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Hooked on AI, or Hungry for Thinking? Interrogating the Interplay Between AI Addiction, Critical Thinking, and Mathematics Achievement in Senior Secondary Schools

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Abstract
Mathematics remains a foundational subject in Nigerian senior secondary education, essential for scientific, technological, and economic advancement. However, students' achievement in the subject remains poor, particularly amid growing reliance on artificial intelligence (AI) tools for learning. This study investigated AI addiction and critical thinking ability as determinants of the mathematics achievement of senior secondary school two (SSS2) students in the Ijebu North Local Government Area, Ogun State, Nigeria. A descriptive survey design was adopted. The population comprised all SSS2 students in the area, from which a sample of 150 was drawn using purposive and simple random sampling techniques. Data were collected with three validated instruments: Mathematics Achievement Test (MAT, r = 0.69), Students' Artificial Intelligence Addiction Rating Scale (SAARS, r = 0.73), and Critical Thinking Evaluation Scale (CTES, r = 0.76). Pearson product-moment correlation and regression analyses were employed for data analysis. Results showed that AI addiction significantly predicted mathematics achievement, accounting for 10.1% of the variance. Critical thinking ability was a stronger predictor, explaining 14.9% of the variance. Positive correlations were observed among AI addiction, critical thinking, and mathematics achievement, with critical thinking demonstrating the strongest relationship. The study concludes that while AI tools can support mathematics learning, cultivating critical thinking skills is vital for enhanced achievement. It was recommended, among other things, that teachers promote responsible AI use and integrate instructional strategies that develop students' critical thinking in mathematics classrooms.

Keywords: Artificial Intelligence addiction, Critical thinking, Academic achievement, Mathemtics, Senior secondary schools

INTRODUCTION

Mathematics is a core subject in secondary education and a fundamental requirement for scientific advancement, technological innovation, and national economic development. It plays a critical role in developing learners' logical reasoning, analytical thinking, and problem-solving abilities, which are essential for higher education and workforce readiness (Cresswell & Speelman, 2020). Mathematics also serves as a prerequisite for admission into science, technology, engineering, and mathematics (STEM)-related disciplines in higher institutions of learning. Von Davier and Kennedy (2025) argued that mathematics is a

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pivotal subject because it is a core building block for successful learning in future.

Despite its importance, students' performance in mathematics has remained persistently unstable, as evidenced by reports from national examination bodies such as the West African Examinations Council (WAEC). In its annual reports on the performance of Nigerian students from 2021 to 2025, WAEC reported that in 2021, 81.7% of students who sat for the Senior Secondary Certificate Examination (SSCE) obtained credit passes in Mathematics and English (Daily Trust, 2021). In 2022, 76.36% passed both English and Mathematics at the credit level, a sharp decrease from 2021 performance (Ogwo, 2022). However, in 2023, performance in both subjects rose to 79.81%, an increase of 3.45% from the previous year (Ogwo, 2023). In contrast, it declined to 72.12% in 2024 (Babalola, 2024). The 2025 report was shocking, as the examination body initially reported that only 38.32% of students passed English and Mathematics at the credit level. Although WAEC announced a review of the performance due to errors in grading the serialised questions, the new performance was set at 69.96%, another decline of 2.16% from the 2024 performance (Wahab & Osayande, 2025). These performances indicate that between 20% and 38% of students will not be able to secure admission to institutions of higher learning to meet the country's higher-level human resource needs, due to their inability to pass mathematics and English at the credit level.

Scholars have attributed unsatisfactory performance to a combination of factors, including ineffective instructional strategies, negative student attitudes, inadequate learning resources, and deficiencies in higher-order cognitive skills, particularly critical thinking (Ajayi & Afolabi, 2020; Olatoye & Aderogba, 2019). Lawal (2025) also identified causes of poor performance in SSCE as poor quality of education in Nigerian public schools, lack of infrastructure and qualified teachers, ineffective teaching methods, overburdening home activities, poor parental involvement, government's refusal to adequately invest and reform education, as well as poor foundation at the primary school level. Policy changes, Artificial Intelligence addiction, inadequate funding for teacher training, and a lack of oversight are additional factors identified.

Meanwhile, rapid advances in digital technologies, especially artificial intelligence (AI), are significantly transforming teaching and learning, including in mathematics education. Artificial intelligence refers to computer systems designed to simulate human intelligence by performing tasks such as learning, reasoning, problem-solving, and decision-making (Russell & Norvig, 2021). In mathematics education, AI-driven tools such as intelligent tutoring systems, virtual assistants, and automated problem-solving applications (e.g., Photomath, GeoGebra, Mathway, and Microsoft Math Solver) provide instant solutions, personalised feedback, and adaptive learning support. Empirical studies suggest that when used appropriately, these tools can enhance student engagement and improve academic performance by addressing individual learning needs (Bennani et al., 2022; Kumar, 2022). The increasing availability of smartphones and internet connectivity has further encouraged the widespread adoption of AI tools among senior secondary school students in Nigeria.

RELATED WORKS

The integration of Artificial Intelligence (AI) in education has transformed instructional delivery, offering both opportunities and challenges for students' development (Vieriu & Petrea, 2025). For instance, AI can support individualised learning, improve academic outcomes, and enhance students' academic engagement when used ethically and responsibly. Ubabuike and Nweke (2024) reported improved student learning, retention, and critical thinking skills when AI was incorporated into the learning process. It also helped teachers conduct seamless assessments of students' learning, enabling the timely identification of learning gaps. However, challenges such as over-reliance on AI, also referred to as AI addiction, involve compulsive dependence on AI-driven systems to complete learning activities, often at the expense of independent reasoning and meaningful cognitive engagement (Marzuki et al., 2023). This syndrome can diminish critical thinking skills, increase data privacy risks, and lead to academic dishonesty.

The study of Zhang et al. (2024) found that AI addiction significantly reduced students' academic performance, critical thinking, and writing skills. It also led to information overload, academic dishonesty, plagiarism, cognitive dependency, diminished long-term retention, and the fostering of indolence among learners. Also, Olarewaju et al. (2025) investigated the impact of AI tools on students' initiative and academic laziness among education undergraduates at the University of Ilorin, Nigeria. Using 372 respondents for the mixed-methods study, it was reported 49.1% of the respondents usually used AI tools, while 64.5% confessed to overrelying on AI tools in their academic work. The study further found that AI addiction is capable of reducing students' critical thinking skills. It was concluded that although AI can improve access to learning materials and support successful learning, its over-reliance can also undermine students' problem-solving skills.

In addition, Ubabuike and Nweke (2024) examined the impact of AI-driven tools and systems on students' academic achievement in public senior secondary schools across Anambra State, Nigeria. The study, which used a qualitative research design to collect data from 820 respondents, revealed that the deployment and use of AI-driven tools are at an infant stage in secondary schools in the state due to inadequate funding, poor digital infrastructure, limited teacher cooperation, and insufficient training. This situation is likely the same across all states in Nigeria. Nevertheless, their use, when available, significantly improved students' learning, critical thinking, and problem-solving skills. The teachers reported that AI-enabled learning platforms helped personalise students' learning, assessments, and the identification of learning gaps. Vieriu and Petrea's (2025) investigation of the impact of AI technologies on students' learning, focusing on their perceptions and the challenges associated with AI adoption, revealed that AI tools led to personalised learning, significantly improved academic achievement, and increased engagement. However, over-reliance on AI tools diminished critical thinking, constituted data privacy risks, and fuelled academic dishonesty. While the study underscores the need for an AI integration framework that maximises benefits and reduces risks, it concluded that the successful use of AI tools requires addressing problems related to accuracy, cognitive disengagement, and ethical implications.

The study of Revesai (2025) investigated the effects of AI addiction among university students in Zimbabwe on their academic performance. The mixed-methods research design indicated that 32.7% of participants demonstrated that they were addicted to AI usage. Statistical analyses revealed a significant negative correlation between addiction severity and academic metric, with heavily addicted students showing a mean GPA deficit of 0.41 points compared to non-addicted peers. This means that AI addiction led to decreased academic performance due to their addiction, described as over-reliance of students on AI tools by the authors. While the qualitative findings revealed irregular use of AI among students, the regression analysis identified three issues associated with its addiction. These include reductions in critical thinking, in the development of writing skills, and in the acquisition of content. The study of Tian and Zhang (2025), which also examined how university students' AI dependence influences their critical thinking, exploring cognitive fatigue as a mediating mechanism and information literacy as a moderating factor, revealed that AI dependence reduced critical thinking, with cognitive fatigue partially mediating this relationship. The study also reported that information literacy reduced the negative impact of AI dependence on critical thinking and improved cognitive fatigue when AI reliance was high. This suggests the need for AI literacy among the learners.

In mathematics learning, where conceptual understanding and logical reasoning are essential, excessive reliance on AI-generated solutions may encourage surface learning, rote memorisation, and procedural imitation rather than deep understanding. Students may prioritise obtaining quick answers over engaging with problem-solving processes, which may ultimately undermine their mathematical reasoning and achievement (Benvenuti et al., 2023). Studies have shown that generative AI, which has uses across all facets of human life, became a global tool in late 2022, making research on its addiction at the secondary school level still at an inchoate

stage. Many studies on the influence of AI addiction on students' academic achievement were conducted at post-secondary school levels, with many of them using social media addiction instead of AI addiction (Rahman et al., 2025; Salari et al., 2025). Thus, this study investigated the influence of AI addiction on students' academic achievement in secondary school mathematics.

Meanwhile, critical thinking is widely recognised as a key determinant of success in mathematics education. It involves the ability to analyse problems, evaluate multiple solution strategies, apply logical reasoning, and make informed judgments (Facione, 2015). Jesto et al. (2025) and Roath et al. (2025) describe critical thinking as a deliberate effort to interpret, analyse, evaluate, and make inferences. It entails an intentional combination of cognitive skills, with a willingness to apply them. Critical thinking is a self-regulated and deliberate judgement that encompasses the ability to interpret, analyse, evaluate, and infer. While observing that learners can leverage critical thinking to solve problems diligently and cautiously, Roath et al. (2025) argued that it is also pivotal to mathematics learning, as problem-solving in mathematics requires logical and analytical thinking, which are sine qua non for critical thinking.

At the senior secondary school level, mathematics learning increasingly demands abstract reasoning, interpretation of complex relationships, and the solution of non-routine problems, all of which rely heavily on critical thinking skills (Dolapcioglu & Doganay, 2022). Empirical evidence consistently indicates that students with well-developed critical thinking and reasoning abilities perform significantly better in mathematics than those with weaker critical thinking skills. For instance, Duru and Obasi (2023) investigated the correlation between critical thinking ability and academic achievement in mathematics among 200 senior secondary schools 2 in Orlu Education Zone in Imo State, Nigeria. The results revealed a low, but significant, positive correlation between critical thinking ability and academic achievement in mathematics. However, there was no significant relationship between critical thinking ability and achievement among high achievers, whereas there was a significant, although negligible, positive relationship among low achievers.

Equally, Jesto et al. (2025) examined the link between critical thinking skills and mathematics performance among teacher education programmes. The correlational aspect of the study reported a significant relationship between critical thinking and mathematics achievement. The regression analysis further indicated that critical thinking significantly influenced mathematics performance. The research concluded that the pathway to effective mathematics learning is critical thinking. Also, Roath et al. (2025) examined the influence of critical thinking skills on learners' problem-solving in mathematics, based on the Trends in International Mathematics and Science Study (TIMSS) framework. The correlational survey study showed a significant positive relationship between students' critical thinking skills and problem-solving in mathematics. Further findings revealed that critical thinking skills significantly influenced learners' problem-solving ability.

Within this context, artificial intelligence addiction and critical thinking are conceptualised as interrelated determinants of students' performance in mathematics. This is because excessive use of AI tools may limit students' opportunities to engage actively in reasoning, reflection, and problem-solving, thereby weakening critical thinking skills (Zhang et al., 2024). Conversely, students with strong critical thinking abilities may be better equipped to use AI tools as supportive learning resources rather than substitutes for thinking. This interaction suggests that artificial intelligence addiction and critical thinking may exert both independent and combined effects on mathematics performance. Also, despite the increasing integration of artificial intelligence into secondary education, empirical studies that simultaneously examine AI addiction and critical thinking as predictors of mathematics performance remain limited, particularly in the Nigerian context. Most existing studies have focused on general forms of technology addiction, such as internet, social media or smartphone overuse, with insufficient attention given to AI-specific learning behaviours and their cognitive implications (Ogunyemi & Adebayo, 2021). Moreover, studies that

investigated how AI addiction and critical thinking jointly shape academic outcomes in mathematics at the senior secondary school level are scarce in the literature.

Guided by this conceptual perspective, the present study examined artificial intelligence addiction and critical thinking as key determinants of senior secondary school students' achievement in mathematics. However, in this study, AI addiction refers to excessive use of Artificial Intelligence in mathematics learning, rather than over-reliance on AI tools for academic activities. By empirically investigating the individual and combined impacts of these variables, the study seeks to generate evidence-based insights to inform responsible AI integration, instructional practices, and policy decisions to improve mathematics learning outcomes in Nigerian secondary schools.

Objectives of the Study

The main objective of this study is to examine artificial intelligence addiction and critical thinking as determinants of senior secondary school students' achievement in mathematics.
The specific objectives are to:

1. Examine the relationship among AI Addiction, Critical thinking, and senior secondary school students' mathematics achievement.
2. Determine the influence of artificial intelligence addiction on senior secondary school students' achievement in mathematics.
3. Assess the relative influence of critical thinking on senior secondary school students' achievement in mathematics.

Research Questions

The following research questions guided the study:

1. Is there a significant relative influence of artificial intelligence addiction on students' achievement in mathematics?
2. Is there a significant relative influence of critical thinking ability on students' achievement in mathematics?
3. Is there a significant relationship among AI Addiction, Critical thinking and senior secondary school students' mathematics achievement?

METHODOLOGY

Research Design

The study adopted a descriptive survey research design. The design was chosen for its effectiveness in soundly collecting data from a large, diverse population to describe the phenomenon of interest, without manipulating variables or attempting to establish causation (Slater & Hasson, 2025).

Target Population

The target population of the study comprised all senior secondary school two (SSS 2) students in public senior secondary schools in the Ijebu-North Local Government Area of Ogun State. The population was targeted because the majority of them have mobile phones, which makes them prone to AI addiction.

Sample and Sampling Techniques

The sample consisted of 150 senior secondary school two (SSS 2) students, purposively selected from public senior secondary schools, whose students had been introduced to the use of AI for mathematics learning. Of the nineteen public secondary schools in Ijebu-North, five that allowed students to bring mobile phones to school for learning purposes were purposively selected. An intact class of SS 2 Science students was selected from each of the selected schools. Simple random sampling was used to select 30 students from each class at the five schools who reported regularly interacting with their phones, for a total of 150 students.

Instrumentation

Three instruments were constructed and validated for data collection. They are: Mathematics Achievement Test (MAT), Students Artificial Intelligence Addiction Rating Scale (SAARS), and Critical Thinking Evaluation Scale (CTES):

Mathematics Achievement Test (MAT): The Mathematics Achievement Test (MAT), which contained 30 items, was constructed to measure senior secondary school students' outcomes in mathematics. The test items were adapted from past West African Examinations Council

(WAEC) mathematics questions to ensure adequate coverage of the senior secondary school 2 mathematics curriculum during the second term, when the instrument was administered. The content and face validity of the instrument were established through reviews by specialists in mathematics education and educational measurement, as well as by secondary school mathematics teachers, regarding the relevance, clarity, and difficulty level of the items. Their suggestions led to minor modifications before the researchers produced the final version of the test and administered it to the students. To assess the instrument's reliability, the MAT was administered to 30 students from a school not included in the main study. Their scores were subjected to split-half reliability statistics, yielding a coefficient of 0.69, considered adequate for performance testing in educational research.

Students' Artificial Intelligence Addiction Rating Scale (SAARS): The Students' Artificial Intelligence Addiction Rating Scale (SAARS), which contained 25 items, was developed to assess the extent of students' dependence on AI-driven tools for mathematics learning. The SAARS was adapted from the 22-item Artificial Intelligence Addiction Scale for Researchers, developed and validated by El-Sayed et al. (2025), and modified to reflect AI-specific behaviours among secondary school students, such as excessive use of automated problem solvers and intelligent tutoring systems. The SAARS is a Likert-type scale, structured on a 4-point response format ranging from Strongly Agree (4) to Strongly Disagree (1). Content and face validity were established through reviews by educational psychologists and measurement experts to ensure that the items adequately represented the concept of AI addiction among secondary school students. Items identified as ambiguous or repetitive were revised accordingly. The instrument was administered to thirty students from a non-participating school. The reliability of SAARS was determined using Cronbach's alpha, yielding a coefficient of 0.73, indicating acceptable internal consistency.

Critical Thinking Evaluation Scale (CTES): The Critical Thinking Evaluation Scale (CTES) was adapted from the work of Rodriguez et al. (2024) to measure students' critical thinking abilities in mathematics. Originally, the 17-item instrument was used in Colombia, an environment different from Nigeria. Hence, the items were modified to suit the Nigerian Senior Secondary School two (SS 2) context. The scale assessed critical thinking dimensions, including reasoning, analysis, evaluation, and problem-solving, in mathematics learning contexts. CTES is a Likert-type scale, designed on a 4-point response format of Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). Content validity was established through reviews by specialists in mathematics education and Educational Technology. The instrument was administered to 30 students from a non-participating school, and its internal consistency was determined using Cronbach's alpha, yielding a reliability coefficient of 0.76, indicating high reliability.

Method of Data Collection

Data were collected through the direct administration of the research instruments to the selected senior secondary school 2 students. Approval to conduct the study was obtained from the school authorities after explaining the purpose of the survey to them. Participation was voluntary, and the confidentiality of students' responses was assured. The Mathematics Achievement Test (MAT) was administered first to assess students' achievement in mathematics under standardised testing conditions. Clear instructions were provided, and adequate time was allowed for completion. Subsequently, the Students' Artificial Intelligence Addiction Rating Scale (SAARS) and the Critical Thinking Evaluation Scale (CTES) were administered to the same participants. The instruments were completed under the supervision of the researchers and the subject teachers to ensure proper administration and students' independence in responding to the instruments' items. All completed instruments were collected immediately after administration to prevent data loss and ensure a high response rate. The retrieved data were screened for completeness and accuracy before analysis.

Method of Data Analysis

The data collected were analysed using inferential statistical techniques. To address the research questions, the Pearson Product-Moment Correlation was used to determine the relationships among artificial intelligence addiction, critical thinking, and students' academic achievement in mathematics. In addition, simple and multiple regression analyses were employed to examine the predictive influences of artificial intelligence addiction and critical thinking on mathematics achievement. The coefficient of determination (R^2) was used to determine the proportion of variance in mathematics performance explained by the independent variables.

RESULTS AND DISCUSSION

Results

The results are presented according to the research questions:

Research Question 1: Is there a significant relative influence of artificial intelligence addiction on students' achievement in mathematics?

Table 1. Relative Influence of Artificial Intelligence Addiction on Students Mathematics Achievement

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	119.034	1	119.034	16.683	0.001
	Residual	1056.006	148	7.135		
	Total	1175.040	149			
	$R = 0.318$; $R^2 = 0.101$; Adjusted $R^2 = 0.095$; Std Error = 2.671					

Table 1 indicates that AI addiction significantly influenced students' achievement in mathematics ($F_{(1, 148)} = 16.683$, $p < 0.05$). The correlation coefficient, $R = 0.318$, suggests a modest positive relationship between AI addiction and students' achievement. The coefficient of determination, $R^2 = 0.101$, indicates that AI addiction accounts for 10.1% of the variance in students' achievement. The remaining 89.9% of the variance is attributable to other factors not included in the model. At the same time, the adjusted R^2 of 0.095 shows that the model is stable and not artificially inflated by sample size or overfitting.

Research Question 2: Is there a significant relative influence of critical thinking ability on students' performance in mathematics?

Table 2. Relative Influence of Critical Thinking on Students' Mathematics Achievement.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	172.448	1	175.448	25.977	0.001
	Residual	999.592	148	6.754		
	Total	1175.040	149			
	$R = 0.386$; $R^2 = 0.149$; Adjusted $R^2 = 0.144$; Std Error = 2.599					

Table 2 indicates that critical thinking ability is a statistically significant predictor of students' achievement in mathematics, $F_{(1,148)} = 25.977$, $p < 0.05$. The correlation coefficient, $R = 0.386$, suggests a moderate positive relationship between critical thinking ability and students' mathematics achievement, indicating that higher levels of critical thinking are associated with better academic outcomes. The coefficient of determination, $R^2 = 0.149$, shows that critical thinking ability accounts for 14.9% of the variance in achievement. This variance accounted for highlights that, while critical thinking is an important factor, other variables also play substantial roles in shaping students' mathematics achievement. The adjusted R^2 value of 0.144 is only slightly lower than the R^2 (0.149), indicating that the model is stable and not significantly affected by sample size or overfitting. This suggests that the model's explanatory power is reliable. Additionally, the standard error of estimate of 2.599 reflects a

reasonable level of precision in the model's predictions, indicating that the observed scores do not deviate excessively from the predicted values.

Research Question 3: Is there a significant relationship among AI Addiction, Critical thinking and senior secondary school students' mathematics achievement?

Table 3. Correlation among AI Addiction, Critical Thinking and Students' Mathematics Achievement.

Correlations				
		Mathematics Achievement	**AI Addiction**	**Critical Thinking**
Mathematics Achievement	Pearson correlation	1	0.318	0.386
	Sig.(1-tailed)		0.001	0.470
	N	150	150	150
AI Addiction	Pearson correlation	0.318	1	0.308
	Sig.(1-tailed)	0.001		0.001
	N	150	150	150
Critical Thinking	Pearson correlation	0.318	0.308	1
	Sig.(1-tailed)	0.001	0.001	
	N	150	150	150

Table 3 reveals statistically significant relationships among AI addiction, critical thinking ability, and students' mathematics achievement. Both AI addiction ($r = 0.318$, $p < 0.01$) and critical thinking ability ($r = 0.386$, $p < 0.01$) show positive associations with mathematics achievement, with critical thinking demonstrating a stronger relationship. These results suggest that, while both variables are relevant to students' achievement, critical thinking ability is a more potent determinant. The relationship between AI addiction and critical thinking ability ($r = 0.308$, $p < 0.01$) is also positive and falls within the weak-to-moderate range. This indicates a degree of overlap between the two constructs, suggesting that students with addiction to AI usage also tend to exhibit slightly higher critical thinking skills.

Discussion

This study aimed to determine whether Artificial Intelligence Addiction and Critical Thinking predict students' learning of mathematics in senior secondary schools. The study found that AI addiction is a statistically significant predictor of students' mathematics achievement, though its explanatory power is modest. The positive relationship indicates that students who frequently engage with AI tools may be using them to support their academic inclination, such as solving mathematical problems, accessing explanations, or receiving instant feedback. Such engagement can enhance understanding and improve performance, particularly in subjects like mathematics that thrive on guided practice and step-by-step reasoning. However, the relatively small effect size suggests that such benefits are limited and dependent on how effectively the tools are used. In this study, AI addiction reflects high usage rather than purely detrimental overdependence. While moderate or purposeful use of AI can support learning, excessive or uncritical reliance may eventually hinder the development of independent problem-solving skills, even if such negative effects are not strongly reflected in the current data. Given that a large proportion of achievement variance remains unexplained, educators should continue to address other key determinants of performance, such as instructional quality, motivation, teaching strategies and foundational skills. These findings align with those of Ubabuike and Nweke (2024), who found that AI's use significantly improved students' learning, critical thinking, and problem-solving skills. They are also consistent with Vieriu and Petrea (2025), who investigated the impact of AI technologies on students' learning

and reported that AI significantly improved academic achievement and increased engagement. It was, however, noted that over-reliance on AI tools diminished critical thinking, constituted data privacy risks, and led to academic dishonesty.

The study also found that critical thinking ability is a significant and potent predictor of students' mathematics achievement. This finding means that mathematics learning inherently requires higher-order cognitive processes such as analysis, reasoning, evaluation, and problem-solving, which are subsets of critical thinking. Students who can interpret problems, evaluate solution strategies, and make logical connections are better positioned to understand mathematical concepts and apply them effectively. This explains the stronger influence of critical thinking compared to AI addiction. However, the moderate level of explained variance also indicates that factors beyond AI addiction and critical thinking determine achievement in mathematics. Thus, while critical thinking and the use of AI are important, other factors shape mathematics learning.

Regarding educational practice, the findings underscore the need to deliberately integrate the development of critical thinking into mathematics instruction. When a critical thing is embedded in mathematics learning, students are likely to learn better. The findings of this study concur with those of Duru and Obasi (2023), who investigated the correlation between critical thinking ability and academic achievement in mathematics and found a significant, positive correlation. It also supported the findings of Jesto et al. (2025), who examined the link between critical thinking skills and mathematics performance in teacher education programmes and found that critical thinking significantly influenced mathematics performance.

Furthermore, this research revealed that AI addiction and critical thinking ability are both significantly associated with students' mathematics achievement, although their relative contributions differ. Critical thinking shows a stronger relationship compared to AI addiction, reinforcing its role as a more potent determinant of academic achievement in mathematics. This pattern is consistent with established evidence that higher-order cognitive skills, such as reasoning, analysis, and evaluation, are central to success in mathematics (Jesto et al., 2025; Tian & Zhang, 2025). The positive relationship between AI addiction and achievement, though weaker, suggests that frequent engagement with AI tools may provide academic benefits. A plausible explanation is that students who use AI extensively may gain increased access to explanations, practice opportunities, and immediate feedback, which can support learning. However, the modest strength of this relationship indicates that such benefits are limited and likely depend on the quality and purpose of use rather than mere frequency. The significant association between AI addiction and critical thinking further suggests an interplay between technology use and cognitive skill development. This may reflect that students who actively engage with AI tools are also involved in processes such as evaluating responses, refining queries, and exploring multiple solution pathways, all of which can stimulate critical thinking. At the same time, the moderate magnitude of this relationship suggests that AI use does not automatically enhance critical thinking; its impact depends on how thoughtfully it is integrated into learning. Excessive use of AI in learning may reduce critical thinking, consistent with the finding of Tian and Zhang (2025), who reported that AI dependence is associated with lower levels of critical thinking.

CONCLUSION AND RECOMMENDATIONS

This study examined artificial intelligence (AI) addiction and critical thinking as determinants of senior secondary school students' achievement in mathematics in the Ijebu-North Local Government Area of Ogun State, Nigeria. The findings revealed that both AI addiction and critical thinking significantly predict students' performance in mathematics, though to varying degrees. Specifically, artificial intelligence addiction demonstrated a statistically significant, yet weak-to-moderate, positive influence on students' mathematics achievement. Thus, it can be concluded that both AI addiction and critical thinking ability are significant predictors of students' mathematics achievement, although their relative contributions differ. Critical thinking ability also showed a stronger association with achievement, accounting for a larger proportion of the variance in achievement. AI addiction shows a weaker but still significant positive relationship, suggesting that frequent engagement with AI tools can support learning when used purposefully, potentially enhancing problem-solving and analytical processes. The moderate positive correlation between AI addiction and critical thinking further indicates that the constructive use of AI may complement the development of critical thinking.

The implications of these findings for mathematics teachers are multifaceted. They underscore the imperative of guiding students toward purposeful, reflective engagement with AI technologies, positioning these tools as cognitive supports that augment rather than supplant independent reasoning. In addition, educators must emphasise AI as a collaborative aid that prompts students to question, verify, and critically extend AI-generated outputs through structured reflection and source evaluation. However, this study acknowledges the limitations of the selected sample, despite the interplay among AI addiction, critical thinking, and mathematics achievement in senior secondary schools. Thus, the findings should be used with caution when generalising, given the small sample size, the early stage of AI use in Nigerian schools, and the prohibition of mobile phones in many schools. Yet, there is a lack of computer facilities. Further studies should sample more students, especially in commercial or humanities classes.

Based on the findings, this study recommends the following:

1. Curriculum developers and mathematics teachers in senior secondary schools should integrate targeted interventions, such as inquiry-based problem-solving sessions and Guided AI-assisted exploration tasks, to foster critical thinking skills.
2. School administrators and mathematics educators should implement awareness programmes on the responsible use of artificial intelligence tools.
3. Mathematics instruction in secondary schools should incorporate guided AI-assisted activities that promote active student engagement.
4. Secondary education mathematics teachers should prioritise the balanced development of both critical thinking abilities and the moderated utilisation of AI to enhance students' achievement in Mathematics.
5. Mathematics lessons should be redesigned to incorporate blended activities where students first engage in independent problem-solving and inquiry-based tasks to build critical thinking, then use AI tools responsibly to solve the problems further.

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