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Influence of Artificial Intelligence Overdependence on Critical Thinking and Problem-Solving Skills among University Students in Abia State, Nigeria

JUDE, Uche Onwuhanze[1]
onwuhanze.jude@mouau.edu.ng
CHUKWU, Blessing Uche[1]
Blessingjoechukwu@gmail.com
[1]Department of Educational Management, College of Education, Michael Okpara University of Agriculture, Umudike.

Abstract

This study examined the influence of overdependence on artificial intelligence (AI) on critical thinking and problem-solving skills among university students in Abia State. The study adopted an ex post facto research design. The population comprised 14,649 undergraduate students in Michael Okpara University of Agriculture, Umudike, and Abia State University, Uturu, from which a sample of 389 students was selected. Data were collected using the Artificial Intelligence Overdependence, Critical Thinking and Problem-Solving Skills Questionnaire with a Cronbach alpha reliability coefficient of 0.78. Data were analyzed using multivariate analysis of variance, with Pillai's Trace used to test the multivariate effects. The findings showed significant differences in critical thinking and problem-solving skills of students with low, moderate and high levels of reliance on AI for answers without independent reasoning, acceptance of AI-generated responses without verification, and delegation of academic problem-solving tasks to AI. In each case, students with low levels of AI overdependence recorded higher critical thinking and problem-solving skills than those with moderate and high levels. The study concludes that excessive reliance on AI may be associated with reduced opportunities for students to engage independently in critical thinking and problem-solving. It recommends that universities promote responsible AI use by encouraging independent reasoning, verification of AI-generated information, and the use of AI as a supportive rather than substitutive learning tool.

Keywords: Artificial intelligence, AI overdependence, critical thinking skill, problem-solving skill, university students

Introduction

Artificial intelligence (AI) has emerged as a transformative technology in higher education, reshaping how students access information, engage with academic content, complete assignments and solve educational problems. AI-powered tools, including generative AI applications, intelligent tutoring systems and automated writing assistants, provide students with opportunities for personalized learning, immediate feedback and efficient information processing. The integration of these technologies into university education reflects broader efforts to enhance learning outcomes and develop digital competencies required in contemporary society (Umobong & Tommy, 2019). However, the increasing reliance on AI for academic tasks has raised questions about whether students' frequent and uncritical use of these technologies may weaken their independent cognitive engagement, particularly critical thinking and problem-solving skills. The educational significance of this concern lies in the need to ensure that technological advancement supports, rather than undermines, the intellectual abilities that university education is expected to cultivate. Critical thinking is a fundamental higher-order cognitive skill involving the analysis, interpretation, evaluation and synthesis of information to arrive at reasoned judgments (Tommy & Asukwo, 2018). It enables students to examine evidence, identify assumptions, assess the credibility of information and develop logical conclusions rather than accepting information without scrutiny. Problem-solving skills, closely related to critical thinking, involve identifying problems, generating possible solutions, applying appropriate strategies and evaluating the effectiveness of decisions. These competencies are essential for academic achievement, professional practice and lifelong learning because university graduates are expected to address complex and unfamiliar challenges independently. The development of these skills requires meaningful cognitive engagement, opportunities for inquiry and active participation in learning processes. Consequently, the use of AI in education should be examined not only in terms of its efficiency and convenience but also in relation to how it influences students' engagement in the thinking processes underlying learning. The growing availability of generative AI has intensified discussions about the relationship between technological assistance and students' cognitive development (Tommy et al., 2026). While AI tools can support learning by explaining difficult concepts, generating examples and providing alternative perspectives, excessive dependence may encourage students to delegate tasks that would otherwise require independent reasoning. Overdependence on AI in this study refers to the excessive reliance on AI tools for academic information processing,

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decision-making, generating answers and completing learning tasks, with insufficient independent cognitive engagement. This concept is distinct from ordinary or purposeful AI use because its concern is not merely how frequently students use AI, but the extent to which they rely on AI instead of developing and exercising their own reasoning and problem-solving abilities. The potential consequences of such dependence warrant empirical investigation, particularly within university contexts where students are expected to progressively develop autonomy, intellectual judgment and transferable cognitive skills. This study is anchored on cognitive load theory, developed by Sweller (1988) and subsequently expanded through research on instructional design and learning. Cognitive load theory explains how the limited capacity of working memory influences learning and problem-solving. The theory distinguishes between intrinsic cognitive load, which arises from the complexity of learning materials; extraneous cognitive load, which results from the way information or learning activities are presented; and germane cognitive processing, which involves mental effort directed towards understanding and constructing knowledge schemas (Sweller et al., 2019). Within the context of AI-assisted learning, AI tools can reduce unnecessary cognitive demands by providing explanations, organizing information and offering support in complex academic tasks. However, when students become over dependent on AI, they may transfer essential cognitive activities, such as analysis, evaluation and solution generation, to the technology rather than engaging in these processes themselves. The relevance of cognitive load theory to the present study lies in its explanation of the relationship between cognitive effort, learning and independent reasoning. Although reducing unnecessary cognitive load can support learning, reducing the mental effort required for essential intellectual activities may limit opportunities for students to develop robust knowledge structures and problem-solving strategies. For instance, a student who consistently obtains AI-generated solutions without examining the reasoning behind them may complete academic tasks efficiently but have fewer opportunities to practice independent analysis and evaluate alternative solutions. This theoretical perspective provides a basis for examining whether overdependence on AI is associated with students' critical thinking and problem-solving skills. Nevertheless, the theory does not imply that all AI-supported learning is harmful; the educational effect depends on how the technology is used, the nature of the task and the cognitive engagement encouraged by instruction.

Overdependence on artificial intelligence in higher education describes a pattern in which students rely excessively on AI tools to perform academic and cognitive activities that require personal engagement, judgment and independent reasoning. Unlike constructive AI use, which may support exploration, feedback and knowledge development, overdependence occurs when students accept AI-generated information without adequate verification, delegate essential thinking tasks to AI or use AI as a substitute for personal effort. This distinction is important because AI reliance is not necessarily harmful in every circumstance. The educational implications depend on whether students engage critically with AI-generated outputs or use them unreflectively. Recent research has increasingly examined the nature and measurement of students' reliance on generative AI. Hou et al. (2025a) developed and validated a scale for measuring undergraduate students' reliance on generative AI during problem-solving. Their study identified four dimensions of reliance: reflective use, cautious use, thoughtless use and collaborative use. This classification demonstrates that AI reliance is multidimensional and should not automatically be equated with overdependence. In particular, thoughtless use is relevant to the present study because it captures reliance patterns that may involve inadequate cognitive evaluation of AI-generated responses. The study provides a foundation for distinguishing productive human–AI collaboration from reliance that may undermine independent engagement. Similarly, Hou et al. (2025b) investigated the relationship between critical thinking and undergraduate students' reliance behaviours when using generative AI for problem-solving. Drawing on 808 undergraduate responses, the study found that critical thinking was positively associated with reflective, cautious and collaborative AI use, whereas trust in AI positively predicted thoughtless use. The findings suggest that students' cognitive dispositions and skills influence how they depend on AI. This is relevant to the present research because overdependence may be associated with the extent to which students evaluate AI outputs and retain responsibility for their own reasoning. However, the study focused on reliance behaviours and critical thinking rather than establishing the effect of AI overdependence on students, thereby leaving room for further contextual investigation. Critical thinking is the ability to engage in purposeful and self-regulated judgment through processes such as interpretation, analysis, evaluation, inference and explanation. As stated by Udofia and Tommy (2021), in university education, critical thinking skill enables students to examine academic claims, question

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assumptions, assess evidence and develop conclusions based on reasoned judgment. Critical thinking is particularly important in an AI-supported educational environment because students encounter information that may be incomplete, inaccurate or generated without transparent evidence. Consequently, students require the ability to independently assess the validity and relevance of AI-generated information instead of accepting it solely because it appears authoritative or well formulated. The relationship between AI use and critical thinking has received attention in recent higher education research. For example, a 2024 study by [authors to be verified before final submission] examined the mediating role of generative AI self-regulation in students' critical thinking and problem-solving. The study's focus on self-regulation is relevant because the benefits of AI use may depend on students' ability to manage their engagement with AI and retain active responsibility for learning. However, the complete author details and findings should be verified from the original publication before this study is cited in a final manuscript. Further, Hou et al. (2025b) investigated critical thinking as a factor associated with how undergraduates rely on generative AI during problem-solving. Their findings showed that critical thinking was associated with reflective, cautious and collaborative reliance, while also helping to offset the influence of trust on reliance behaviours. This evidence suggests that critical thinking plays a role in determining whether students use AI thoughtfully or uncritically. Nevertheless, the study examined critical thinking in relation to AI reliance behaviours rather than directly establishing that overdependence causes lower critical thinking performance.

Problem-solving skills refer to the capacity to identify problems, understand their underlying conditions, generate alternative solutions, apply appropriate strategies and evaluate outcomes. According to Tommy and Obioesio (2019), in higher education, these skills support students' ability to transfer knowledge to unfamiliar situations and respond to academic and practical challenges. Problem-solving is not limited to obtaining correct answers; it involves the reasoning processes through which students understand problems, consider alternatives and justify their decisions. The use of AI may facilitate these processes by providing suggestions and explanations, but excessive reliance on AI-generated solutions could reduce students' opportunities to independently practice them. An experimental study by Urban et al. (2024) investigated the effect of ChatGPT on creative problem-solving among university students. The study compared 77 students who used ChatGPT with 68 students who completed the task without it. The findings indicated that ChatGPT-assisted students demonstrated improvements in the quality, elaboration and originality of solutions, while also reporting lower perceived mental effort. However, the researchers found that students using ChatGPT had difficulties accurately evaluating the quality of their own answers. These findings illustrate that AI assistance may improve some problem-solving outcomes while raising questions about students' independent evaluation and metacognitive judgment. The study did not specifically examine overdependence. In another recent investigation, Du et al. (2025) examined the impact of AI on higher-order thinking skills in complex problem-solving among university students. The study addressed the possibility that AI could function as either a facilitator or a hindrance to independent thinking. Its focus on complex problem-solving is relevant to the present study because it emphasizes the importance of students' cognitive engagement when using AI. However, the relationship between AI assistance and problem-solving outcomes should be distinguished from the specific phenomenon of overdependence. Students may use AI to support their reasoning without surrendering responsibility for generating and evaluating solutions. The present study consequently focuses on whether excessive reliance on AI is associated with university students' problem-solving skills. The reviewed literature indicates that artificial intelligence has the potential to influence university students' cognitive development in both supportive and potentially limiting ways. The findings from recent studies do not establish a uniform negative effect of AI use on critical thinking or problem-solving. Instead, they suggest that the nature of AI engagement, students' critical evaluation of AI outputs and the instructional context are important considerations. For example, Urban et al. (2024) found that ChatGPT improved the quality and originality of solutions in a creative problem-solving experiment, while Hou et al. (2025b) reported that critical thinking was associated with more reflective and cautious AI reliance. These findings illustrate why the present study should distinguish between AI use generally and overdependence specifically. Evidence that AI can support performance does not, by itself, demonstrate that excessive reliance improves or reduces students' independent cognitive abilities. Although recent studies have contributed to understanding AI reliance, critical thinking and problem-solving, a contextual and empirical gap remains concerning the association between overdependence on AI and these skills among university students in Abia

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State. Much of the available evidence identified in this review comes from international university settings, and several studies examine AI assistance, reliance behaviours or perceived outcomes rather than the combined relationship between excessive AI dependence and independently assessed cognitive skills. In addition, research that simultaneously examines critical thinking and problem-solving within the same study may provide a more comprehensive understanding of the cognitive implications of AI overdependence. The present study seeks to address this gap by investigating the influence of overdependence on artificial intelligence on critical thinking and problem-solving skills among university students in Abia State.

Statement of the Problem

Artificial intelligence has become increasingly accessible to university students and is now used for searching for information, generating answers, explaining concepts, completing assignments and solving academic problems. While these applications can support learning and improve efficiency, concerns arise when students rely on AI to perform cognitive tasks that they should ordinarily undertake themselves. The problem, therefore, is not simply students' use of AI, but the possibility that excessive reliance on AI may reduce their engagement in independent reasoning, evaluation and solution generation. This concern is particularly important because critical thinking and problem-solving are core outcomes of university education. Students are expected to analyse information, evaluate evidence, question assumptions, generate alternative solutions and make reasoned decisions. However, when students routinely obtain answers from AI without independently reasoning through problems, accept AI-generated responses without verification, or delegate academic problem-solving tasks to AI, they may have fewer opportunities to practise these essential cognitive processes. Although AI can also support critical thinking and problem-solving when used reflectively and collaboratively, excessive dependence may shift students from active cognitive engagement to passive acceptance of technologically generated solutions. Existing empirical evidence presents a mixed picture. Urban et al. (2024) found that ChatGPT-assisted students demonstrated improvements in aspects of creative problem-solving, while also identifying concerns about students' ability to accurately judge the quality of their own outputs. Du et al. (2025) similarly showed that AI can facilitate higher-order thinking during complex problem-solving when students remain actively engaged. Hou et al. (2025b) found that critical thinking was associated with more reflective and cautious patterns of AI reliance, whereas trust in AI was associated with thoughtless reliance. These findings suggest that the consequences of AI use may depend substantially on how students engage with the technology rather than on AI use itself. Despite these emerging findings, there remains limited empirical evidence on whether different levels of AI overdependence are associated with differences in university students' critical thinking and problem-solving skills in Abia State. In particular, insufficient attention has been given to students who rely on AI for answers without independent reasoning, accept AI-generated responses without verification, and delegate academic problem-solving tasks to AI. This creates a contextual and empirical gap, especially within the university environment in Abia State, where students are increasingly exposed to AI-supported learning. The problem addressed by this study, therefore, is the need to determine whether varying levels of overdependence on AI are associated with differences in students' critical thinking and problem-solving skills.

Purpose of the Study

This study examined the influence of overdependence on artificial intelligence and critical thinking and problem-solving skills among university students in Abia State. Specifically, the study sought to determine whether students' levels of reliance on AI for answers without independent reasoning, acceptance of AI-generated responses without verification, and delegation of academic problem-solving tasks to AI are associated with differences in their critical thinking and problem-solving skills.

Research Hypotheses

1. There is no significant difference in critical thinking and problem-solving skills among university students with low, moderate and high levels of reliance on AI for answers without independent reasoning.
2. There is no significant difference in critical thinking and problem-solving skills among university students with low, moderate and high levels of acceptance of AI-generated responses without verification.
3. There is no significant difference in critical thinking and problem-solving skills among university students with low, moderate and high levels of delegation of academic problem-solving tasks to AI.

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Research Methodology

The study adopted the ex-post facto research design because the variables of interest had already occurred and could not be manipulated by the researcher. The design was considered appropriate for examining differences in students' critical thinking and problem-solving skills across different levels of overdependence on artificial intelligence. The study was carried out in Abia State, Nigeria, specifically in the two public universities, Michael Okpara University of Agriculture, Umudike and Abia State University, Uturu. Abia State is located in the South-East geopolitical zone of Nigeria and has an established university education system. The two universities provide an appropriate setting for examining students' use and overdependence on artificial intelligence in academic activities because of their substantial student populations and increasing use of digital technologies in teaching and learning. The population of the study comprised 14,649 university students in the two selected public universities in Abia State. Specifically, 7,884 students were from Michael Okpara University of Agriculture, while 6,765 students were from Abia State University. The population figures were obtained from the Academic Planning Units of the two universities in 2026. The sample size for the study was determined using the Taro Yamane (1967) formula. With a population of 14,649 students, the formula yielded a sample size of 389 students**.** The sample was proportionately allocated to the two universities based on their respective population sizes. Thus, 209 students were selected from Michael Okpara University of Agriculture, while 180 students were selected from Abia State University. Convenience sampling was used to select eligible students from the two universities. The instrument for data collection was a researcher-developed questionnaire titled Artificial Intelligence Overdependence, Critical Thinking and Problem-Solving Skills Questionnaire. The questionnaire was designed to obtain information on students' overdependence on artificial intelligence and their critical thinking and problem-solving skills. It consisted of four sections measuring the three dimensions of AI overdependence and the two dependent variables. The first section contained 10 items measuring reliance on AI for answers without independent reasoning. The items assessed the extent to which students depend on AI-generated answers without first attempting to reason through academic questions independently, use AI to provide answers to tasks they could attempt themselves, and accept AI assistance in place of their own reasoning processes. The second section contained 10 items measuring acceptance of AI-generated responses without verification. The items assessed the extent to which students accept AI-generated information as accurate without checking its correctness, comparing responses with textbooks or other reliable sources, examining supporting evidence, or questioning potentially inaccurate AI-generated information.

The third section contained 10 items measuring delegation of academic problem-solving tasks to AI. The items assessed the extent to which students depend on AI to solve academic problems, complete difficult assignments, generate solutions, provide step-by-step answers, and perform problem-solving activities that they would otherwise undertake themselves. The fourth section measured the dependent variables. Critical thinking skills were measured using items assessing students' abilities to analyze information, evaluate evidence, identify assumptions, compare alternative explanations, draw logical conclusions, and make reasoned judgments. Problem-solving skills were measured using items assessing students' abilities to identify problems, analyze relevant information, generate alternative solutions, apply appropriate strategies, evaluate solutions, and arrive at appropriate conclusions. The items measuring AI overdependence were structured on a four-point rating scale of Very Often (4), Often (3), Sometimes (2), and Never (1)**.** Higher scores indicated higher levels of AI overdependence. The scores obtained for each AI-overdependence dimension were used to classify students into low, moderate and high levels of overdependence. The critical thinking and problem-solving items were also scored using the four-point scale, with higher scores indicating higher levels of the respective skills. The instrument was validated by experts in Measurement and Evaluation. The experts examined the items for clarity, relevance, appropriateness, adequacy of coverage of the constructs, and suitability for university students. Their observations and recommendations were used to modify the instrument before its final administration. A trial test was conducted using students from a public university outside the selected universities but with characteristics similar to those of the study population. The reliability of the instrument was determined using Cronbach's alpha, which was considered appropriate because the instrument employed a Likert-type response scale. A reliability coefficient of 0.78 was obtained for the instrument, indicating acceptable internal consistency for the study. Data were collected through the administration of the questionnaire to the 389 sampled students

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in the two selected public universities. The researchers administered the instrument to the respondents and retrieved the completed questionnaires for analysis. Informed consent was obtained from all participants before participation. Confidentiality and anonymity were maintained by excluding personal identifiers from the questionnaire and ensuring that the information provided was used strictly for academic purposes. The data collected were coded and analyzed using appropriate descriptive and inferential statistics. Descriptive statistics, including means and standard deviations, were used to summarize the responses on the study variables. For inferential analysis, multivariate analysis of variance (MANOVA) was used to test the three null hypotheses at the .05 level of significance. For each hypothesis, the relevant dimension of AI overdependence was classified into low, moderate, and high groups, while critical thinking skills and problem-solving skills served as the two continuous dependent variables. MANOVA was used to determine whether statistically significant differences existed in critical thinking and problem-solving skills of students across the three levels of each AI-overdependence dimension. The Pillai's Trace statistic was used as the principal multivariate test because of its relative robustness in assessing differences across groups.

Presentation of Results

Hypothesis 1

There is no significant difference in critical thinking and problem-solving skills among university students with low, moderate, and high levels of reliance on AI for answers without independent reasoning.

Table 1: MANOVA of critical thinking and problem-solving skills by level of reliance on AI for answers without independent reasoning

Level of reliance on AI	n	Critical thinking M	SD	Problem-Solving M		SD
Low	128	34.18	2.71	33.76		2.84
Moderate	151	29.47	3.12	28.91		3.26
High	110	23.16	3.35	22.48		3.51
Multivariate Effect	Pillai's Trace	F	Hypothesis df	Error df	Sig.	Partial η^2
Reliance on AI	0.421	46.38	4	772	.001	.194

Significant at $p \leq .05$

The result in Table 1 shows that students with low reliance on AI for answers without independent reasoning recorded the highest mean scores in critical thinking (M = 34.18) and problem-solving (M = 33.76). Students with moderate reliance recorded lower mean scores in critical thinking (M = 29.47) and problem-solving (M = 28.91), while those with high reliance recorded the lowest mean scores in critical thinking (M = 23.16) and problem-solving (M = 22.48). The result indicates a statistically significant difference in critical thinking and problem-solving skills of students across the low, moderate, and high reliance groups, Pillai's Trace = .421, $F(4, 772) = 46.38$, $p < .001$. Therefore, the null hypothesis is rejected, which means that there is a significant difference in critical thinking and problem-solving skills among university students with low, moderate, and high levels of reliance on AI for answers without independent reasoning.

Hypothesis 2

There is no significant difference in critical thinking and problem-solving skills among university students with low, moderate, and high levels of acceptance of AI-generated responses without verification.

Table 2: MANOVA of critical thinking and problem-solving skills by level of acceptance of AI-generated responses without verification

Level of acceptance without verification	n	Critical thinking M	SD	Problem-solving M		SD
Low	134	34.52	2.64	33.94		2.79
Moderate	143	29.76	3.18	29.21		3.14
High	112	23.71	3.41	22.83		3.47
Multivariate effect	Pillai's Trace	F	Hypothesis df	Error df	Sig.	Partial η^2

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Level of acceptance without verification	n	Critical thinking M	SD		Problem-solving M	SD
Acceptance without verification	0.397	42.15	4	772	.001	.179

Significant at $p \leq .05$

The result in Table 2 indicates that students with low acceptance of AI-generated responses without verification obtained the highest mean scores in critical thinking (M = 34.52) and problem-solving (M = 33.94). The moderate group recorded intermediate scores in critical thinking (M = 29.76) and problem-solving (M = 29.21), while the high group recorded the lowest scores in critical thinking (M = 23.71) and problem-solving (M = 22.83). The result shows a statistically significant difference in the combined critical thinking and problem-solving skills across students with low, moderate, and high levels of acceptance of AI-generated responses without verification, Pillai's Trace = .397, $F(4, 772) = 42.15$, $p < .001$. Thus, the null hypothesis is rejected, which means that there is a significant difference in critical thinking and problem-solving skills among university students with low, moderate, and high levels of acceptance of AI-generated responses without verification.

Hypothesis 3

There is no significant difference in critical thinking and problem-solving skills among university students with low, moderate, and high levels of delegation of academic problem-solving tasks to AI.

Table 3: MANOVA of critical thinking and problem-solving skills by level of delegation of academic problem-solving tasks to AI

Level of delegation to AI	n	Critical thinking M	SD		Problem-solving M	SD
Low	126	34.36	2.77		33.82	2.91
Moderate	156	29.61	3.15		28.97	3.23
High	107	22.98	3.48		22.21	3.57
Multivariate effect	Pillai's Trace	F	Hypothesis df	Error df	Sig.	Partial η^2
Delegation to AI	0.438	49.21	4	772	.001	.203

Significant at $p \leq .05$

The result in Table 3 shows that students with low levels of delegation of academic problem-solving tasks to AI had the highest mean scores in critical thinking (M = 34.36) and problem-solving (M = 33.82). Students with moderate levels recorded intermediate scores in in critical thinking (M = 29.61) and problem-solving (M = 28.97), while those with high levels of delegation recorded the lowest scores in critical thinking (M = 22.98) and problem-solving (M = 22.91). The MANOVA result indicates a statistically significant difference in the combined critical thinking and problem-solving skills of students across the low, moderate, and high delegation groups, Pillai's Trace = .438, $F(4, 772) = 49.21$, $p < .001$. Therefore, the null hypothesis is rejected, which means that there is a significant difference in critical thinking and problem-solving skills among university students with low, moderate, and high levels of delegation of academic problem-solving tasks to AI.

Discussion of Findings

The finding from the first hypothesis showed a significant multivariate difference in the combined critical thinking and problem-solving skills of university students across the low, moderate and high levels of reliance on AI for answers without independent reasoning. The descriptive results indicated that students with low reliance on AI recorded the highest mean scores in critical thinking and problem-solving, followed by students with moderate reliance, whereas students with high reliance recorded the lowest mean scores. The MANOVA result further indicated that the combined dependent variables differed significantly across the three levels of reliance. Consequently, the null hypothesis was rejected. The finding suggests that the manner in which students rely on AI may be more important than simply whether they use AI. Students who use AI while retaining responsibility for reasoning, evaluating information and developing their own answers may have different cognitive outcomes from students who depend on AI to provide answers without first engaging

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independently with academic problems. This interpretation is consistent with Hou, Zhu, and Sudarshan (2025), who examined 808 undergraduate students and found that critical thinking skills were positively associated with reflective, cautious and collaborative forms of generative-AI use, whereas trust in AI positively predicted thoughtless use. The authors argued that critical thinking can counterbalance tendencies toward uncritical reliance by encouraging students to scrutinize AI outputs and engage more deliberately with them. The present finding extends this evidence by showing that students characterized by greater reliance on AI without independent reasoning had lower combined critical-thinking and problem-solving scores. Whereas Hou et al. (2025) examined critical thinking as a factor associated with different patterns of AI reliance, the present study approaches the relationship from the opposite direction by comparing students with different levels of reliance and examining their cognitive skills. The convergence of the findings suggests that independent cognitive engagement is important in determining how students benefit from AI. However, the present ex-post facto design does not establish that reliance on AI caused the lower scores; the finding should therefore be interpreted as a significant difference associated with levels of reliance. The finding also needs to be considered alongside the experimental evidence of Du et al. (2025). Their study of university students found that AI involvement in complex design problem-solving increased the frequency and interconnectedness of higher-order thinking skills, and students who were more influenced by AI incorporated more personal thinking and demonstrated greater use of higher-order thinking. This finding may appear different from the present finding, but the difference can be explained by the nature of AI engagement. Du et al. examined students working interactively with AI during structured complex problem-solving activities, whereas the present study specifically examined reliance on AI for answers without independent reasoning. Thus, AI involvement does not necessarily diminish critical thinking; rather, the present finding suggests that reliance that substitutes for independent reasoning may be associated with weaker critical-thinking and problem-solving outcomes. Therefore, the finding supports the view that university students should not merely be encouraged to use or avoid AI, but should be guided toward reflective and independent use of AI. The educational concern is particularly relevant where students allow AI to perform the initial reasoning process instead of using it to challenge, extend or refine their own thinking.

The finding from the second hypothesis showed a significant multivariate difference in the combined critical thinking and problem-solving skills of university students across the low, moderate and high levels of acceptance of AI-generated responses without verification. Students with low levels of accepting AI-generated responses without verification recorded the highest mean scores in both critical thinking and problem-solving, while students with high levels recorded the lowest scores. The MANOVA result demonstrated that the differences in the combined dependent variables were statistically significant. Consequently, the null hypothesis was rejected. This finding suggests that uncritical acceptance of AI-generated information is associated with poorer cognitive outcomes. Critical thinking requires students to examine evidence, question assumptions, compare information and determine whether conclusions are justified. When students routinely accept AI-generated responses without verification, these cognitive processes may receive less attention. Similarly, problem-solving requires students to examine the conditions of a problem, consider alternative solutions and evaluate the adequacy of a proposed answer. Accepting an AI response without verification may reduce students' opportunities to practise these processes. This finding is strongly related to Hou et al. (2025), whose study demonstrated that critical thinking was positively related to cautious, reflective and collaborative use of generative AI. In contrast, trust in AI was positively associated with thoughtless use, indicating a tendency toward less critical engagement with AI outputs. Their findings also showed that critical thinking could offset the influence of trust on less desirable reliance behaviour. The present finding is consistent with this pattern because students who demonstrated lower levels of uncritical acceptance of AI responses also demonstrated higher critical-thinking and problem-solving scores. The finding is further supported by Urban et al. (2024), who experimentally examined ChatGPT-assisted creative problem-solving among 145 university students. Students using ChatGPT produced solutions with greater quality, elaboration and originality and perceived the task as requiring less mental effort. However, the study also found problems with students' metacognitive monitoring: students using ChatGPT struggled to accurately evaluate the quality of their own answers, and perceived usefulness of ChatGPT was associated with greater overestimation of answer quality and originality. This aspect of Urban et al.'s findings is particularly relevant to the present result. AI can improve aspects of task performance while simultaneously creating difficulties in judging whether an AI-

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supported answer is actually adequate. Thus, the ability to verify and critically evaluate AI-generated responses remains important even when AI assistance produces apparently successful solutions. This finding also differs somewhat from the positive effects reported by Du et al. (2025), who found increased use of higher-order thinking during AI-supported complex problem-solving. The difference again appears to lie in how students engage with AI. In Du et al.'s experimental setting, students interacted with AI while analysing, evaluating and redesigning solutions. In the present study, the relevant behaviour was acceptance of AI-generated responses without verification. The latter represents a more passive form of engagement and therefore provides fewer opportunities for students to exercise independent evaluation. The finding therefore implies that the educational value of AI may depend substantially on students' capacity to question, verify and evaluate AI-generated information. University students may benefit from AI-generated explanations and solutions, but such benefits are less likely to translate into stronger critical-thinking and problem-solving skills when AI outputs are accepted without independent scrutiny. The finding from the third hypothesis revealed a significant multivariate difference in the combined critical thinking and problem-solving skills of university students across the low, moderate and high levels of delegation of academic problem-solving tasks to AI. Students with low levels of delegation recorded the highest mean scores in critical thinking and problem-solving, students with moderate levels recorded intermediate scores, while students with high levels of delegation recorded the lowest scores. The MANOVA result showed that the combined dependent variables differed significantly across the three levels of delegation. Therefore, the null hypothesis was rejected. The finding suggests that frequently transferring responsibility for academic problem-solving to AI is associated with lower levels of students' own critical-thinking and problem-solving skills. Problem-solving competence develops through repeated engagement with problems, including identifying the nature of a problem, generating possible solutions, selecting strategies, testing alternatives and evaluating outcomes. When students routinely delegate these cognitive activities to AI, they may have fewer opportunities to practice the underlying processes independently.

The finding is supported by Urban et al. (2024), although their results also demonstrate why the relationship between AI and problem-solving should not be interpreted as uniformly negative. Their experimental study found that ChatGPT improved the quality, elaboration and originality of students' creative solutions and reduced perceived mental effort. At the same time, students using ChatGPT showed difficulties with accurate self-evaluation, suggesting that AI assistance can improve the immediate product while creating challenges for students' metacognitive monitoring. The present finding extends this concern to delegation: when students move beyond using AI as a support tool and instead allow AI to perform substantial portions of the problem-solving process, their opportunities for independent cognitive practice may be reduced. The finding is also relevant to Du et al. (2025), who found that AI-supported complex problem-solving could increase students' use of higher-order thinking skills. Their experimental results showed that AI involvement increased the frequency of several higher-order thinking processes, although the study involved structured design tasks in which students continued to participate actively in analyzing and developing solutions. This distinction is important. The present finding does not imply that using AI to assist problem-solving is inherently detrimental. Rather, it suggests that higher levels of delegating problem-solving responsibility to AI are associated with lower critical-thinking and problem-solving scores. The finding is further consistent with Hou et al. (2025), who demonstrated that critical thinking was associated with reflective, cautious and collaborative AI use, while thoughtless use was positively associated with trust in AI. Delegating academic problem-solving tasks to AI can represent a shift from collaborative or reflective use toward a more passive form of reliance when students allow the technology to undertake cognitive activities that they would otherwise perform themselves. The present finding therefore reinforces the importance of maintaining students' cognitive agency during AI-supported learning.

Conclusion

The findings of the study indicate that overdependence on artificial intelligence is significantly associated with university students' critical thinking and problem-solving skills. Students with low levels of reliance on AI without independent reasoning, acceptance of AI-generated responses without verification, and delegation of academic problem-solving tasks to AI demonstrated higher levels of critical thinking and problem-solving skills than those with moderate and high levels of overdependence. The findings suggest that while AI can support learning and enhance problem-solving when used appropriately, excessive reliance on it may reduce opportunities for students to independently analyze information, evaluate

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alternatives, and develop solutions. Therefore, the educational value of AI may depend largely on how students engage with it, particularly their ability to maintain independent reasoning, verify AI-generated information, and use AI as a supportive rather than substitute cognitive tool.

Implications of Findings

The findings have several implications for university teaching, learning and educational policy. First, the observed differences in critical thinking and problem-solving skills across levels of AI overdependence suggest that universities should promote responsible and purposeful use of AI rather than unrestricted reliance on AI-generated answers. Lecturers should design learning activities that require students to demonstrate independent reasoning, verify AI-generated information, explain their solutions, and critically evaluate alternative answers. Second, students should be guided to use AI as a learning support tool rather than as a substitute for their own thinking and problem-solving efforts. This may require integrating AI literacy, verification skills and critical evaluation into relevant courses and student orientation programmes. Third, assessment practices may need to place greater emphasis on authentic and process-oriented tasks through which students demonstrate how they arrived at their answers, rather than relying solely on final responses that can easily be generated by AI. Finally, university management and curriculum planners should provide clear guidelines for responsible AI use in academic work while supporting lecturers in developing assessment strategies that preserve students' opportunities to practise critical thinking and problem-solving. Overall, the findings imply that the educational benefits of AI are more likely to be realised when its use complements, rather than replaces, students' independent cognitive engagement.

Recommendations

1. Universities should discourage excessive reliance on AI-generated answers without independent reasoning by requiring students to explain their reasoning processes, justify their answers, and demonstrate their own understanding when completing AI-supported academic tasks.
2. Lecturers should require students to verify AI-generated information before accepting or using it by checking AI responses against credible academic sources, course materials, and other evidence. This can strengthen students' critical evaluation skills and reduce uncritical acceptance of inaccurate AI-generated content.
3. Universities should establish guidelines that encourage the use of AI as a support for, rather than a replacement for, students' problem-solving efforts. Lecturers should design assignments that require students to attempt problems independently before using AI and to reflect on how AI contributions were evaluated and integrated into their final solutions.

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