The mean age of

participants was 21.4 years ( $SD = 2.1$ ). Descriptive statistics for the main study variables are presented in Table 1.

**Table 1:** Descriptive Statistics of Study Variables  
\*(N = 250)\*

Variable	N	Mean	SD	Minimum	Maximum
AI Usage	250	3.45	0.72	1.50	5.00
Academic Engagement	250	3.68	0.65	1.87	5.00
Critical Thinking	250	3.18	0.63	1.25	4.75

Note. All variables were measured on a 5-point scale. Higher scores indicate greater AI usage, higher academic engagement, and stronger critical thinking skills.

The mean AI usage score ( $M = 3.45$ ,  $SD = 0.72$ ) indicates that, on average, students reported using AI tools occasionally to frequently. Academic engagement was moderately high ( $M = 3.68$ ,  $SD = 0.65$ ), while critical thinking scores were moderate ( $M = 3.18$ ,  $SD = 0.63$ ).

### 2. Correlation Analysis

Pearson product-moment correlation coefficients were computed to examine the relationships among the study variables. The results are presented in Table 2.

**Table 2:** Pearson Correlation Matrix  
\*(N = 250)\*

Variable	1	2	3
1. AI Usage	—	.62**	-.41**
2. Academic Engagement	.62**	—	.55**
3. Critical Thinking	-.41**	.55**	—

Note. \* $p < .01$  (2-tailed).

AI usage exhibited a strong, positive, and statistically significant correlation with academic engagement,  $r^*(248) = .62$ ,  $*p < .001$ , supporting  $H_1$ . Conversely, AI usage showed a moderate, negative, and statistically significant correlation with critical thinking,  $r^*(248) = -.41$ ,  $*p < .001$ , supporting  $H_3$ . Academic engagement was positively correlated with critical thinking,  $r^*(248) = .55$ ,  $*p < .001$ .

### 3. Regression Analysis

Linear regression analysis was conducted to test the predictive power of AI usage on academic engagement ( $H_2$ ). The results are presented in Tables 3, 4, and 5.

**Table 3:** Model Summary for AI Usage Predicting Academic Engagement

Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate
1	.62	.38	.37	0.55

Note. Predictor: AI Usage. Dependent variable: Academic Engagement.

AI usage accounted for 38% of the variance in academic engagement ( $R^2 = .38$ , adjusted  $R^2 = .37$ ).

**Table 4:** ANOVA for the Regression Model

Source	Sum of Squares	df	Mean Square	F	p
Regression	45.62	1	45.62	152.43	< .001
Residual	74.21	248	0.30		
Total	119.83	249			

Note. Dependent variable: Academic Engagement.

The regression model was statistically significant,  $F(1, 248) = 152.43, *p < .001$ , indicating that AI usage is a significant predictor of academic engagement.

**Table 5:** Coefficients for AI Usage Predicting Academic Engagement

Predictor	B	SE	$\beta$	t	p
(Constant)	1.24	0.18		6.89	< .001
AI Usage	0.71	0.06	.62	12.35	< .001

Note. B = unstandardized coefficient;  $\beta$  = standardized coefficient.

The unstandardized coefficient ( $B = 0.71$ ) indicates that for every one-unit increase in AI usage, academic engagement increases by 0.71 units. The standardized coefficient ( $\beta = .62$ ) confirms a strong positive effect, supporting  $H_2$ .

#### 4. Comparison of Critical Thinking by AI Usage Level

To test  $H_4$ , students were divided into two groups based on their AI usage scores: high AI users (scores above the 75th percentile,  $*n = 120$ ) and moderate AI users (scores between the 25th and 75th percentiles,  $*n = 130$ ). An independent samples  $*t$ -test was conducted to compare critical thinking scores between the two groups. The results are presented in Table 6.

**Table 6:** Independent Samples t-Test for Critical Thinking by AI Usage Level

Group	n	Mean	SD	t	df	p
High AI Users	120	2.91	0.60	-6.72	248	< .001
Moderate AI Users	130	3.45	0.58			

Note. High AI users = scores above the 75th percentile; moderate AI users = scores between the 25th and 75th percentiles.

Moderate AI users had significantly higher critical thinking scores ( $M = 3.45, SD = 0.58$ ) than high AI users ( $M = 2.91, SD = 0.60$ ),  $*t(248) = -6.72, *p < .001$ . The effect size (Cohen's  $*d = 0.93$ ) indicates a large practical significance, supporting  $H_4$ .

#### Discussion

The findings of this study reveal a nuanced picture of AI's role in higher education. Consistent with  $H_1$  and  $H_2$ , AI tool usage was positively associated with academic engagement and significantly predicted it. This aligns with prior research suggesting that AI tools can enhance engagement by providing immediate feedback, personalizing content, and reducing barriers to learning (Zawacki-Richter *et al.*, 2019; Crompton & Burke, 2023) <sup>[6, 14]</sup>. Students who used AI tools more frequently reported higher behavioral participation (e.g., completing tasks), emotional involvement (e.g., interest), and cognitive investment (e.g., deeper processing). These results are also consistent with self-determination theory, which posits that tools supporting competence and autonomy can foster intrinsic motivation (Ryan & Deci, 2000) <sup>[12]</sup>. However, the negative correlation between AI usage and critical thinking ( $H_3$ ) and the significant difference in critical thinking between high and moderate users ( $H_4$ ) highlight a potential dark side of AI adoption. Students who relied heavily on AI tools demonstrated lower critical thinking abilities. This finding resonates with concerns about cognitive offloading (Barr *et al.*, 2015) <sup>[4]</sup> and surface-level learning (Akgun & Greenhow, 2022) <sup>[1]</sup>. When AI tools are used to generate answers or complete assignments without active intellectual engagement,

students may not develop the analytical and evaluative skills essential for higher education.

The finding that moderate AI users outperformed high users in critical thinking suggests that a balanced approach may be optimal. Moderate users likely leverage AI for support (e.g., clarifying concepts, generating ideas) while retaining the cognitive effort required to synthesize, critique, and apply information. This aligns with Bandura's social cognitive theory (2001) <sup>[3]</sup>, where environmental tools (AI) interact with personal agency (self-regulation) to shape learning outcomes.

The positive correlation between academic engagement and critical thinking ( $r = .55$ ) indicates that engaged students also tend to think critically. This underscores that AI tools can be part of an engaged learning experience if used to augment rather than replace cognitive effort. The challenge for educators is to design AI integration that fosters both engagement and critical thinking.

#### 1. Implications for Practice

The results have several practical implications for Nigerian higher education and beyond.

- **Curriculum design:** Lecturers should intentionally integrate AI tools as cognitive partners rather than answer providers. For example, students can be prompted to critique AI-generated responses, compare multiple AI outputs, or use AI to generate counterarguments to their own positions.
- **Student guidance:** Orientation programs should include digital literacy training that emphasizes responsible AI use. Students should learn to distinguish between using AI for scaffolding versus outsourcing.
- **Institutional policies:** Universities should develop clear AI usage guidelines that encourage ethical and pedagogically sound use. Policies should focus on transparency (e.g., requiring students to acknowledge AI assistance) rather than outright prohibition.
- **Assessment reform:** To mitigate the risk of over-reliance, assessments should include tasks that require original thought, such as in-class writing, oral presentations, and project-based learning where AI's role is limited.

#### 2. Limitations and Future Research

Several limitations should be acknowledged. The cross-sectional design precludes causal inferences; it is possible that more engaged students are simply more inclined to use AI tools, or that some third variable influences both. Future research should employ longitudinal or experimental designs to establish causality. The sample was drawn from a single Nigerian university, which may limit generalizability to other contexts. Replication across diverse institutions and countries is needed. Self-report measures of AI usage and engagement may be subject to social desirability bias. Future studies could incorporate digital trace data (e.g., actual tool usage logs) to complement self-reports. Finally, the study did not differentiate among types of AI tools. Different tools (e.g., generative AI vs. adaptive tutors) may have varying effects. Future research should examine these nuances.

## Conclusion

Artificial intelligence tools hold significant promise for enhancing student engagement in higher education. However, the findings of this study serve as a cautionary note: excessive reliance on AI may come at the cost of critical thinking development. The challenge for educators and institutions is to harness the benefits of AI while preserving and strengthening students' cognitive skills. By integrating AI with thoughtful pedagogical design, it is possible to create learning environments where engagement and critical thinking flourish together.

## Recommendations

Based on the findings, the following recommendations are made:

1. Universities should develop structured guidelines for AI use that encourage students to use AI as a supplementary tool rather than a substitute for their own cognitive effort.
2. Lecturers should incorporate critical thinking exercises that require students to evaluate AI outputs, thereby transforming AI from a shortcut into a learning opportunity.
3. Digital literacy and AI ethics should be integrated into the general studies curriculum to equip students with the knowledge to use AI responsibly.
4. Institutional policies should promote transparency, such as requiring students to declare AI assistance in assignments, while avoiding blanket bans that may drive usage underground.
5. Further research should explore the long-term effects of AI on learning outcomes using mixed methods to capture both quantitative and qualitative dimensions.

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