

The Effect of Using AI in Learning on Critical Thinking Skills Through Students' Digital Literacy

Sutarsi Suhaeb

Makassar State University, Indonesia

Nurfauziah

Makassar State University, Indonesia

Nur Athiyyah Fadhilah

Makassar State University, Indonesia

Corresponding Author: sutarsi.suhaeb@unm.ac.id

Abstract

The increasing use of generative AI in university learning has raised important questions regarding its contribution to students' cognitive development. Although applications such as ChatGPT, Gemini, and Claude can facilitate personalized and efficient learning, their educational value may be constrained when students lack sufficient digital literacy. To investigate these relationships, this study employed a quantitative cross-sectional survey involving active university students with prior experience using generative AI for learning. Data were collected through a structured five-point Likert questionnaire and examined through Partial Least Squares Structural Equation Modeling (PLS-SEM). The analysis involved evaluating the measurement properties of the constructs, examining the structural model, and estimating both direct and mediated effects. The findings confirmed satisfactory measurement quality for AI use, digital literacy, and critical thinking. AI utilization was positively related to students' critical thinking, but its direct effect was comparatively small. A considerably stronger association was observed between AI utilization and digital literacy. In turn, digital literacy was positively associated with critical thinking. The mediation results further indicate that the contribution of AI utilization to critical thinking operates partly through students' level of digital literacy, suggesting that the development of digital competencies is an important pathway connecting AI-supported learning with higher-order cognitive skills. This suggests that the contribution of AI to students' critical thinking is strengthened when students possess adequate digital literacy. Therefore, higher education institutions should integrate digital literacy development into AI-supported learning, particularly

2909

IJEVSS, Volume 05 Issue 04, 2026



Copyright at authors some right reserved this work is licensed under a [Creative Commons Attribution-Share Alike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/)

by strengthening students' abilities to verify information, recognize potential algorithmic bias, and regulate their use of AI. In this way, AI can function as a tool that supports intellectual development rather than replacing students' critical thinking processes.

Keywords: Artificial Intelligence; Digital Literacy; Critical Thinking; SEM-PLS; College Students

INTRODUCTION

The integration of Artificial Intelligence (AI) into the higher education ecosystem has sparked a rapid shift in perspectives on learning between 2024 and 2026. This phenomenon is characterized by the use of generative and interactive AI tools such as ChatGPT, Gemini, and other adaptive learning systems that promise improved cognitive efficiency and personalized learning (Ateeq & Alfiras, 2025) (Braz~ao & Tinaco, 2025) (Sardi, 2025). In the student community, the use of AI is no longer merely a technological trend but has become a primary tool for expanding ideas, providing in-depth insights, and facilitating the exploration of complex information (Lawasi et al., 2024) (Jasmadi et al., 2024). Despite its considerable potential to transform educational practices, the integration of artificial intelligence also raises concerns about its influence on higher-order cognitive development, particularly students' capacity for critical thinking. Within higher education, the application of AI can produce diverse learning outcomes. When used appropriately, AI-based technologies may facilitate more efficient learning, deepen students' understanding of complex concepts, stimulate creativity, and encourage greater involvement in academic activities.

However, the use of AI also carries potential risks such as plagiarism, technological dependence, and a decline in critical thinking skills. Furthermore, limitations in AI literacy and the lack of clear institutional guidelines pose challenges to its optimal utilization in higher education settings (Nurfauziah et al., 2025). The urgency of critical thinking skills in the AI era is crucial because students are confronted with a flood of machine-generated information, which often contains bias, contextual inconsistencies, or factual inaccuracies (Fakour & Imani, 2024) (Jasmadi et al., 2024). Critical thinking enables students to evaluate, analyze, and synthesize AI outputs, rather than passively accepting them (Lawasi et al., 2024) (Sardi, 2025). Recent research shows mixed results; on the one hand, interaction with AI can stimulate cognitive engagement and reflection (Demir & Akar, 2025) (Braz~ao & Tinaco, 2025), however, on the other hand, excessive reliance on the convenience of AI risks reducing motivation for independent learning and

2910



weakening students' analytical capacities (Anita et al., 2025)(Zhou et al., 2024) (Jasmadi et al., 2024). This phenomenon poses a real threat where AI is used to automate tasks without deep thinking.

In the dynamic relationship between AI use and critical thinking, digital literacy emerges as a crucial determining factor. Digital literacy encompasses not only the technical ability to operate devices but also self-regulation, ethical awareness, and the ability to critically evaluate digital resources (Demir & Akar, 2025)(Zhou et al., 2024). literature findings (2024–2025) indicate that digital literacy acts as a mediator that explains how AI use influences critical thinking skills (Ateeq & Alfiras, 2025). Students with high digital literacy tend to be able to utilize AI as a thinking tool to strengthen their analytical capacities (Anita et al., 2025). Conversely, low digital literacy causes the use of AI to have a negative impact because students lack the ability to filter the information provided by AI (Andrian et al., 2025)(Anita et al., 2025).

Although the mediating role of digital literacy has been identified, there is a significant research gap in the current literature. Most studies remain sector-specific with mixed results; some demonstrate the positive influence of digital literacy as a direct predictor (Ateeq & Alfiras, 2025), while others position it as a moderator (Anita et al., 2025) (Arinto et al., 2026). or report a lack of robust mediation testing (Arinto et al., 2026). Furthermore, there is heterogeneity in the definitions and measurement instruments for digital literacy and AI literacy, which makes it difficult to synthesize findings universally (Fatih, 2025)(Demir & Akar, 2025). In Indonesia, research that explicitly tests this mediation model at the undergraduate level remains very limited, particularly studies employing robust quantitative approaches to validate the role of digital literacy in mitigating the risks of AI dependency (Kurniawati et al., 2025)(Arnu & Sobandi, 2025).

Several recent studies indicate that AI can provide cognitive stimulation that encourages students to analyze, evaluate, and reflect on the information obtained during the learning process. AI can serve as a tool to help students develop problem-solving and critical thinking skills when used pedagogically and purposefully (Andrian et al., 2025). However, using AI without sufficient digital literacy may cause students to rely too much on technology and reduce their ability to think independently. Previous studies have shown that AI can support and improve the learning process. However, studies that examine the connection between AI use, digital literacy, and students' critical thinking skills are still limited. Therefore, this study examines how the use of AI in learning affects students' critical thinking skills and how digital literacy contributes to this relationship. Understanding this relationship can help higher education institutions develop appropriate learning strategies and digital literacy programs. In this way, AI can be used to support



students' intellectual development while maintaining their ability to think critically and independently.

Drawing on the preceding discussion, the present research examines the interplay among artificial intelligence (AI) utilization, digital literacy, and students' critical thinking abilities. Specifically, the study seeks to determine whether incorporating AI into learning activities is associated with students' critical thinking development, whether such utilization contributes to the enhancement of their digital literacy, and whether digital literacy functions as an intervening mechanism linking AI use with critical thinking. The results are anticipated to extend the theoretical understanding of technology-supported learning while also providing practical insights for designing instructional strategies that incorporate digital technologies effectively within higher education contexts.

METHOD

Research Design

This research investigates the relationship between AI utilization, digital literacy, and students' critical thinking through a quantitative explanatory survey. Rather than following participants over an extended period, the investigation captured the required information at a single point in time using a standardized questionnaire. Within the proposed model, AI use represents the exogenous variable, critical thinking serves as the outcome, while digital literacy is positioned as the intervening variable that may explain the relationship between AI use and critical thinking. The conceptual relationships guiding the analysis are depicted in the following research framework.

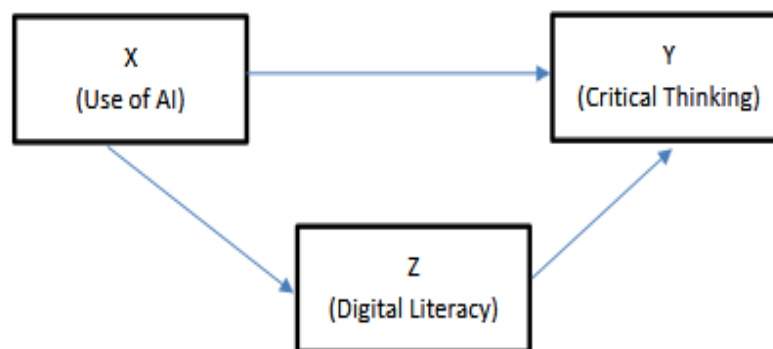


Figure 1. Research Design

Population and Sample

The participants in this study were active students at Makassar State University. The study used non-probability sampling with a purposive sampling technique. Students were selected if they had used generative AI tools, such as ChatGPT, Gemini, Claude, or other similar applications, to support their learning activities for at least one semester. The sample size was determined using a commonly applied rule for path analysis and Structural Equation Modeling (SEM). Based on these criteria, a total of 193 students participated in the study.

Research Instruments

Table 1. Operational Definition of Variables

Variable	Operational Definition of Variables	Dimension		Source	Scale
X = Use of AI	The level of intensity and diversity in students' use of adaptive and interactive AI technologies to support the learning process. This variable is measured using indicators of the frequency of AI use for concept exploration, writing assistance, information synthesis, and academic	X ₁ , X ₂ , X ₃ , X ₄	Frequency & Intensity of AI Use	(Ng et al., 2024);(Chai et al., 2024); (Marengo et al., 2025)	1–5-point Likert scale Strongly Agree , Agree , Undecided, Disagree, and Strongly Disagree
		X ₅ , X ₆ , X ₇ , X ₈	Perceptions of the Benefits of AI in Learning		
		X ₉ , X ₁₀ , X ₁₁	Attitudes Toward AI in Learning		



	problem-solving.				
Z = Digital Literacy	Students' capacity to access, evaluate, integrate, and communicate information ethically and critically through digital technology. In the context of this study, the focus is on self-regulation in the use of AI (AI self-regulation), awareness of algorithmic bias, and proficiency in verifying digital data.	Z ₁ , Z ₂ , Z ₃	Digital Information Literacy	(Wang et al., 2023); (Hwang et al., 2023)(Zhou et al., 2025)	1–5-point Likert scale Strongly Agree , Agree , Undecided, Disagree, and Stronglyn Disagree
		Z ₄ , Z ₅ , Z ₆	Digital Communication & Collaboration		
		Z ₇ , Z ₈ , Z ₉	Digital Content Creation & Management		
		Z ₁₀ , Z ₁₁ , Z ₁₂	Digital Security & Ethics		
Y = Critical Thinking	Students' cognitive skills in conducting in-depth analysis, Objective evaluation, and synthesis of information,	Y ₁ , Y ₂ , Y ₃	Information Analysis & Interpretation	(Payan-Carreira et al., 2022); (Li et al., 2022); (Rodríguez-Rojas et al., 2024)	1–5-point Likert scale Strongly Agree , Agree , Undecided, Disagree, and Stronglyn Disagree
		Y ₄ , Y ₅ , Y ₆	Evaluation & Assessment of Evidence		
		Y ₇ , Y ₈ , Y ₉	Inference & Drawing Conclusions		

	particularly. information generated by AI systems. Indicators include th ability to identify arguments, evaluate the credibility of sources, and draw conclusions based on logical evidence.	Y ₁₀ , Y ₁₁ , Y ₁₂	Reflective Thinking & Self- Regulation		
--	---	--	--	--	--

Data Analysis Techniques

The study employed PLS-SEM as the analytical technique, with SmartPLS 4.0 serving as the software.

1. Measurement Model Testing (Outer Model)

The outer model examines the relationship between latent variables and their indicators.

Table 2. Measurement Model Testing (Outer Model)

Test	Purpose	Criterion
Convergent validity	Assesses the validity of each indicator	Factor loading > 0.7; AVE > 0.5
Discriminant validity	Ensures indicators are distinct from other variables	Cross-loading on its own variable is the highest
Reliability	Assesses the consistency of the instrument	Composite reliability and Cronbach's alpha > 0.7



2. Structural Analysis (Inner Model)

The inner model examines the magnitude of influence among variables, the model's goodness of fit, and the hypotheses.

Table 3. Structural Analysis (Inner Model)

Test	Function	Criterion
R^2 (coefficient of determination)	Measures how much exogenous constructs explain endogenous constructs	Higher values indicate greater explanatory power
F^2 (effect size)	Assesses the effect of each predictor at the structural level	0.02 small; 0.15 moderate; 0.35 large
Q^2 (Stone-Geisser)	Tests the predictive power of the model	$Q^2 > 0$ indicates good predictive relevance
Model fit (GoF)	Evaluates the overall fit of the model	Based on the NFI value

3. Hypothesis Testing

Testing uses a significance level of $\alpha = 5\%$ (0.05). H_0 is rejected when the p-value is < 0.05 and the t-statistic is > 1.96 , indicating a significant effect.

a. Direct effects

H_1 : The use of AI in learning affects students' critical thinking skills.

H_2 : The use of AI in learning affects students' digital literacy skills.

b. Indirect effect (mediation)

H_3 : Digital literacy may mediate the relationship between the use of AI in learning and students' critical thinking skills. This is tested using specific indirect effects.

c. Total effect = direct effect + indirect effect.



RESULT AND DISCUSSION

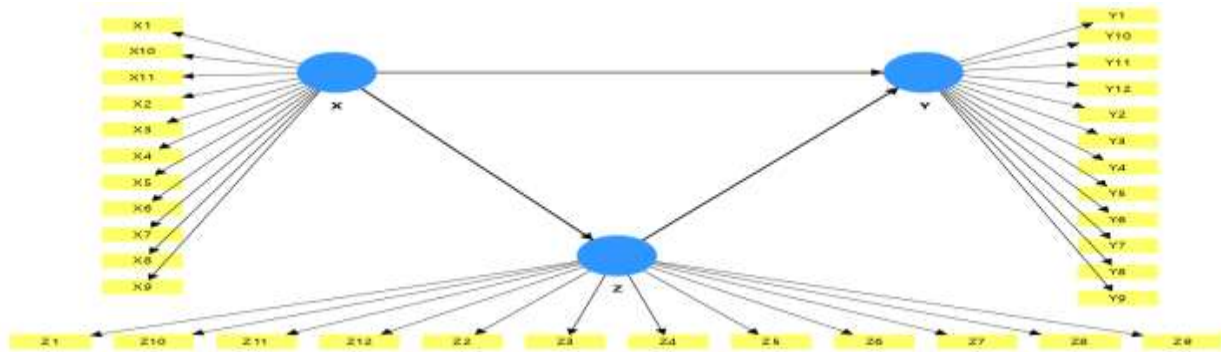


Figure 2. Relationships Among Latent Variables and Their Constructs

Research Results

1. Outer Model Test

a. Convergent Validity

The data analysis showed that the indicators met the required validity criteria. Indicators that did not meet the criteria were excluded from the research model. The valid indicators identified through the convergent validity test are presented below.

Table 4. Results of the Convergent Validity Test

Variable	Indocator	Loading Factor (>0,7)	AVE (>0,5)	Ket.
X = Use of AI	X1	0,794	0,610	Valid
	X10	0,775		
	X11	0,824		
	X2	0,779		
	X3	0,763		
	X4	0,788		
	X5	0,821		
	X6	0,773		
	X7	0,789		
	X8	0,716		
	X9	0,765		
Z = Digital Literacy	Z10	0,783	0,602	Valid
	Z11	0,837		

	Z12	0,749		
	Z2	0,775		
	Z3	0,733		
	Z4	0,805		
	Z5	0,785		
	Z6	0,730		
	Z7	0,776		
	Y1	0,801		
	Y10	0,756		
	Y11	0,739		
Y = Critical Thinking	Y12	0,723	0,583	Valid
	Y2	0,714		
	Y4	0,741		
	Y5	0,783		
	Y6	0,833		
	Y7	0,772		

b. Discriminant Validity

Table 5. Discriminant Valid

Indicator	Critical Thinking	Digital Literacy	The Use of AI in Learning	Description
X1	0,513	0,523	0,794	Valid
X10	0,559	0,623	0,775	Valid
X11	0,558	0,577	0,824	Valid
X2	0,517	0,534	0,779	Valid
X3	0,476	0,490	0,763	Valid
X4	0,516	0,534	0,788	Valid
X5	0,546	0,597	0,821	Valid
X6	0,500	0,522	0,773	Valid
X7	0,536	0,596	0,789	Valid
X8	0,432	0,476	0,716	Valid
X9	0,570	0,604	0,765	Valid
Y1	0,801	0,688	0,551	Valid
Y10	0,756	0,56	0,527	Valid
Y11	0,739	0,582	0,482	Valid
Y12	0,723	0,603	0,480	Valid
Y2	0,714	0,604	0,509	Valid
Y4	0,741	0,615	0,477	Valid
Y5	0,783	0,601	0,516	Valid
Y6	0,833	0,649	0,518	Valid
Y7	0,772	0,654	0,531	Valid
Z10	0,645	0,783	0,545	Valid
Z11	0,666	0,837	0,562	Valid
Z12	0,621	0,749	0,433	Valid
Z2	0,609	0,775	0,622	Valid
Z3	0,641	0,733	0,525	Valid
Z4	0,659	0,805	0,606	Valid
Z5	0,606	0,785	0,593	Valid
Z6	0,597	0,730	0,488	Valid
Z7	0,619	0,776	0,568	Valid



The cross-loading results indicate that all indicators meet the requirements for discriminant validity. Each indicator has a stronger relationship with its own construct than with other constructs in the model. This confirms that the indicators appropriately represent their respective variables. Similar results are also shown by the AVE values based on the Fornell-Larcker criterion, as presented in Table 4.

Table 6. AVE- Fornell-Larcker criterion

	Critical Thinking	Digital Literacy	Use of AI in Learning
Critical Thinking	0,764		
Digital Literacy	0,812	0,776	
Use of AI in Learning	0,669	0,711	0,781

The Fornell-Larcker test shows that all variables meet the discriminant validity requirement. The AVE value of each variable is greater than its correlation with the other variables in the model. This indicates that each variable has a clear distinction from the others.

c. Composite Reliability

Table 7. Composite Reliability

	<u>Cronbach's alpha</u>	<u>Composite reliability (rho a)</u>	<u>Composite reliability (rho c)</u>	<u>Average variance extracted (AVE)</u>
Critical Thinking	0,910	0,912	0,926	0,583
Digital Literacy	0,917	0,918	0,931	0,602
Penggunaan AI dalam Pembelajaran	0,936	0,938	0,945	0,610

Based on the Composite Reliability values, it can be seen that both Cronbach's alpha and Composite Reliability are greater than 0.7; therefore, it can be concluded that each indicator in the instrument for each variable is reliable



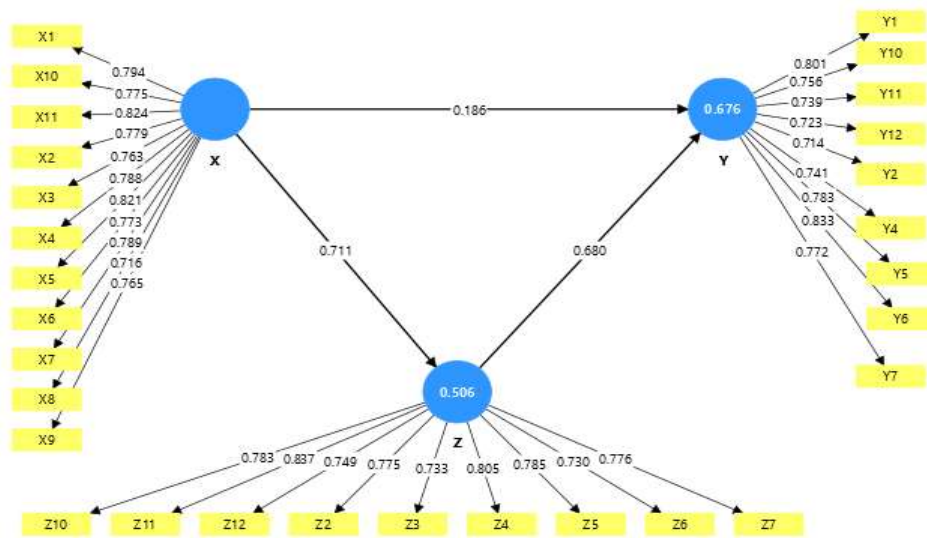


Figure 3. Structural Equation Model

2. Structural Test (Inner Model)

Table 7. R Square

Endogenous Constructs	R ² Adjusted	T-statistics	P-value	95% CI	Interpretation
Y	0,673	14,502	0,000	0,583–0,762	Strong
Z	0,503	8,011	0,000	0,382–0,629	Moderate–strong

The targeted outcome displays a substantial dependence on the antecedent factors tested. While the quantitative regression analysis validates the high strength of this explanatory network, minor residual discrepancies stem from external variables omitted in the current study.

Regarding construct Z, the corrected coefficient of determination stands at 0.503, demonstrating that the specified external predictors account for roughly half of its variance. Conversely, unmeasured external forces drive the residual 49.7% of the fluctuations. Based on this result, the model has a moderate level of explanatory power for construct Z and is relatively close to the strong category. The statistical test produced a t-statistic of 8.011 and a p-value of 0.000, confirming that the result is statistically significant. The 95% confidence interval for construct Z is

between 0.382 and 0.629. Overall, these findings indicate that the structural model provides a relatively good explanation of the dependent constructs, with a greater explanatory contribution to construct Y than to construct Z.

Model FIT

Table 8. Model Fit

Indikator	Saturated Model	Estimated Model	95% CI	99% CI	Interpretation
SRMR	0,059	0,059	0,055	0,059	Good
d_G	0,928	0,928	0,836	0,931	Good

Model fit evaluation was conducted to determine the level of fit between the research model and the empirical data. The test results showed that the SRMR values for the saturated model and the estimated model were 0.059, respectively. These values are below the 0.08 threshold, indicating that the model has a good fit. Furthermore, the d_G value of 0.928, with a 99% confidence interval upper limit of 0.931, indicates that the discrepancy value remains within an acceptable range. Meanwhile, the d_ULS value of 1.519 is slightly higher than the 99% confidence interval upper limit of 1.512. However, this difference is relatively very small, at 0.007. Considering the overall results of the model fit indicators, particularly the SRMR value, which falls into the “good” category, the research model can be said to have adequate fit with the empirical data and is suitable for further structural model testing

Direct effect Hypothesis Test

Table 9. Results of the direct effect hypothesis test

Relationship	β (O)	T-statistics	P-value	CI 95%	Relationship	Interpretation
X → Y	0,186	2,709	0,007	0,052–0,322	Significant	Positive, relatively weak
X → Z	0,711	16,123	0,000	0,621–0,794	Significant	Positive, strong



Z → Y	0,68	10,983	0,000	0,555–0,798	Significant	Positive, strong
-------	------	--------	-------	-------------	-------------	------------------

The structural model analysis reveals that every link among the latent constructs is favorable in direction and statistically meaningful. X is shown to exert a direct influence on Y ($\beta = 0.186$, $p = 0.007$), and a 95% confidence interval that stays clear of zero reinforces this conclusion. A noticeably stronger association emerges between X and Z, where the path coefficient reaches 0.711 ($p < 0.001$). Z, in turn, contributes positively to Y ($\beta = 0.680$, $p < 0.001$), and its confidence interval likewise excludes zero. Taken together, the data lend empirical backing to all three hypothesized paths in the structural model. Because the coefficients for $X \rightarrow Z$ and $Z \rightarrow Y$ exceed the direct $X \rightarrow Y$ effect, Z appears to serve as a key mechanism that accounts for variation in Y.

Table 10. Effect Size

Relationship	f^2 (O)	Category	T-statistics	P-value	Conclusion
X → Y	0,053	Small	1,213	0,225	Not significant
X → Z	1,023	Large	3,708	0	Significant
Z → Y	0,705	Large	3,353	0,001	Significant

The results of the effect size (f^2) test indicate that the contribution of each exogenous construct to the endogenous construct has a different level of influence. The relationship between X and Y yields an f^2 value of 0.053, which falls into the small effect category. However, this relationship is not statistically significant based on a t-statistic of 1.213 and a p-value of 0.225. Furthermore, the relationship between X and Z yields an f^2 value of 1.023, which falls into the large effect category, with a t-statistic of 3.708 and a p-value < 0.001 , thus indicating a significant and substantive effect. Meanwhile, the relationship between Z and Y has an f^2 value of 0.705, which also falls into the large effect category. This relationship is significant, with a t-statistic of 3.353 and a p-value of 0.001. The 95% confidence interval results show that the effect size for $X \rightarrow Z$ ranges from 0.628 to 1.707 and for $Z \rightarrow Y$ ranges from 0.386 to 1.208, neither of which includes zero. Overall, construct Z plays a strong role in explaining Y, while X has a very strong contribution to Z; however, X's direct contribution to Y is relatively small and not significant.



Indirect Effect Hypothesis Test**Table 11.** Results of the indirect effect hypothesis test

Mediation Relationship	β Indirect Effect	T-statistics	P-value	CI 95%	Decision
$X \rightarrow Z \rightarrow Y$	0,483	9,08	0	0,385–0,592	Significant

The mediation test indicates that Z acts as an intermediary that carries the influence of X over to Y. The size of this indirect effect is 0.483 ($p < 0.001$), and because its confidence interval does not contain zero, the effect can be considered statistically significant. This finding is reinforced by the bias-corrected confidence interval, which likewise stays clear of zero, making the presence of a mediating effect even more convincing. In addition, X continues to exert a significant direct influence on Y (coefficient = 0.186, $p = 0.007$). These findings indicate that Z partially mediates the relationship between X and Y. The magnitude of the indirect effect (0.483), which is higher than that of the direct effect (0.186), indicates that Z is the dominant mechanism through which X influences Y. Based on the VAF calculation, approximately 72.2% of X's total effect on Y is mediated through Z, while 27.8% occurs through the direct pathway. These findings indicate that the presence of Z plays a strategic role in explaining how X influences Y.

Table 12. Type of Influence

Type of Influence	Coefficient
Direct Effect $X \rightarrow Y$	0,186
Indirect Effect $X \rightarrow Z \rightarrow Y$	0,483
Total Effect	0,669

DISCUSSION**1. How Student Use of AI Relates to Critical Thinking Ability**

The findings reveal a favorable link between students' engagement with AI and their capacity for critical thinking. Even so, the direct influence of AI on that capacity is fairly modest, and the statistical test indicates that it is not strong enough to be considered significant. This pattern is consistent with the findings of the study Firdaus et al., (2025) which examined students' reliance on AI for academic assignments. The study found that the majority of students felt that AI provided them with immediate assistance in completing assignments; however, this

2923



improvement was not necessarily accompanied by a consistent strengthening of their critical and creative thinking skills. Some respondents also appeared to engage less in deep thinking when using AI. These results suggest that the link between AI use and critical thinking is not straightforward. Its effect may depend on how students use AI and the purpose for which it is used.

Gerlich, (2025) found a significant negative correlation between the frequency of AI use and critical thinking skills, with cognitive offloading acting as a mediating variable. When students become accustomed to delegating the processes of analysis, evaluation, and decision-making to AI, the opportunities for them to practice independent reasoning actually diminish. It is this phenomenon that most likely contributed to limiting the positive influence of AI in this study, preventing it from developing into a statistically significant relationship, the benefits of AI in providing information and accelerating task completion go hand in hand with the risk of reduced independent thinking practice, so that the two cancel each other out in the aggregate data.

This explanation is further supported by the findings Fan et al., (2025) introduces the term “metacognitive laziness,” which refers to a situation where students do show an improvement in their final assignment scores but exhibit no significant difference in knowledge transfer and deep understanding compared to the group that did not use AI. This means that AI can accelerate the final output of an assignment without actually improving the quality of the underlying thought process. This condition logically explains why, in this study, the effect of AI on critical thinking was detected but was too slight to be considered significant.

These findings are also consistent with the results of the literature review Ramadhan et al., (2025) which explicitly concludes that the impact of AI on students’ critical thinking skills is ambivalent. On the one hand, AI can be an effective partner in fostering reflective and argumentative thinking when used actively and accompanied by adequate digital literacy. On the other hand, passive use of AI merely seeking instant answers has the potential to undermine the motivation for independent thinking and the ability to construct arguments

The consistency of these findings is also evident in the study Santana et al., (2025). The study found that although the majority of students have developed critical and creative thinking skills, only a small fraction of them actually feel they rely excessively on AI. This pattern indicates that the use of AI among students is generally still supplementary or supportive in nature, rather than a complete replacement for their own thought processes. If the use of AI is limited to a supplementary role and has not yet been deeply integrated into structured learning strategies, then logically its impact on changes in higher-order cognitive abilities—such as critical thinking



will not yet be statistically significant, because the intensity and quality of cognitive engagement are not yet deep enough to produce measurable changes.

2. The Impact of AI Use on Students' Digital Literacy

Empirical evidence indicates a substantial positive correlation between artificial intelligence adoption and higher levels of digital competency among students. Data confirms that a deliberate and frequent integration of AI technologies into academic routines directly enhances learners' capabilities in retrieving, interpreting, critically assessing, and ethically applying online information. This shift reflects contemporary transformations in tertiary education, where generative platforms have transitioned from mere supplementary aids into core components of academic practice shaping how undergraduates conduct research, execute tasks, and internalize subject matter.

More specifically, the influential power identified in this study can be interpreted as evidence that AI acts as a cognitive facilitator that accelerates students' digital literacy process. When students interact with an AI system, they do not merely receive information passively; they are also required to formulate appropriate questions, assess the quality of the answers provided, and verify their accuracy using other sources. It is this process that ultimately trains students' sensitivity to the validity of information one of the core elements of digital literacy itself. These findings reinforce the results of the study Putri et al., (2025) which found that the use of artificial intelligence in conjunction with digital literacy makes a significant contribution to students' critical thinking skills. The magnitude of this contribution underscores that AI and digital literacy are two variables that reinforce one another in shaping students' competencies in the digital age, rather than functioning as independent variables. The results of this study are also consistent with the findings Supriyadi & Nasution, (2024), found that AI technology and digital literacy jointly and simultaneously influence student learning outcomes. The use of AI and digital literacy is not a coincidental finding or one specific to a single group of students, but rather a relatively consistent pattern in the Indonesian higher education environment.

To understand the mechanisms behind this significant relationship, a study conducted by Börekci & Çelik, (2024) The study suggests that students with adequate foundational digital literacy will find it easier and more prudent to utilize AI, and at the same time, repeated experiences in using AI reflectively help hone and improve their digital literacy. It is this positive cycle that appears to be reflected in the results of the statistical tests in this study, which show a strong and significant relationship between the two variables.



These findings are further supported by the results of the study Nasution et al., (2025), which shows that the use of AI in interactive learning can improve students' numeracy skills. Research Nasution et al., (2025) It is worth noting that the use of AI that is not balanced by critical awareness has the potential to produce the opposite effect, such as a decline in interest in reading, the emergence of dependency, a reduction in creativity, and an increased risk of plagiarism as students rely on AI-generated answers as their primary source without further verification. The differing direction of these findings does not actually contradict the results of this study; rather, they complement one another. The positive impact of AI on digital literacy in this study most likely occurred because the student respondents used AI in a relatively reflective manner that is, as a thinking aid rather than a substitute for the thinking process itself.

3. How Digital Literacy Shapes Students' Critical Thinking Skills

Students who are more proficient with digital tools generally demonstrate sharper critical thinking. The analysis points to a robust, favorable influence of digital literacy on this ability, and the statistical test confirms that the connection is meaningful rather than coincidental, showing that the two competencies are tightly intertwined. This finding implies that the better students are at accessing, filtering, understanding, and evaluating information from various digital platforms, the greater their capacity to analyze problems, assess arguments objectively, and make decisions based on sound reasoning. These findings underscore that digital literacy is not merely a technical skill in operating devices or applications, but rather a cognitive foundation that underpins how students think amid the overwhelming flow of information in today's digital age.

More specifically, the strong influence found in this study can be interpreted as evidence that the digital literacy process actually trains students' thinking structures in a gradual manner. When students are confronted with an abundance of information on the internet, they are required not to accept every piece of information they encounter at face value, but rather to discern which sources are credible, which are biased, and which require further verification. It is this process of selection and verification that gradually fosters the habit of critical thinking. These findings are consistent with the results of other studies Sitompul et al., (2025), More specifically, the strong influence found in this study can be interpreted as evidence that the digital literacy process actually trains students' thinking structures in a gradual manner. When students are confronted with an abundance of information on the internet, they are required not to accept every piece of information they encounter at face value, but rather to discern which sources are credible, which are biased, and which require further verification. It is this process of selection



and verification that gradually fosters the habit of critical thinking. These findings are consistent with the results of other studies

Research Panduwina & Setiawati, (2024), A study conducted on Office Administration Education students at Surabaya State University, using the Partial Least Squares Structural Equation Modeling (SEM-PLS) method, the study found that digital literacy significantly affects students' critical thinking skills. Digital literacy enables students to gather, organize, and evaluate information from different digital sources. These abilities help students understand issues more clearly and develop stronger and more logical arguments. This mechanistic explanation provides a more detailed picture of how digital literacy actually translates into critical thinking skills namely, through the stages of information gathering, data organization, analysis, and argument synthesis a line of reasoning that is essentially identical to the stages of critical thinking itself.

Similar findings were also reported by Vernanda et al., (2025) which shows that digital literacy, together with information literacy, has a significant impact on students' critical thinking skills. This study adds an important dimension, that digital literacy should ideally not stand alone but go hand in hand with information literacy to foster optimal critical thinking skills. Students who are able to operate digital technology but lack the ability to evaluate the credibility of information risk falling into fallacies, whereas students who possess both skills in a balanced manner will be better able to distinguish facts from opinions, detect bias, and objectively assess the credibility of sources a pattern also reflected in the strength of the relationship found in this study.

From a statistical perspective, the significance of the relationship found in this study indicates that the likelihood of these results arising by chance is extremely low; therefore, the relationship between digital literacy and students' critical thinking skills can be generalized to a broader population, not limited solely to the sample in this study. The combination of a relatively strong relationship and statistical significance that has been consistently validated in various previous studies both nationally and internationally provides a solid empirical foundation for higher education institutions to begin incorporating the enhancement of digital literacy as one of the key strategies in developing students' critical thinking skills, rather than merely as a supplement to information technology competencies. Overall, the findings of this study enrich the body of educational research in the digital age by affirming that digital literacy is a key predictor of students' critical thinking skills. With this approach, strengthening digital literacy can truly transform into a meaningful improvement in critical thinking skills rather than merely the ability to use technology thereby better preparing students to face the complexities of issues in both the



academic world and society at large.

4. Examining How Digital Literacy Intervenes in the Relationship Between Artificial Intelligence Utilization and Critical Thinking Ability

Research findings indicate that the use of AI has an indirect effect on students' critical thinking skills, with digital literacy serving as a mediating variable. Interestingly, the inclusion of digital literacy as a mediating variable amplifies the effect of AI use on students' critical thinking skills. The mediating role of digital literacy has a greater impact than the direct effect of AI use on students' critical thinking skills. This relationship pattern is consistent with the research findings. Handayani et al., (2026) found that all pathways of influence both direct and indirect were found to be significant, and confirmed that digital literacy plays a key role in bridging the relationship between AI use and critical thinking skills. Furthermore, Gerlich, (2025) The study found that high AI usage is negatively correlated with critical thinking skills through the mechanism of cognitive offloading that is, the tendency to delegate thinking processes to machines. However, this risk essentially arises when AI users lack the ability to critically evaluate what the AI produces, and it is at this point that digital literacy serves as a balancing factor.

These findings regarding the importance of digital literacy are also highly consistent with the results of the study Andani & Friyatmi, (2025) which found that digital literacy contributes a much greater coefficient of influence to critical thinking skills than the direct use of AI. The study Fan et al., (2025) The researchers who introduced the term "metacognitive laziness" also provided a crucial foundation for understanding why AI's direct impact on critical thinking was relatively weak in this study. Their experimental study showed that students who used ChatGPT to write essays did indeed achieve higher final scores, but did not demonstrate a significant improvement in knowledge transfer or deep understanding. This phenomenon occurs because the direct use of AI tends to shift students' cognitive efforts from the process of analysis to mere acceptance. However, when AI use is accompanied by adequate digital literacy, students do not merely accept the AI's output but also evaluate the reliability of the source, check the consistency of the arguments, and integrate them with their existing knowledge. It is this evaluative process that truly fosters critical thinking, and this can only occur when digital literacy serves as the bridge explanation that accurately illustrates why the mediating pathway in this study proved to be far stronger than the direct pathway.



CONCLUSION

Partial least squares structural equation modeling (PLS-SEM) among undergraduates at Makassar State University reveals that artificial intelligence adoption does not substantially boost critical analytical skills on its own. Without mindful usage, direct interaction with AI remains minor and statistically negligible, raising concerns about cognitive laziness. However, AI adoption sharply enhances digital competence, which subsequently serves as a powerful catalyst for analytical reasoning. Crucially, digital fluency partially bridges the path between AI usage and cognitive growth, showing an indirect influence that dramatically outweighs the direct route. This confirms that digital competence is the primary channel for unlocking the mental benefits of AI. From a theoretical stance, these findings reinforce mediation models in educational technology while filling an empirical gap within Indonesian higher education. Practically, institutions must move beyond merely providing AI access by embedding digital literacy specifically content validation, awareness of algorithmic tendencies, and self-directed learning into coursework. This ensures smart technologies complement rather than replace analytical thought. Nevertheless, the study is restricted by its single-site sample and cross-sectional methodology. Upcoming investigations should implement longitudinal frameworks, expand sampling across diverse campuses, and explore potential moderating variables like specific AI engagement habits.

REFERENCES

- Andani, P., & Friyatmi. (2025). *Pengaruh Pemanfaatan Artificial Intelligence dan Literasi Digital terhadap Kemampuan Berpikir Kritis*. 8(1952), 6241–6246.
- Andrian, R. D., Widiyanti, Y. M., & Wati, D. A. R. (2025). *on Smart Learning Technologies The Role of Artificial Intelligence in Enhancing Critical Thinking Skills of Educational Technology Students : The Moderating Influence of Digital Literacy and Usage Regulation*. *Journal on Smart Learning Technologies*, 1(2), 109–120.
- Anita, Mulawarman, W. G., & Susilo. (2025). *Cognitive Leap or Digital Divide? A Comparative Study on AI-Driven Learning and Student Analytical Capacity in Samarinda and Aceh*. *JPP Jurnal Pendidikan Progresif*, 15(03), 1811–1828. <https://doi.org/10.23960/jpp.v15i3.pp1811-1828>
- Arinto, M., Septian, Y., & Ihsani, H. R. (2026). *STRENGTHENING STUDENTS' READING LITERACY AND CRITICAL THINKING AS AN ADAPTIVE STRATEGY TO THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE IN THE DIGITAL AGE: A LITERATURE STUDY*. *Jurnal Inovasi Dan Teknologi Pendidikan JURINOTEP*, 4(3), 735–751.



- Arnu, A. P., & Sobandi, A. (2025). *THE ROLE OF ARTIFICIAL INTELLIGENCE (AI) ON CRITICAL THINKING SKILLS IN A CASE STUDY OF STUDENTS OF THE FACULTY OF ECONOMICS AND BUSINESS (FEB) OF UNIVERSITAS SINGAPERBANGSA KARAWANG. PERSPEKTIF Ilmu Pendidikan*, 39(1), 27–34.
- Ateeq, A., & Alfiras, M. (2025). *The impact of adaptive and interactive ai tools on student learning : From digital literacy to advanced skills. International Journal of Innovative Research and Scientific Studies*, 8(6), 961–973. <https://doi.org/10.53894/ijirss.v8i6.9775>
- Börekci, C., & Çelik, Ö. (2024). *Exploring The Role of Digital Literacy in University Students' Engagement with AI through the Technology Acceptance Model. Sakarya University Journal of Education*, 14(Special Issue-AI in Education), 228–249. <https://doi.org/10.19126/suje.1468866>
- Braz~ao, P., & Tinaco, L. (2025). *Artificial intelligence and critical thinking : a case study with educational chatbots. Frontiers in Education*, 10(September), 1–12. <https://doi.org/10.3389/feduc.2025.1630493>
- Chai, Ching Sing, Yu, Ding, King, Ronnel B, & Zhou, Ying. (2024). *Development and Validation of the Artificial Intelligence Learning Intention Scale (AILIS) for University Students. Sage Open*, 14(2), 21582440241242188. <https://doi.org/10.1177/21582440241242188>
- Demir, R., & Akar, C. (2025). *Transforming Clicks into Critical Thinking: An AI- Based Media Literacy Program for Children. Research Square*. <https://doi.org/10.21203/rs.3.rs-6786882/v1>
- Fakour, H., & Imani, M. (2024). *Socratic wisdom in the age of AI : a comparative study of ChatGPT and human tutors in enhancing critical thinking skills. Frontiers in Education*, 10(Januari), 01–12.
- Fan, Y., Tang, L., Le, H., Shen, K., Tan, S., Zhao, Y., Shen, Y., Li, X., & Gašević, D. (2025). *Beware of metacognitive laziness: Effects of generative artificial intelligence on learning motivation, processes, and performance. British Journal of Educational Technology*, 56(2), 489–530. <https://doi.org/https://doi.org/10.1111/bjet.13544>
- Fatih, M. (2025). *Interaction Problem Based Learning of AI Assisted on Digital Literacy and Critical Thinking Abilities. Journal of Development Research*, 9(1), 164–173.
- Firdaus, J. A., Ummah, R. I., Aprialini, R. R., & ... (2025). *Ketergantungan penggunaan kecerdasan buatan (AI) pada tugas akademik mahasiswa terhadap kemampuan berpikir kritis dan kreatif. Didaktika: Jurnal ...*, 14(1), 1203–1214. <https://mail.jurnaldidaktika.org/contents/article/view/1634>
- Gerlich, M. (2025). *AI Tools in Society: Impacts on Cognitive Offloading and the Future of Critical*



- Thinking. Societies*, 15(1). <https://doi.org/10.3390/soc15010006>
- Handayani, J. R., Marsofiyati, M., & Adha, M. A. (2026). Pengaruh Penggunaan Artificial Intelligence terhadap Berpikir Kritis dengan Literasi Digital sebagai Variabel Mediasi Siswa di Era Society 5.0. *Jurnal Pendidikan Dan Kebudayaan (JURDIKBUD)*, 6(1 SE-Articles), 44–64. <https://doi.org/10.55606/jurdikbud.v6i1.10910>
- Hwang, H. S., Zhu, L. C., & Cui, Q. (2023). Development and Validation of a Digital Literacy Scale in the Artificial Intelligence Era for College Students. 17(8), 2241–2258.
- Jasmadi, Saddam, & Lasri. (2024). Critical thinking: An analytical study on the impact of Artificial Intelligence (AI) usage on students at Al Washliyah Darussalam University, Banda Aceh. *Sekumpul: Journal of Multidisciplinary Education Sciences*, 2(1). <https://doi.org/10.62568/jomes.v2i1.168>
- Kurniawati, S., Nuriansyah, F., Sukamto, R., Fadhillah, S., & Febriyanti, A. (2025). MEDIATING ROLE OF DIGITAL LITERACY ON THE EFFECT OF AI GENERATED USAGE ON CRITICAL THINKING SKILL. *The International Conference on Sustainable Economics Management and Accounting Proceeding*, 1, 3534–3542. <https://doi.org/10.32424/icsema.1.1.458>
- Lawasi, M., Rohman, V., & Shoreamanis, M. (2024). The Use of AI in Improving Student's Critical Thinking Skills. *Proceedings Series on Social Sciences & Humanities*, 18, 366–370. <https://doi.org/10.30595/pssh.v18i.1279>
- Li, S., Tang, S., Geng, X., & Liu, Q. (2022). Constructing a critical thinking evaluation framework for college students majoring in the humanities. *Frontiers in Psychology*, Volume 13-2022. <https://doi.org/10.3389/fpsyg.2022.1017885>
- Marengo, A., Karaoglan-Yilmaz, F. G., Yilmaz, R., & Ceylan, M. (2025). Development and validation of generative artificial intelligence attitude scale for students. *Frontiers in Computer Science*, Volume 7-2025. <https://doi.org/10.3389/fcomp.2025.1528455>
- Nasution, J. S., Siregar, A. M., Hasibuan, E. S., Difla, F., Azizah, T. N., Negeri, I., & Utara, S. (2025). Dampak Negatif Penggunaan AI Terhadap Mahasiswa Dalam Proses Pembelajaran. *AMI Jurnal Pendidikan Dan Riset*, 3(1), 35–42.
- Ng, D. T. K., Wu, W., Leung, J. K. L., Chiu, T. K. F., & Chu, S. K. W. (2024). Design and validation of the AI literacy questionnaire: The affective, behavioural, cognitive and ethical approach. *British Journal of Educational Technology*, 55(3), 1082–1104. <https://doi.org/https://doi.org/10.1111/bjet.13411>
- Nurfauziah, Atmasani, D., Patawari, A. M., Fadhillah, N. A., & Saleh, H. (2025). Artificial Intelligence in Higher Education : A Systematic Review of its Impact on Student Learning. *Journal of*



- Information Technology Education*, 4(2), 205–216.
- Panduwinata, L., & Setiawati, F. (2024). *Digital Literacy's Influence on Critical Thinking Skills of Office Administration Education Students at UNESA*. *Jurnal Simki Pedagogia*, 7(2 SE-Articles), 609–618. <https://doi.org/10.29407/jsp.v7i2.733>
- Payan-Carreira, R., Sacau-Fontenla, A., Rebelo, H., Sebastião, L., & Pnevmatikos, D. (2022). *Development and Validation of a Critical Thinking Assessment-Scale Short Form*. In *Education Sciences* (Vol. 12, Issue 12, p. 938). <https://doi.org/10.3390/educsci12120938>
- Putri, J. A., Arpizal, A., & Ulfah, F. (2025). *Pengaruh Penggunaan Artificial Intelligence (AI) dan Literasi Digital terhadap Keterampilan Berfikir Kritis Mahasiswa Pendidikan Ekonomi Universitas Jambi Angkatan 2023 di Era Digital*. *Jurnal Pendidikan Tambusai*, 9(2 SE-Articles of Research), 13008–13016. <https://doi.org/10.31004/jptam.v9i2.26908>
- Ramadhan, M. A., Gunawan, A., Lorenza, S., Ainy, Z., & Subhan, M. (2025). *Analisis Dampak Penggunaan Artificial Intelligence Terhadap Kemampuan Berpikir Kritis Mahasiswa*. *JURNAL MUDABBIR*, 5(2), 241–249.
- Rodríguez-Rojas, María-Paula, Ramírez-Segura, Ana-María, Valenzuela-Mora, Pedro, Dampuré, Julien, & Riveros Munévar, Fernando. (2024). *Critical Thinking Evaluation Scale: Design and Validation in a Colombian Population*. *Sage Open*, 14(4), 21582440241297416. <https://doi.org/10.1177/21582440241297418>
- Santana, A., Agnes, A., Yani, D., Ananda, D., Bella, E., Harahap, F. I., & Amalia, N. (2025). *PENGARUH PENGGUNAAN ARTIFICIAL INTELEGENCE (AI) TERHADAP KEMAMPUAN BERPIKIR KRITIS DAN KREATIF MAHASISWA JURUSAN BAHASA DAN SASTRA INDONESIA 1Richo*. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, 10(2), 385–396.
- Sardi, J. (2025). *How Generative AI Influences Students' Self-Regulated Learning and Critical Thinking Skills? A Systematic Review*. *IJEP International Journal Of Engineering Pedagogy*, 15(1), 94–108.
- Sitompul, B., Purba, S., Tamba, P. M., & Sianturi, F. (2025). *Kemampuan Berpikir Kritis terhadap Literasi Digital Mahasiswa*. *Jurnal Pendidikan Tambusai*, 9(1 SE-Articles of Research), 10154–10161. <https://doi.org/10.31004/jptam.v9i1.26241>
- Supriyadi, & Nasution, Z. (2024). *Teknologi Artificial Intelligence (AI) dan Literasi Digital Mahasiswa terhadap Hasil Belajar Mata Kuliah Evaluasi Pembelajaran: Artificial Intelligence, Literasi Digital, Evaluasi Pembelajaran*. *Jurnal TEKNODIK*, 28(2), 113–118. <https://doi.org/10.32550/teknodik.vi.1185>
- Vernanda, C., Dewi, V. C., Jayanti, W. E., Bina, U., & Informatika, S. (2025). *PENGARUH ARTIFICIAL*



- INTELLEGENCE (AI) TERHADAP KETERAMPILAN BERFIKIR KRITIS PELAJAR ATAU MAHASISWA. *Journal of Information Systems Management and Digital Business (JISMDB)*, 2(4), 346–357.
- Wang, B., Rau, P.-L. P., & Yuan, T. (2023). *Measuring user competence in using artificial intelligence: validity and reliability of artificial intelligence literacy scale*. *Behaviour & Information Technology*, 42(9), 1324–1337. <https://doi.org/10.1080/0144929X.2022.2072768>
- Zhou, X., Sun, K., Zhu, K., Feng, L., Sun, Q., & Zhong, D. (2025). *The impact of digital literacy on university students' innovation capability: evidence from Ningbo, China*. *Frontiers in Psychology*, Volume 16-2025. <https://doi.org/10.3389/fpsyg.2025.1548817>
- Zhou, X., Teng, D., & Al-Samarraie, H. (2024). *The Mediating Role of Generative AI Self-Regulation on Students' Critical Thinking and Problem-Solving*. *Education Sciences*, 14(12). <https://doi.org/10.3390/educsci14121302>

