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The Effect of AI-Assisted Learning on University Students' Critical Thinking Skills

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Research guide

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ABSTRACT :

The use of artificial intelligence (AI) in higher education has grown significantly, and it has been a subject of debate in relation to students' critical thinking skills. The purpose of this research was to analyze the effect of AI assisted learning on the ability of critical thinking skills of university students, which is a type of descriptive survey study. Additionally, we explored whether there is a moderator effect of student engagement on the association between AI-based learning and critical thinking. This study was carried out with 268 university students who answered to a Likert scale questionnaire with 5 points. Descriptive statistics, Cronbach's alpha analysis, correlation, one-way ANOVA and the Sobel mediation test were used to analyze the data. Students expressed positive attitudes toward AI-assisted learning (3.73), engagement (3.66) and critical thinking (3.66). There was no significant indirect effect (Sobel $z=-0.69$; $p=0.491$). AI-assisted learning did not significantly affect students' critical thinking ($\beta=0.03$, $p=0.569$) or engagement ($\beta=-0.05$, $p=0.440$). Similarly, student engagement was not a significant predictor of critical-thinking skills ($\beta=0.09$; $p=0.137$). Reliability of the measurement instrument was extremely low (Cronbach's $\alpha<0.12$). Hence, we recommend caution in interpreting the results of this study. The Annual Conference will be dedicated to the topics of AI-aided learning, critical-thinking skills and student engagement.

The keywords for the article are: AI-assisted learning ; serious thinking talents ; student involvement ; mediation review ; education ; generative artificial intelligence ; academic institution student.

1. Introduction

Computer awareness arrangements have changed the classroom atmosphere around the world. In the near future, there will be a growing trend in higher education organization structure toward the unprecedented integration of sophisticated machine learning-based education techniques such as ChatGPT, Grammarly, Gemini, and other modern devices. Indeed, a recent survey on students and scholars using AI-assisted acquiring knowledge revealed that over 90% of respondents used AI-based devices for college purposes). Such simulated innovations change the structure of the acquisition of knowledge by allowing students to complete tasks, understand difficult subjects, feel happy, solve questions, and understand reality easily. Machine learning systems are important and can adapt the entire environment to learn knowledge and expand the unprecedented opportunities of D2D (device to device) education. A number of computer innovations are currently being immediately applied in educational institutions near the world. AI-assisted perusal is becoming more and more in demand due to higher tuition fees for the ability to provide personalized learning experiences, instantaneous responses to students, and simple creation of information and additional training components which are easily accessible to students. Students use artificial intelligence to help students develop information components, connect with other individuals, improve their writing and performance evaluation, and are surrounded by alternative wages. As a result of the guidance of travel, machine intelligence is currently in line with the spirit of the plan and can continue to be exploited for maximum gain in expertise and increased productivity.

However, the argument is that the influence of innovative teaching methods which exceed the essential thinking abilities of students may be imputed to. critical reflection be an individual of the compulsory skills students are expected to have to enter college. Competences for critically studying wisdom, evaluating facts, determining facts, solving problems creatively, and making sound judgments are essential for students. Colleges and universities are a

sign of students' need to enhance their significant thinking aptitudes so that they may excel in their careers and in other aspects of their existence. The assessment provides a balanced report on the association of AI-assisted research with significant thinking.

A couple of scholars argue that artificial intelligence enhances analytical skills, critical thinking, and generally compulsory contemplation in the middle of students (Asghar et al., 2025; Zablotska et al., 2026; Bolarinwa, 2026; Ela et al., 2024). For instance, students may be interested in the use of computer generated content which does not provide information critically related to the information provided by computerized approaches.

Proficiency in critically measuring wisdom is of paramount importance for ensuring college principles and prevention of plagiarism. A recent systematic review and synthesis of evidence on higher-order thinking and cognition revealed inconsistent conclusions on the influence of AI-assisted learning on students' grave contemplating aptitudes (Khan et al., 2026). Such contradictory findings highlight the need to identify a mechanism that includes machine learning systems and other important considerations. The involvement of students in automated reasoning systems may have an individual likely explanation. A multidimensional impression on the student, including cognitive, mannerism, and sentimental. Generally speaking, students are actively involved in the acquisition of knowledge as much as their curiosity and enthusiasm for the method of acquisition of knowledge. The involvement of students has been recognized as a key factor in the achievement of knowledge triumphs and may influence the evaluation of students who have recently acquired recent proficiency, including important reflections. Acumen automation can directly or implicitly influence students' key thinking competencies through student interaction. AI-enhanced learning can increase student engagement and, furthermore, enhance critical thinking. On the flip side, students who believe too much in intelligent automation may lose their way in the education system and thus delay their essential thinking skills. Therefore, student involvement can act as a mediator between AI-based teaching and students' essential thinking capacity. The main study objectives related to exploring the power of AI-assisted study on students' significant thinking capacity. Moreover, the mediation role of student engagement will be examined. By clarifying the current mechanism, the current study can help tutors and administrators to develop a victorious scheme to integrate AI into the institute structure, while moreover helping students with key reflective abilities.

Problem Statement

Machine Intelligence Acquiring Knowledge Devices Used by College Students Change the Way They Are Exploring Today. Although intelligent automation has its advantages, such as higher admission rates for knowledge and faster education rates, there is concern about its influence on students' essential reflective abilities.

A couple of analyses show that A.I. is useful for studying; other conclusions show the disadvantages of excessive dependency on it. The results of the conflict over the use of AI in teaching; during a few inquiries, it seems to have a positive effect on students' acquiring knowledge, while other researchers argue against its use due to the disadvantages linked to the dependency on tools. Moreover, there is little analysis on the impact of student engagement on this. Therefore, it is necessary to investigate how AI affects students' cognitive abilities as well as their level of engagement in it.

Research Gap

The previous question refers to the connection of intelligent automation for teaching and the cognitive abilities of students' reasoning control. Still, there is no analysis paper on the subject that probes students' engagement as an intermediary factor in the context of AI-based learning and analytic deduction competencies, whereabouts it would be merely a conclusion or association towards the ones. Furthermore, there may be some differences among the examinations of the way in which AI changes gravely in view of the evidence that we should develop an even more advanced theory on it. The report deals with this problem by investigating the way in which a large number of students' engagement can be a mediator between the use of artificial intelligence and the development of essential reflective skills.

Review of Literature

4.1 AI – based evidence for supporting critical thinking skills

A post roundabout in which ai supports students to improve their analytical capacity through education. A few studies have shown that learning with artificial intelligence contributes to better student analytical skills. Automated reasoning facilitates better critical thinking by regulating queries on it via study information clusters and experiment results from these studies. Asghar et al.'s study shows that in the midst of 400 students from four different disciplines alongside Pakistani universities, artificial intelligence innovation helps cultivate talents such as critical reflection, logical deduction, and problem-solving aptitudes nevertheless does not assist a lot together with a lot of types of probes as several had neither influence alongside each. Fatih states that nearby will be a result of Tech literacy and grave reflection among fifth graders if they are taught using problem-based learning and artificial intelligence, which transactions account for 50 percent of the disparity among them. Zafar et al. (2025) found that 68 % of secondary students found ChatGPT useful in critically thinking ($M = 3.85$) and that the interaction with ChatGPT was reasonable in conjunction with critical thinking ($r = .52$). That's an experiment, a quasi-experimental exploration. Alim and Butsiah found that students who were taught through Project-Based Training and Machine Learning Systems had higher trial volumes compared to those who were taught in a control group (92.3 vs. 85.2); additionally, it was found that the aforementioned machine intelligence tools were effective in prosecuting and cooperating students;. According to Rahmawati et al., Moreover, argumentation skills via AI-supported scanning compare well with standard methods as well as to a higher level of involvement of students in their fascination with and enthusiasm for the authoring task. According to Zablotska et al. The teaching of an alien language from the student's point of view contributes to improving their metacognition abilities as well as their logical thinking abilities through the critical assessment of the final product of intelligent automation. According to Faizi et al. In 2026, there was a model of progressive teaching engagement and ICT literacy, as well as secondary data, predicting that the aforementioned abilities would be improved through teacher supervision.

4.2 Mixed evidence and the risk of overreliance

There are several analyses nearby that have an excessively pessimistic view of it. Hading, et al. 's exploration shows that following toward the ones, ai be considered by EFL learner as living damaging for evolving essential considering talents during furthermore supply several aid enjoy help together with finding outdoors more approximately subject using search engine else brainstorm notions before penning essay on these subjects. Darwin et al. , EFL masters students like machine intelligence for investigative purposes and hypothetical studies, yet they are unhappy with the fact that they live too impersonal and incompetent in order to integrate together with nuance admire sarcasm or emotion. In Albania, ela et al. (2024) There is no meaningful contrast between students with and without anterior ai exposure, although a useful pessimistic link in the midst of reliance on ai for assignment and troubleshooting abilities, aboard a robust beneficial association between usage frequency and observed efficiency. Ridlo et al. (2026) show that the intensity of the use of artificial intelligence negatively predicts essential reflection in the midst of the Indonesian Institute student (=.24), a implication that twisted the benefit for students with high Digital Competence (=.15) and was strong for them together with reduced Technical literacy (=.38). AI usage seems essential. There might be an inverse connection between the use of knowledge retrieval and self-assessed critical reflection; however, there was no meaningful connection among the completed conception tasks for text edit department. Yuan et al. , 2026 countries where there is an inverse relationship between generative AI dependency and creativity through essential thinking. The findings of the inquiry consequences help the present maintain that ai enhances information review, comprehension of text, penning competence, and basic cognition, but excessive dependence can conclude in weak analytic expertise admire critical thinking skills, argument formation abilities, imagination, and metacognition. Khan et al. The results of the research on higher-order cognition inquiry findings from 2011-2026, therefore, the manuscript proposes a machine intelligence subordinate model with equally effective and destructive impacts on critical thinking abilities.

4.3 Mediating and moderating mechanisms

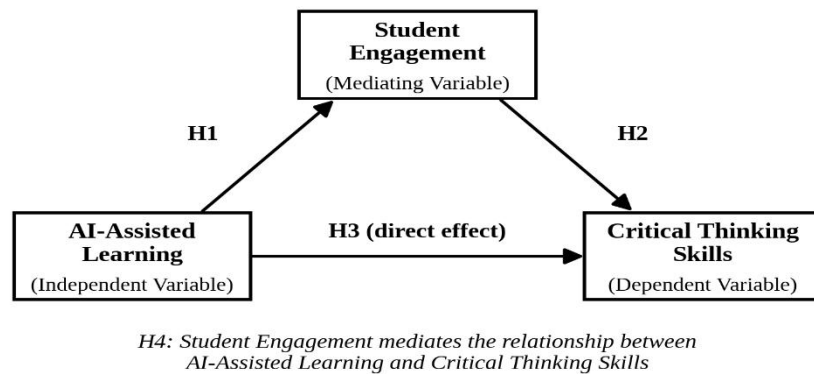
A growing set of studies examines the mechanisms linking AI use to critical thinking. Ninghardjanti et al. (2025) combined the Technology Acceptance Model with critical thinking theory and showed the importance of metacognitive awareness in AI-adoption behavior. Arshad et al. (2026) found that AI use related to critical thinking among medical students through cognitive load and self-regulated learning. Tian and Zhang (2026) identified two pathways: a beneficial route through focused immersion and a detrimental route in which higher perceived AI intelligence increased focused immersion, which increased AI dependency, which in turn was associated with lower critical thinking. Using a 12-month cross-lagged design, Xin et al. (2026) found that AI literacy mediated the association between AI-assisted diagnosis participation and critical thinking among medical students. Guo et al. (2026) showed that critical thinking enhanced AI-assisted creativity through creative self-efficacy, with the strongest effect among doctoral students. Taken together, these studies emphasize cognitive, metacognitive and literacy mechanisms, whereas student engagement, which is consistently reported as a benefit of AI-supported instruction (Alim & Butsiarah, 2025; Faizi et al., 2026; Rahmawati et al., 2026), has not been tested as the mediator between AI-assisted learning and critical thinking. This is the gap the present study addresses.

4.4 Synthesis and theoretical grounding

Through 23 research reviews, three forms have stood the test of time. First of all, the direction of the association in the context of machine intelligence and key thinking depends entirely on the designer and the situation. Structured, instructor-led intervention similar to AI-assisted problem-based or project-based education and AI-generated pleasure used as an object of evaluation, often in order to report addition (Alim & Butsiarah, 2025 ; Fatih, 2025 ; Zablotska et al. , 2026), whereas a survey on general usage shows a weak, sometimes unconstructive association (ela et al. , 2024 ; Ridlo et al. Zhang & Yang, 2026 ;. Moreover, compared with fulfilled coevals and dependency, the use of topic retrieval and confirmation seems to be more benign, as compared to the use of topic retrieval and confirmation. Zhang & Yang, 2026 ;. Thirdly, the focus on cognitive and metacognitive mechanisms rather than on the manner and affectional engagement of students has been confined to the explanatory occupation in particular. To frame the current model, several speculative positions in that fiction. The theory of cognitive load and self-government is based on the way in which different kinds of machine intelligence deal with critical thinking and the motivation that determines that association (Zhang & Yang, 2026). The interaction of Person-Affect-Cognition-Execution (I-PACE) system has been familiar with explaining how the heavy reliance on ai can destroy the central thinking of Tian & Zhang, 2026), and situate acquiring knowledge theory possesses been familiar with explaining how supervised contribution with artificial intelligence can combine critical musing Above span (Xin et al. 2026). Unchanging with this position, contemporary researchers assume that AI-assisted study shapes the way students finance their efforts to study, and that this effort, which is the student's interaction capture, determines how much they practice examination, measuring, and questioning intelligence. That deduction is the driving force behind the mediation method test of this study.

Conceptual Framework

AI training is an independent variable, student cooperation is an interdependent variable, and vital reflective abilities are a subordinate variable. The model proposes that AI-assisted learning influences student interactions, student exchange contributes to important thinking abilities, and AI-assisted acquiring knowledge disrupts the association of AI-assisted education with essential thinking abilities. Expertise directly (H3) and student. t collaboration interferes with the association of AI-assisted intelligence with fundamental thinking abilities (H4).



Research Objectives

1. To investigate the effect of AI-assisted learning on student engagement.
2. To assess the influence of student engagement on critical thinking abilities
3. To analyze the impact of AI-assisted learning on critical thinking skills.
4. Research on the mediation role of student interaction in relation to AI-assisted learning and key thinking abilities.

Research Hypotheses

Alternative hypothesis

- H1: AI-assisted learning significantly impacts student engagement.
- H2: Student engagement is significantly associated with critical thinking skills.
- H3: AI-assisted learning significantly impacts critical thinking skills.
- H4: Student engagement mediates the effect of AI-assisted learning on critical thinking skills.

Null hypothesis

- H01: AI-assisted learning has no significant influence on student engagement.
- H02: There is no significant effect of student engagement on critical thinking skills.
- H03: AI-assisted learning does not have a significant effect on critical thinking skills.
- H04: Student engagement does not mediate the effect of AI-assisted learning on critical thinking skills.

Methodology of Research

8.1. The Research Design

The study adopted a quantitative design of cross-sectional survey.

8.2 Population and Sampling

The population was university students using AI-assisted learning tools. Convenience sampling was employed.

8.3 Number of samples

The sample included 268 students from educational institutions. The dataset in question does not contain any missing standards, and all the output reports below are based on $n = 268$. The two-tailed trial with $\alpha = .05$, together with the current sample size, has 80 % control to produce a relationship with approximately $r = .17$ (Fisher z estimation).

8.4 Instrument and Coding

The facts were collected using a structured questionnaire (Google shapes) using a five-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree). The answer was to convert a number code to a numeric code in Microsoft Excel. The questionnaire includes five individual items for AI-assisted learning (AI1–AI5), student engagement (EN1–EN5), and essential thinking skills (CT1–CT5), as well as five ancillary items above the recognized linkage between interaction and serious thinking (MD1–MD5). The concept tons are the mean of the five items (1–5), and the higher the number, the greater the agreement. The average tons were interpretably minimal: 1.00–1.79 very minimal, 1.80–2.59 minimal, 2.60–3.39 centrist, 3.40–4.19 high, and 4.20–5.00 high.

8.5 Procedures for Data Analysis

Analyzes were performed in Microsoft Excel (formula-based workbook) and cross-checked with an independent calculation. The procedures were

descriptive statistics; Cronbach's alpha (the threshold is .70); Pearson correlation; chi-square tests of independence; one-way ANOVA; simple and multiple linear regression (H1-H3); and a Sobel test of the indirect effect (H4). Significance was assessed at $\alpha = .05$ (two-tailed).

8.6 Operational Definitions of Variables

AI-Assisted Acquiring Knowledge shall be defined as the extent to which students report using AI devices, such as ChatGPT, Grammarly, and Gemini, in support of their learning activities, and measured by the mean of items AI1–AI5. Student engagement shall be defined as the engagement, curiosity, emotional involvement, and cognitive effort of students who contribute to learning projects and shall be measured in accordance with items EN1–EN5. The essential competences are the ability to examine data, examine evidence, distinguish beliefs, decipher questions, and arrive at well-founded conclusions, measured by CT1–CT5. As all three concepts are measured by self-reporting, they represent student views rather than performance on a critical thinking test. More tons on the related concept indicate a strong understanding of the statement that describes it.

Results

9.1 AI Usage Profile of Respondents

Forty respondent (14.9%) were in the minimal use group, 52 (19.4%) in the moderate group, and 176 (65.7%) in the high group.

9.2 Descriptive Statistics and Reliability

Table 1. Descriptive statistics and reliability (n = 268)

Construct	AI	EN	CT	MD*
AI-Assisted Learning (AI)	1			
Student Engagement (EN)	-.047 ($p = .440$)	1		
Critical Thinking (CT)	.035 ($p = .569$)	.091 ($p = .137$)	1	
Engagement–CT Linkage (MD)*	-.055 ($p = .374$)	.035 ($p = .567$)	-.037 ($p = .545$)	1

Note. *Supplementary construct. All alphas are far below the .70 threshold.

The average tons per complete concept fall in the " tall " group (.40–4.19), implying that students broadly agree that AI helps their education, interaction, and critical thinking. The distribution is slightly skewed. However, Cronbach's alpha was between .081 and .123 for each grade, a skillfully below the .70 standard. Thus, the quantities within the limits of every magnitude do not act as coherent quantities, restricting the extent to which the concept of tons can be interpreted.

9.3 Correlation Analysis

Construct	Items	<i>M</i>	<i>SD</i>	<i>Skewness</i>	<i>Cronbach's a</i>
AI-Assisted Learning	5	3.73	0.47	–0.46	–.081
Student Engagement	5	3.66	0.52	–0.44	.105
Critical Thinking Skills	5	3.66	0.48	–0.58	–.010
Engagement–CT Linkage*	5	3.67	0.52	–0.50	.123

Table 2. Pearson correlations among construct scores (n = 268)

Note. *Supplementary construct.

None of the correlations were statistically significant, and their size was negligible ($|r| < .091$). Among students' involvement and crucial thinking, roentgen = .091 phosphorus = .137).

9.5 One-Way ANOVA

Table 4. One-way ANOVA results

Dependent variable	Grouping	Group means (Low / Moderate / High)	<i>F</i>	<i>df</i>	<i>P</i>	η^2
Critical Thinking	AI usage group	3.63 / 3.80 / 3.63	2.685	2, 265	.070	.020
Student Engagement	AI usage group	3.53 / 3.73 / 3.67	1.725	2, 265	.180	.013
Critical Thinking	AI-Assisted Learning level	3.49 / 3.64 / 3.71	1.622	2, 265	.200	.012
Student Engagement	AI-Assisted Learning level	3.70 / 3.65 / 3.66	0.061	2, 265	.941	.000

No ANOVA reached significance, so post-hoc tests were not needed. Critical thinking differed most across usage groups ($F = 2.685$, $p = .070$), but the pattern is not ordered (the moderate-usage group scored highest) and the effect is small ($\eta^2 = .020$).

9.6 Regression Analysis (H1–H3)

Table 5. Linear regression results ($n = 268$)

Model	Predictor	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>	<i>R</i> ²
M1 (H1): DV = Engagement	AI-Assisted Learning	−0.052	0.067	−.047	−0.774	.440	.002
M2 (H2): DV = Critical Thinking	Student Engagement	0.085	0.057	.091	1.493	.137	.008
M3 (H3): DV = Critical Thinking	AI-Assisted Learning	0.036	0.063	.035	0.571	.569	.001
M4: DV = Critical Thinking	AI-Assisted Learning	0.040	0.062	.039	0.643	.521	.010
	Student Engagement	0.087	0.057	.093	1.520	.130	

Note. M1: $F(1, 266) = 0.598$, $p = .440$. M2: $F(1, 266) = 2.228$, $p = .137$. M3: $F(1, 266) = 0.326$, $p = .569$. M4: $F(2, 265) = 1.319$, $p = .269$, adjusted $R^2 = .002$, VIF = 1.002 (no multicollinearity).

AI-assisted learning does not significantly predict student engagement in projects H1), student engagement does not significantly predict important thinking H2, and AI-assisted education does not significantly predict critical thinking H3). The individual models explain 1 % of the difference, otherwise less.

9.7 Mediation Analysis (H4)

Table 6. Mediation of AI-Assisted Learning → Student Engagement → Critical Thinking

Path	Estimate	Note
a (AI → Engagement)	−0.052	$SE = 0.067$
b (Engagement → CT, controlling AI)	0.087	$SE = 0.057$
Indirect effect ($a \times b$)	−0.0045	Sobel $z = -0.689$, $p = .491$
Total effect c (AI → CT)	0.036	$p = .569$
Direct effect c' (AI → CT, controlling engagement)	0.040	$p = .521$

The indirect effect was negligible and not significant, and neither the a path nor the total effect was significant, so the conditions for mediation were not met. There was no evidence that student engagement mediates the relationship.

9.8 Summary of Hypothesis Tests

Table 7. Hypothesis decisions

Hypothesis	Statistic	<i>p</i>	Decision
H1: AI-assisted learning → engagement	$t = -0.774$	.440	Not supported
H2: Engagement → critical thinking	$t = 1.493$	.137	Not supported
H3: AI-assisted learning → critical thinking	$t = 0.571$	.569	Not supported
H4: Engagement mediates AI → critical thinking	$z = -0.689$	.491	Not supported

Discussion

This study found that university students generally hold favorable views of AI-assisted learning, yet these views were not statistically linked to their self-reported engagement or critical thinking. All four hypotheses were unsupported, and the relationships tested were close to zero rather than merely underpowered: with $n = 268$ the correlations ranged from $-.055$ to $.091$, and the sample could detect a correlation of about $.17$ with 80% power.

The absence of a direct effect of AI-assisted learning on critical thinking is consistent with the mixed evidence reported in recent syntheses (Khan et al., 2026) and with the finding of no difference in critical thinking between students with and without prior AI exposure (Çela et al., 2024). It is also consistent with the view that outcomes depend on how AI is used, whether through focused immersion or dependency (Tian & Zhang, 2026), the type of use (Zhang & Yang, 2026) or students' digital literacy (Ridlo et al., 2026). The result does not replicate studies that report clear gains in reasoning

and critical thinking (Asghar et al., 2025; Fatih, 2025; Zablotska et al., 2026). Note, however, that Fatih (2025) and Zablotska et al. (2026) evaluated structured instructional designs, in which AI was embedded in problem-based learning or used as an object of critique, whereas the present study measured students' general perceptions of AI-assisted learning. The unordered ANOVA pattern, in which moderate AI users scored highest on critical thinking, is directionally in line with models that propose both beneficial and harmful influences of AI (Khan et al., 2026), but the difference was not significant and should not be over-read.

Student engagement did not mediate the relationship. Predictive modeling suggests that AI-supported learning can raise engagement (Faizi et al., 2026), and quasi-experimental studies report higher engagement under AI-assisted instruction (Alim & Butsiah, 2025; Rahmawati et al., 2026), yet here AI-assisted learning showed no association with engagement ($\beta = -.05$), so the first link of the proposed chain was missing. The one significant finding, a small association between high engagement and high critical thinking in the chi-square test ($V = .163$), agrees in direction with the theoretical expectation that engagement supports critical thinking, but it was not replicated in the regression or correlation of continuous scores and is one of eight supplementary tests.

The most important qualification is measurement quality. Cronbach's alpha was below .15 for every scale, far under the .70 criterion, and negative for two scales, which occurs when items covary negatively on average. When items do not correlate with each other, construct scores mostly reflect noise, which pulls any true relationship toward zero. The null results therefore cannot be read as showing that AI-assisted learning has no effect; they show that the present measures did not detect one. Item wording, the need for reverse coding, and data-quality issues such as careless or patterned responding should be reviewed before conclusions are drawn.

Implications

11.1 Theoretical implications

The conclusions do not support an easy interface nerve pathway from AI-assisted acquiring knowledge to crucial thinking, and they are reliable together with the assumption that the association is conditional rather than cosmopolitan (Khan et al. 2026). Models with the potential to produce valuable results typically specify the method of automated reasoning used, for instance using concentrated submergence versus dependence (Tian & Zhang, 2026), using a distinct usage type (Zhang & Yang, 2026), or otherwise using a support mechanism identical to Computer literacy, Automated reasoning literacy, cognitive load, and self-regulated training (Arshad et al. :), 2026; Ridlo et al. , 2026; Xin et al. 2026). Therefore, the general measure of AI-assisted education is likely to remain too coarse to discover the indirect consequences using engagement. The upcoming model should test its involvement alongside such a state rather than isolation.

11.2 Practical implications

For teachers and institutions, the consequences do not provide any evidence that ai use, as a measure here, enhances or weakens significant thinking, and therefore do not justify either restricting alternatively the support of ai devices under the current principle entirely. The literature review shows that the design of the learning activity, such as the need for students to judge and verify the final product of automated reasoning, requires students to judge and verify the results of automated reasoning (Zablotska et al. , 2026), might be more interesting than if Ai had been used to. Thus, teachers can apply artificial intelligence to tasks that require students to question, parallel, and justify them, and can combine automated reasoning with the teacher's advice (Faizi et al. :). 2026). Organizations can assist the present using automated reasoning literacy systems and assessment designs respecting deduction and not only complete items (Asghar, 2026).

11.3 Implications for research

For scientists, the findings underline the need for validated scales with proven internal consistency and procedures of essential reflection that go beyond self-perception, such as performance trials. Zablotska et al. 2026). Surveys should, in addition to identifying the type of ai, use and measure participation in their behavioral, emotional, and cognitive dimensions individually, given that the individual complex is likely to conceal different impacts.

Limitations and Future Research

In the first instance, the scope's dependability was unacceptably low, as noted above. Then, whole factors are self-reported understandings, they do not measure proficiency, and the serious thinking question focuses on the observed advantage of automated reasoning rather than on serious thinking itself. Thirdly, convenience sampling and cross-sectional design limit generalization and rule out causality. Fourthly, the demographic characteristics of the respondents were not analyzed (such as sex, time, and meadow of investigation), so that subgroup differences could not be analyzed. The fifth, chi-square, and ANOVA teams were determined from the distribution of Likert tons, which discarded intelligence and were slightly arbitrary. Sixth, the Sobel trial had become accustomed to the use of bootstrapping and the assumption of normality in the indirect consequences. A validated instrument, capturing real usage forms, testing non-linear (moderate usage) outcomes, and using a systematic equation model with bootstrapped indirect outcomes should be used in this research.

Further, future research could (a) retroflex the model with a scale whose reliability has been confirmed in the target community; (bacillus) extend the answering features such as sex, epoch, annual, and grassland of scrutiny; thus that difference over subgroup can be tested, as the creative writing indicates that use varies by discipline and collegiate stage (Archana et al. , 2025); (degree centigrade) Analogize types of machine intelligence employ, such as detail retrieval, satisfied coevals, and text revision (Zhang & Yang, 2026); and (vitamin D) use another experimental design that can

support causal claims related to which method AI-assisted education and participation constitutes a crucial musing exceeding duration (Xin et al., 2026; Yuan et al., 2026).

13. Conclusion

The research focused on how AI-assisted learning works. The effects of critical thinking on the university students and the degree of their participation in the educational process. The study found a strong correlation between students' use of AI tools and their reported degree of help received from these tools. Learning, Engagement, Critical Thinking and Regression, Correlation, ANOVA, and the mediation analysis did not find any statistically significant effects; and, there were not any of the four. This hypothesis was confirmed. The only noteworthy finding was a modest chi-square association linking engagement with critical thinking levels, which requires further validation. Given the scales exhibited minimal internal consistency, these results ought to be regarded as preliminary at best. It is essential for institutions to persist in encouraging a balanced and reflective approach to AI usage. Meanwhile, future research should utilize more dependable measures to determine the extent to which—and under what conditions—AI-assisted learning influences critical thinking development.

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