Does AI Dependency Hinder or Enhance Critical Thinking? Examining the Role of Self-Regulation

Firman Alamsyah Ario Buntaran*, Dhani Irmawan, Ahmad Sabir
Universitas Mercu Buana, Indonesia
firman.alamsyah@mercubuana.ac.id*

Submitted:
2025-09-02

Revised:
2026-05-07

Published:
2026-05-29

Keywords:
Artificial Intelligence, Critical Thinking, Higher Education, Mediation Analysis, Self-Regulation

Copyright holder:
© Author/s (2026)

This article is under:

How to cite:
Buntaran, F. A. A., Irmawan, D., & Sabir, A. (2026). Does AI Dependency Hinder or Enhance Critical Thinking? Examining the Role of Self-Regulation. *Bulletin of Counseling and Psychotherapy*, *8*(2).
https://doi.org/10.51214/002026081616000

Published by:
Kuras Institute

E-ISSN:
2656-1050

ABSTRACT: The reliance on artificial intelligence (AI) in higher education raises questions about its impact on students' critical thinking. This study aims to examine the mediating role of self-regulation (SR) in the relationship between AI dependency (AID) and critical thinking (CTh) among university students with a total of 112 respondents, 35 male students and 77 female students, with an average age of 24 years old. Correlation analysis revealed no direct relationship between AI dependency (AID) and critical thinking (CTh), but AID showed a significant correlation with self-regulation (SR), and SR was strongly correlated with critical thinking (CTh). Mediation analysis demonstrated that SR partially mediating the relationship between AID and CTh, indicating that the impact of AI dependency on critical thinking depends on its influence on self-regulation. These findings align with prior research highlighting the critical role of self-regulation in technology-based learning. Further research is recommended to explore in more depth the role of self-regulation as a variable that may influence the relationship between AI use and potential dependency.

INTRODUCTION

Critical thinking is essentially the ability of a disciplined and skilled individual to engage in purposeful, reflective, and reasoned judgment guided by clear criteria, self-correction, and contextual awareness and to analyze, evaluate, and decide carefully what to believe or do. (Facione, 1990). From a psychological perspective, critical thinking is defined as "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Ren et al., 2020). Thinking ability constitutes a cognitive process that encompasses the strategies and mental representations individuals employ to solve problems, make decisions, and learn new concepts effectively, ultimately enhancing the likelihood of achieving favorable outcomes (Ritter et al., 2014).

In the academic world, critical thinking is an essential skill that students must develop. Critical thinking is the ability to analyze and evaluate information or arguments based on evidence and logic, rather than emotions or personal bias. The academic environment demands that students think critically, as it is crucial for logical analysis, decision-making, and problem-solving (Huamán-Tapia et al., 2023). Critical thinking is a way to answer various problems with strong belief in facts, a desire to have complete information, consideration of alternatives, fairness to other people's opinions, and a willingness to admit mistakes when they misunderstand something (Umam, 2022).

Critical thinking involves the attitude of questioning assumptions, recognizing patterns, understanding relationships, and drawing conclusions through rational judgment. This ability

encourages students to go beyond surface-level understanding, allowing them to engage more deeply with the material and connect various ideas in their pursuit of knowledge. Students need critical thinking to write high-quality argumentative essays at the higher education level (Klimova, 2013). AI can enhance critical thinking by providing personalized learning and immediate feedback, as well as assisting students in constructing arguments, understanding diverse perspectives, and improving academic writing (Zawacki-Richter et al., 2019; Holmes et al., 2022).

The emergence of artificial intelligence (AI) in the current internet era has significantly influenced the psychological processes underlying human cognition, particularly in the area of critical thinking. As AI-based internet tools—such as generative language models, adaptive learning systems, and algorithm-based content curation—become increasingly integrated into academic and everyday social life, individuals' ways of interpreting, evaluating, and responding to information are undergoing a profound transformation. AI has become an invaluable tool in academia, offering instant feedback, personalized learning experiences, and support for various academic tasks. AI can also assist students in AI-based learning related to the development of critical thinking, evaluation, and self-assessment among university students across disciplines (Melisa et al., 2025).

Lawasi et al. (2024) found that AI can significantly support the development of critical thinking through personalized learning experiences and interactive simulations; however, challenges remain, such as potential biases and the need for a strong foundational understanding. When used carefully and with proper comprehension, AI can help enhance critical thinking—wise interaction with AI can serve as an effective support tool in the learning process (Fabio et al., 2025). AI can strengthen critical thinking by providing tailored learning and immediate feedback, as well as helping students construct arguments, understand diverse perspectives, and improve academic writing (Holmes et al., 2022; Zawacki-Richter et al., 2019).

However, the ideal critical thinking that should serve as a foundation for students—and are demanded by the education system as a fundamental competency—are now being challenged by artificial intelligence technology, which advances in parallel with rapid digital and internet developments. The growth of artificial intelligence (AI), such as ChatGPT, DeepSeek, and others, has brought convenience in accessing information and completing tasks efficiently. However, excessive reliance on this technology may have negative impacts on human critical thinking abilities.

From a psychological perspective, critical thinking involves cognitive processes such as analysis, evaluation, synthesis, and independent decision-making (Facione, 2020). On the other hand, passive use of AI may reduce individuals' opportunities to practice critical thinking, potentially weakening cognitive capacity over the long term. One major risk is the decline in cognitive engagement (cognitive offloading), where individuals tend to rely on AI without engaging in deep information processing, leading to cognitive laziness—the brain avoiding the mental effort required for solving complex problems (Sparrow et al., 2011). Additionally, AI often provides instant answers without scientific context or nuance, which may reduce users' ability to evaluate the validity of information independently (Dwivedi et al., 2023). Intensive use of AI in educational contexts can also weaken students' awareness of their own thinking processes (Flavell, 1979). Furthermore, AI has the potential to reproduce biases, making users less critical of alternative perspectives (Bolukbasi et al., 2016), and the answers provided by AI may limit users' exploration of original ideas (Runco & Jaeger, 2012). Today's students are exposed to the negative impacts of technological developments; therefore, they need the ability to manage independent learning in order to achieve their academic goals (Aprianti & Widiatmini, 2019).

Ideally, higher education institutions expect students to develop critical thinking and strong problem-solving skills; however, AI technology tends to indulge students in the current educational process. The rise of Artificial Intelligence (AI) adds to concerns, as students become vulnerable to being passive consumers of information and prone to committing plagiarism (Fernandes et al., 2024). In relation to the current era of artificial intelligence, self-regulation has become an

important factor mediating the impact of AI use on critical thinking. Self-regulation refers to an individual's ability to control cognition, emotions, and behavior in order to achieve personal goals (Zimmerman, 2002). Therefore, self-regulation plays a crucial role in determining whether the use of AI will strengthen or instead weaken the user's critical thinking capacity. Individuals with high self-regulation tend to use AI selectively and reflectively, rather than relying on it instantly without deep analysis (Faza & Lestari, 2025). Those with strong self-regulation also utilize AI as a scaffolding tool rather than a substitute for independent thinking, thereby remaining actively engaged in the processes of evaluation and synthesis of information (Hadwin et al., 2017). In contrast, individuals with low self-regulation are more vulnerable to cognitive offloading, where they excessively depend on AI, thus reducing active cognitive engagement (Risko & Gilbert, 2016).

However, research on the role of self-regulation in relation to AI use and its impact on critical thinking remains very limited among university students. This is concerning, as understanding this issue is crucial in the current context where AI is increasingly being used and has become an integral part of the educational landscape. The negative effects of AI dependency and its potentially harmful impacts have yet to be thoroughly explored. Due to this issue, higher education institutions need to integrate self-regulation training into AI-based curricula, with an emphasis on self-reflection following the use of AI in the learning process (Järvelä et al., 2021). Additionally, AI systems should be designed to promote user engagement, for example by providing guiding questions instead of direct answers (Aleven et al., 2016).

Study Aim and Hypothesis

This study aims to examine the mediating role of self-regulation (SR) in the relationship between AI dependency (AID) and critical thinking (CTh) among university students. The hypothesis is that self-regulation could play a mediating role in the link between AI dependency and critical thinking among university students.

METHODS

Design

After the data were obtained through an online questionnaire, descriptive analysis was conducted using SPSS for data processing, followed by inferential statistical analysis through mediation testing. Mediation analysis in quantitative research is a statistical procedure used to understand the mechanism or process underlying the relationship between an independent variable (X) and a dependent variable (Y) through an intervening or mediating variable (M). Through the explanation of the Macro PROCESS application, Hayes (2022) revolutionized mediation analysis. It shifted from traditional methods like the Sobel test or the Baron and Kenny steps to a more robust and flexible approach that focuses on testing the significance of the indirect effect through bootstrapping.

Participants

This study uses a survey method for quantitative data collection with a cross-sectional design, with a target population of active students at a private campus in West Jakarta, with a total of 112 participants, with an age range of 19 to 26 years, active in semester lecture classes, and actively using the internet and AI in the learning process (ChatGPT, Perplexity, Gemini, Gbt). Respondents live in urban areas around Jakarta, some work while studying, and some students depend on income from their parents.

Instruments

This study used three instruments to assess critical thinking (CTh), self-regulation (SR), and AI dependency (AID). A reliability test was conducted after the data were collected to ensure the instruments' reliability values.

AI Dependency, AI Dependency Scale by Hoffmann et al. (2024). The AI Dependency scale is a psychometric instrument designed to measure an individual's psychological reliance on artificial intelligence (AI) tools for cognitive tasks and decision-making. It moves beyond mere usage frequency to assess a deeper, perceived need for AI assistance. Uji reliabilitas yang dilakukan oleh Hoffman et al., (2024) mendapati nilai $\alpha = 0.898$; AVE = 0.690; $r^2max = 0.933$.

Critical Thinking Scale was used to measure critical thinking developed by Kobylarek et al. (2022). Kobylarek et al. (2024), in testing the reliability of this scale, found that the internal consistency coefficient of Cronbach's Alpha was 0.87. The participants' critical thinking was assessed using the 26-item Critical Thinking Scale (Kobylarek et al., 2022). Participants rated their agreement with statements such as "I can identify the key elements of a complex problem" on a 5-point Likert scale from 1 (strongly disagree) to 4 (strongly agree). Both the critical thinking and AI dependency scales were adapted into Indonesian, involving two experts in the field of psychology, following the adaptation principles outlined in the ITC (International Test Commission) guidelines for translating and adapting tests.

Self-Regulation Questionnaire developed by Brown et al. (1999), known as the Self-Regulation Questionnaire (SR). The instrument utilized in this study was the short-form adaptation validated by Tresnadiani and Taufik (2020) in Indonesia. This adaptation was itself based on the earlier Spanish short-form developed by Pichardo et al. (2018). The results of the reliability test of the self-regulation construct conducted by Tresnadiani and Taufik (2020) showed a Cronbach's $\alpha > 0.70$, so it can be concluded that the reliability of each construct is classified as good.

Data Analysis

Hypothesis testing was conducted using mediation analysis using JASP version 0.18.1 to examine the role of self-regulation in the relationship between dependence on AI and critical thinking in college students. Correlation tests were also conducted to determine the strength of the relationship between variables. Descriptive analysis included data frequency, instrument reliability testing, normality testing, and correlation testing using SPSS version 27.

RESULTS AND DISCUSSION

Results

Table 1 presents data on instrument reliability. All three measurement tools (AID, CTh, and SR) demonstrated reliability with $\alpha > 0.7$, indicating good reliability.

Table 1. Reliability Statistics

Instruments	α Cronbach's	N
AID	.724	5
CTh	.877	26
SR	.890	9

The normality test in Table 2 shows that the dependent variable (CTh) is normally distributed; therefore, Pearson correlation was used for the correlation analysis (Kolmogorov-Smirnov significance $p > .05$).

Table 2. Tests of Normality CTh

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Critical thinking (CTh)	.079	112	.086

The total number of respondents in this study was 112, consisting of 77 female respondents and 35 male respondents. The average age of the respondents in this study was 24 years old. Table 3 shows the differences in variable means based on gender. In terms of AI dependency, female respondents were more dependent than male respondents. For self-regulation, females demonstrated higher levels of self-regulation than males. Meanwhile, for critical thinking, there was no difference in the average scores between genders.

Table 3. Variables Mean

Gender	AID	SR	CTh
Male	M=11.46, SD=3.30	M=18.49 SD=6.33	M=83.86 SD=8.77
Female	M=12.22, SD=3.23	M= 20.83 SD=5.90	M=83.25 SD=9.20

Table 4 presents data on the correlations between variables. Dependency on AI (AID) was not correlated with critical thinking (CTh), r =-.036, .036; however, despite the weak correlation, their relationship was negative. Dependency on AI showed a significant correlation with self-regulation (SR), r = .317**. Self-regulation was significantly correlated with critical thinking (r = -.345**).

Table 4. Correlations between variables

	AID	SR	CTh
AID	1	.317**	-.036
SR		1	-.345**
CTh			1

** Correlation is significant at the 0.01 level (2-tailed).

Table 5 presents data on the path coefficients of the mediation analysis. In path a (X → M), the estimated coefficient is 0.097; in path b (M→Y), the coefficient value is -0.371; while in path c (X→Y), the estimated coefficient is 0.025.

Table 5. Path Coefficients

							95% Confidence Interval	
			Estimate	SE	z-value	p	Lower	Upper
SR	→	CTh	-0.371	0.093	-3.978	<0.01	-0.553	-0.188
AID	→	CTh	0.025	0.029	0.875	>0.05	-0.031	0.081
AID	→	SR	0.097	0.027	3.54	<0.01	0.043	0.151

The results of the Sobel test to determine whether self-regulation (SR) mediates the relationship between AI dependency (AID AI) and critical thinking (CTh). The Sobel test results indicate a p-value of < .001, with a z-value of -2.66, SE=0.01. This indicates that self-regulation plays a mediating role in the relationship between AI dependency and critical thinking (CTh).

Discussion

The current study aims to examine the mediating role of self-regulation (SR) in the relationship between AI dependency and critical thinking among university students. Mediation analysis showed that self-regulation (SR) fully mediates the relationship between AI dependency and critical thinking. Good self-regulation—such as the ability to control behavior toward a goal, plan tasks, and engage in self-reflection—is correlated with higher critical thinking. The relationship between AID and CTh is entirely explained by self-regulation (SR), meaning that the influence of AID on critical thinking only occurs if AID first affects SR. A study by Hadwin et al. (2011) revealed that the use of educational technology (such as AI) does not directly impact learning outcomes but is mediated by self-regulation strategies. They found that students who used digital tools with effective planning and self-evaluation showed significant improvements in analytical and critical thinking abilities (Hadwin et al., 2011). This finding aligns with Zimmerman's (2002) theory of self-regulated learning, which emphasizes that individuals with effective self-regulation strategies—such as goal setting, progress monitoring, and reflection—tend to develop higher-order cognitive skills, including critical analysis and evaluation. In the context of AI use, students with high SR do not rely on AI merely as a crutch (Duckworth et al., 2019), but rather use it as a supportive tool to deepen their understanding, for example, by verifying AI-generated results or integrating them into their self-directed learning process.

The results of this study support previous findings that dependency on AI (AID) does not have a direct relationship with critical thinking (CTh), but its effect is fully mediated by self-regulation (SR). Technology can be a beneficial tool when used with appropriate self-regulation strategies. Without good self-regulation, dependency on AI may reduce students' initiative for independent learning; however, if students are able to manage their use of AI effectively, it can instead support the development of higher-order cognitive skills.

The correlation test showed that there was no correlation between AI dependency (AID) and critical thinking (CTh); however, AID was correlated with self-regulation (SR). Contrary to what might be expected in this era of rapidly integrated AI tools, this finding indicates that the frequency of, or reliance on, AI tools alone does not necessarily directly diminish or enhance students' critical thinking capacity. This non-significant finding is crucial, as it shifts the discourse beyond a deterministic view of technology use (that AI use automatically impairs cognitive skills) and instead points toward more complex intervening variables (Bennett & Maton, 2010). AI dependency is a multifaceted construct; for some students, this reliance may act as a crutch that avoids intellectual effort, while for others, AI can function as a tool that complements and supports complex problem-solving (Crompton & Burke, 2023).

The absence of a direct correlation between AI dependency and critical thinking suggests that these opposing effects may cancel each other out within a general sample. This finding emphasizes the necessity of investigating how students use AI, rather than simply measuring how frequently they use it. A significant correlation between AI dependency and self-regulation provides an important clue for understanding the underlying mechanisms. This relationship implies that students' tendency to rely on AI is intricately linked to their ability to manage their own learning processes, including goal setting, metacognitive monitoring, and strategic planning (Zimmerman, 2002). One interpretation is that students with low self-regulation skills may become more dependent on AI as an external cognitive source, using it to compensate for challenges in planning, organizing, and executing academic tasks independently (Azevedo et al., 2021). Conversely, it is also possible that learners with high self-regulation may strategically use AI tools to enhance their efficiency, making them appear dependent on the technology when in fact they maintain a high degree of control over its use. In both scenarios, self-regulation emerges as a key individual differences variable that shapes the nature of student engagement with AI.

Based on the analysis of mean scores for each variable by gender, it was found that female students showed higher dependency on AI compared to male students. This aligns with previous research reporting that females tend to use educational support technologies more frequently to cope with academic anxiety (Wajcman, 2010). Women are more likely to use assistive tools to ensure answer accuracy, whereas men tend to rely more on independent trial-and-error approaches (Sánchez-Franco et al., 2023). Females are often encouraged to avoid academic risk, making them more inclined to use AI as a "safety net" (Else-Quest et al., 2010).

The average self-regulation (SR) score among male participants in this study was higher. This finding is consistent with a meta-analysis by Duckworth and Seligman (2017), which found that males tend to exhibit greater self-discipline in terms of time management and impulse control. Possible explanations include motivational differences, where males are more driven by competitive challenges that require strategic planning (Voyer & Voyer, 2014), and the socialization of males to be more independent in problem-solving (Eagly & Wood, 2013).

Another finding is that there was no significant difference in critical thinking (CTh) between male and female participants. This supports Hyde's (2014) gender similarities hypothesis, which states that gender differences in cognitive abilities are often minimal or nonexistent when socialization factors and access to education are equal. This finding also aligns with cross-cultural research by Stoet and Geary (2018), which found that the gender gap in critical thinking disappears when motivation and learning experiences are controlled. A meta-analysis by Halpern et al. (2007) also indicated that gender differences in cognitive skills (including critical thinking) are more influenced by pedagogical practices than by biological factors.

The research findings indicate that dependency on AI (AID) is not directly correlated with critical thinking (CTh) among university students. This suggests that AI is a neutral tool, and its impact depends on how it is used (Wing, 2006). Students who use AI passively (e.g., using ChatGPT to complete assignments without further analysis) do not engage in developing their cognitive skills, whereas those who use AI critically (e.g., verifying and reflecting on AI-generated outputs) may actually enhance their critical thinking (Dwivedi et al., 2023). Therefore, AI dependency itself does not determine the increase or decrease in CTh; rather, it is the self-regulation strategies that ultimately shape the outcome (Zimmerman, 2002).

Self-regulation also shows a strong correlation with critical thinking (CTh). This means that dependency on AI does not directly enhance or diminish students' critical thinking. AI dependency may influence how students manage themselves—for example, in terms of time management, motivation, or learning strategies. Research by Zimmerman (2002) indicates that the use of technology, including AI-based tools, can affect an individual's self-regulation abilities, especially in learning contexts. This study found that students who rely too heavily on external aids tend to experience a decline in self-initiated learning; however, when used with appropriate self-regulation strategies, technology can actually enhance learning efficiency (Zimmerman, 2002).

Research by Duckworth et al. (2019) also found that self-regulation skills, including time management and impulse control, positively correlate with critical thinking. They argue that individuals with strong self-regulation are better able to analyze information deeply because they can manage distractions and focus on higher-order cognitive processing (Duckworth et al., 2019). Based on the correlation test results, the relationship between AI dependency and critical thinking is negative, meaning that the higher the dependency on AI, the lower the critical thinking. Excessive reliance on AI can lead to cognitive offloading, where individuals shift their thinking processes to technology, reducing the cognitive practice needed for developing critical skills (Risko & Gilbert, 2016). However, offloading is not always negative—if done strategically (for example, using AI to save time on routine tasks in order to focus on complex analysis), it can actually enhance learning efficiency (Sweller, 2011). Thus, AI dependency is not inherently harmful to CTh, but the risk arises if it is not accompanied by metacognitive awareness.

Excessive dependency on AI can lead to cognitive offloading, where individuals shift their thinking processes to technology, thereby reducing the cognitive practice necessary for the development of critical skills (Risko & Gilbert, 2016). However, offloading is not always negative—if done strategically (e.g., using AI to save time on routine tasks in order to focus on complex analysis), it can actually enhance learning efficiency (Sweller, 2011). Thus, AI dependency is not inherently detrimental to critical thinking (CTh); the risk arises when it is not balanced with metacognitive awareness.

In the context of AI, students with high self-regulation (SR) tend to use AI as an analytical tool rather than a substitute for independent thinking, allowing them to continue developing their critical thinking. In contrast, students with low SR may fall into passive dependency on AI, which hinders the development of their cognitive abilities. Mediation analysis revealed that SR fully explains the relationship between AI dependency (AID) and critical thinking (CTh), consistent with the findings of Hadwin et al. (2011) on educational technology. This means that the impact of AI on critical thinking is not direct, but depends on how students manage their use of it. For instance, students with strong SR may allocate specific time to analyze the outcomes of AI use, while students with low self-regulation tend to accept AI outputs as-is without evaluation (Zimmerman, 2002). This reinforces the argument that self-regulation-based interventions (such as training in metacognitive awareness) can help moderate the negative risks of technology dependency.

Implications

The practical implication of this study is the need for educational interventions that strengthen self-regulation in AI dependency. For example, training in metacognition and time management can help students use AI productively without compromising their critical thinking. In addition, educators can encourage students to critically reflect on AI-generated results rather than accepting them at face value.

The respondents in this study were limited, reducing the generalizability of the findings to the broader population, as participants came from only one university. Longitudinal or experimental studies are needed to confirm the direction of causality. Moderator variables such as intrinsic motivation or the type of AI dependency (generative vs. analytical) could be further explored. Measurement of AI dependency (AID) should also be expanded to distinguish between different types of AI reliance (e.g., ChatGPT vs. data analysis tools).

The finding that self-regulation (SR) fully mediates the relationship between AI dependency and critical thinking (CT) challenges simplistic, deterministic models of educational technology impact (e.g., “AI is good” or “AI is bad”). Instead, it supports more complex theoretical frameworks, such as the Self-Regulated Learning (SRL) theory (Zimmerman, 2002), which emphasizes the active role of the learner in controlling their learning processes. This implies that the effects of AI are not inherent but depend on how learners regulate their use of technology.

AI can be used to manage cognitive load through strategic offloading, but without metacognitive oversight (a key aspect of SR), it may lead to passive learning. Thus, future theoretical models should incorporate SR as a crucial variable moderating the relationship between technology use and cognitive outcomes. The absence of gender differences in critical thinking, coupled with nuanced differences in AI dependency and self-regulation, supports Hyde’s (2014) gender similarities hypothesis. This suggests that gender should be considered within broader socio-cognitive and motivational contexts rather than as a standalone predictor of cognitive ability. Practical (Educational) Implications. Since SR fully mediates the impact of AI on CT, educators should integrate explicit training in self-regulation strategies into their teaching. This includes goal-setting and planning workshops, metacognitive exercises (e.g., reflection journals, self-assessment), time management and impulse control training. Educational AI developers should design tools that encourage active engagement rather than passive consumption. Educators should be trained to

recognize signs of passive vs. active AI use and to guide students in using AI as a complementary tool rather than a crutch. This includes designing assignments that require critical engagement with AI outputs.

Limitations and Further Research

This study has several limitations. The cross-sectional design precludes any causal inferences about the relationships between the variables. Furthermore, the measurement of AI dependency likely captured a general tendency without distinguishing between various types of AI applications (e.g., chatbots, writing assistants, data analyzers), each of which may have a unique relationship with self-regulation and critical thinking. Future research should employ longitudinal designs to track the developmental trajectories of these relationships over time. Qualitative methods, such as interviews and think-aloud protocols, would also be invaluable for understanding the motivations and strategies behind AI use, helping to elucidate why students with low self-regulation become dependent and how that dependency manifests in their learning behaviors.

Future research should use longitudinal designs to examine how changes in SR influence AI dependency and CT over time. Experimental studies could test interventions aimed at improving SR to mitigate potential negative effects of AI dependency. Explore Additional Mediating and Moderating Variables, while SR is a key mediator, other factors may play a role, such as motivation and academic self-efficacy. As emphasized in the findings, how students use AI matters. Qualitative methods (e.g., interviews, think-aloud protocols) can provide deeper insights into the strategies learners employ when using AI and how these strategies relate to SR and CT.

CONCLUSION

AI dependency and critical thinking. This finding emphasizes that AI is not a direct threat to cognitive skills as long as students possess effective self-regulation strategies. Therefore, future educational approaches must prioritize the development of self-regulation (SR) to maximize the benefits of AI in learning. In conclusion, this study offers a critical refinement to the debate on AI in education. The findings suggest that attention should not be narrowly focused on whether AI use correlates with lower critical thinking (CTh), but rather on how AI interacts with the crucial skill of self-regulation. The significant relationship between AI dependency and self-regulation signals the need for pedagogical interventions. Educators and institutions must prioritize the development of metacognitive and self-regulatory competencies alongside digital literacy. Explicitly teaching students how to use AI tools strategically, ethically, and as a complement—rather than a replacement—for their own cognitive effort is essential (Crompton & Burke, 2023). By fostering strong self-regulation, we can empower students to harness the power of AI as a partner in learning, ensuring that AI enhances, rather than undermines, their critical thinking capacity.

ACKNOWLEDGMENTS

We gratefully acknowledge the full financial support for this research provided by Mercu Buana University. We would also like to thank the participants for their valuable contributions to this project.

AUTHOR CONTRIBUTIONS STATEMENT

Author 1 [Firman Alamsyah Ario Buntaran]: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft Preparation, Project Administration.

Author 2 [Dhani Irmawan]: Validation, Resources, Writing – Review & Editing, Visualization, Supervision.

Author 3 [Ahmad Sabir]: Software, Validation, Investigation, Resources.

REFERENCES

Aleven, V., McLaughlin, E. A., Glenn, R. A., & Koedinger, K. R. (2016). Instruction based on adaptive learning technologies. Handbook of research on learning and instruction, 2, 522-560.

Aprianti, M., & Widiatmini, T. (2019). Self-regulated learning in digital era. In *International Conference on Psychology and Communication 2018 (ICPC 2018)* (pp. 77-88). Atlantis Press. https://doi.org/10.2991/icpc-18.2019.7

Azevedo, R., Taub, M., Mudrick, N. V., Martin, S. A., & Grafsgaard, J. (2018). *Using multi-channel trace data to infer and foster self-regulated learning between humans and advanced learning technologies.* Handbook of self-regulation of learning and performance, 2, 254-270. https://doi.org/10.4324/9781315697048-17

Beyond the 'digital natives' debate: Towards a more nuanced understanding of students' technology experiences. *Journal of Computer Assisted Learning*, 26(5), 321–331. https://doi.org/10.1111/j.1365-2729.2010.00360.x.

Bolukbasi, T., Chang, K. W., Zou, J. Y., Saligrama, V., & Kalai, A. T. (2016). Man is to computer programmer as woman is to homemaker? debiasing word embeddings. *Advances in neural information processing systems*, 29. https://doi.org/10.48550/arXiv.1607.06520.

Brown, J. M., Miller, W. R., & Lawendowski, L. A. (1999). *The self-regulation questionnaire. In L. VandeCreek & T. L. Jackson (Eds.)*, Innovations in clinical practice: A source book, Vol. 17, pp. 281–292). Professional Resource Press/Professional Resource Exchange.

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *International journal of educational technology in higher education*, 20(1), 22. https://doi:10.1186/s41239-023-00392-8IF.

Duckworth, A. L., Taxer, J. L., Eskreis-Winkler, L., Galla, B. M., & Gross, J. J. (2019). Self-control and academic achievement. *Annual review of psychology*, 70(1), 373-399. https://doi.org/10.1146/annurev-psych-010418-103230.

Duckworth, A. L., & Seligman, M. E. (2017). The science and practice of self-control. *Perspectives on Psychological Science*, 12(5), 715-718. https://doi.org/10.1177/1745691617690880.

Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., ... & Wright, R. (2023). Opinion Paper:"So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International journal of information management*, 71, 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642.

Eagly, A. H., & Wood, W. (2013). The nature–nurture debates: 25 years of challenges in understanding the psychology of gender. *Perspectives on Psychological Science*, *8*(3), 340-357. https://doi.org/10.1177/1745691613484767.

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: a meta-analysis. *Psychological bulletin*, 136(1), 103. https://doi.org/10.1037/a0018053.

Fabio, R. A., Plebe, A., & Suriano, R. (2025). AI-based chatbot interactions and critical thinking skills: an exploratory study. *Current Psychology*, 44(9), 8082-8095. https://doi:10.1007/s12144-024-06795.

Facione, P. A. (2011). Critical thinking: What it is and why it counts. Insight assessment, 1(1), 1-23.

Faza, A., & Lestari, I. A. (2025). Self-regulated learning in the digital age: A systematic review of strategies, technologies, benefits, and challenges. *International Review of Research in Open and Distributed Learning*, 26(2), 23-58. https://doi.org/10.19173/irrodl.v26i2.8119

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American psychologist*, 34(10), 906. https://doi.org/10.1037/0003-066X.34.10.906

Fernandes, R., Willison, J., & Boyle, C. (2024). Characteristics, prevalence and tensions of critical thinking in Indonesian high school English language classes resulting from policy-driven teaching. *Thinking Skills and Creativity*, 53, 101605. https://doi.org/10.1016/j.tsc.2024.101605

Hadwin, A. F., Järvelä, S., & Miller, M. (2011). *Self-regulated, co-regulated, and socially shared regulation of learning.* Handbook of self-regulation of learning and performance, 30, 65-84.

Hadwin, A., Järvelä, S., & Miller, M. (2017). *Self-regulation, co-regulation, and shared regulation in collaborative learning environments.* In Handbook of self-regulation of learning and performance (pp. 83-106). Routledge. https://doi.org/10.4324/9781315697048-6

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest, 8*(1), 1–51. https://doi.org/10.1111/j.1529-1006.2007.00032.x.

Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* Guilford publications.

Hyde, J. S. (2014). Gender similarities and differences. *Annual review of psychology*, *65*(1), 373-398. https://doi.org/10.1146/annurev-psych-010213-115057

Hoffmann, S., Lasarov, W., & Dwivedi, Y. K. (2024). AI-empowered scale development: Testing the potential of ChatGPT. *Technological Forecasting and Social Change*, 205, 123488. https://doi.org/10.1016/j.techfore.2024.123488

Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., Shum, S. B., ... & Koedinger, K. R. (2022). Ethics of AI in education: Towards a community-wide framework. *International Journal of Artificial Intelligence in Education*, 32(3), 504-526. https://doi.org/10.1007/s40593-021-00239-1

Huamán-Tapia, E., Almanza-Cabe, R. B., Sairitupa-Sanchez, L. Z., Morales-García, S. B., Rivera-Lozada, O., Flores-Paredes, A., & Morales-García, W. C. (2023). Critical thinking, generalized anxiety in satisfaction with studies: The mediating role of academic self-efficacy in medical students. *Behavioral Sciences*, 13(8), 665. https://doi.org/10.3390/bs13080665

Hyde, J. S. (2014). *Gender similarities and differences*. Annual review of psychology, 65(1), 373-398. https://doi.org/10.1146/annurev-psych-010213-115057

Järvelä, S., Malmberg, J., & Koivuniemi, M. (2016). Recognizing socially shared regulation by using the temporal sequences of online chat and logs in CSCL. *Learning and Instruction*, 42, 1-11. https://doi.org/10.1016/j.learninstruc.2015.10.006

Lawasi, M. C., Rohman, V. A., & 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

Klimova, B. F. (2013). Developing thinking skills in the course of academic writing. *Procedia-Social and Behavioral Sciences*, 93, 508-511. https://doi.org/10.1016/j.sbspro.2013.09.229

Kobylarek, A., Błaszczyński, K., Ślósarz, L., & Madej, M. (2022). Critical Thinking Questionnaire (CTh)–construction and application of critical thinking test tool. *Andragogy Adult Education and Social Marketing*, 2(2), 1-1. https://doi.org/10.15503/andr2022.1

Melisa, R., Ashadi, A., Triastuti, A., Hidayati, S., Salido, A., Ero, P. E. L., ... & Al Fuad, Z. (2025). Critical Thinking in the Age of AI: A Systematic Review of AI's Effects on Higher Education. *Educational Process: International Journal*, 14, e2025031. https://doi.org/10.22521/edupij.2025.14.31

Pichardo, M. C., Cano, F., Garzón-Umerenkova, A., De la Fuente, J., Peralta-Sánchez, F. J., & Amate-Romera, J. (2018). *Self-regulation questionnaire (SRQ) in Spanish adolescents: factor structure and rasch analysis.* Frontiers in psychology, 9, 1370. https://doi.org/10.3389/fpsyg.2018.01370

Ren, X., Tong, Y., Peng, P., & Wang, T. (2020). *Critical thinking predicts academic performance beyond general cognitive ability: Evidence from adults and children*. Intelligence, 82, 101487. https://doi.org/10.1016/j.intell.2020.101487

Risko, E. F., & Gilbert, S. J. (2016). Cognitive offloading. *Trends in cognitive sciences*, 20(9), 676-688. https://doi.org/10.1016/j.tics.2016.07.002.

Ritter, F. E., Baxter, G. D., & Churchill, E. F. (2014). *Cognition: Mental Representations, Problem Solving, and Decision Making. In Foundations for Designing User-Centered Systems: What System Designers Need to Know about People (pp. 165-200).* London: Springer London. https://doi.org/10.1016/j.intell.2020.101487

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal*, 24(1), 92-96. https://doi.org/10.1080/10400419.2012.650092

Sánchez-Franco, M. J., Cegarra-Navarro, J. G., & Roldán, J. L. (2023). A gender perspective on the use of AI in education: A systematic literature review. *Computers & Education*, 196, 104727. https://doi.org/10.1016/j.compedu.2023.104727

Sparrow, B., Liu, J., & Wegner, D. M. (2011). Google effects on memory: Cognitive consequences of having information at our fingertips. *Science*, 333(6043), 776-778. https://doi.org/10.1126/science.1207745

Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. *Psychological Science, 29*(4), 581–593. https://doi.org/10.1177/0956797617741719.

Sweller, J. (2011). Cognitive load theory. In Psychology of learning and motivation (Vol. 55, pp. 37-76). Academic Press. https://doi.org/10.1016/B978-0-12-387691-1.00002-8

Tresnadiani, D., & Taufik, A. (2020). The Development and Validation of Short Self-Regulation Scale (SSR) on Indonesian College Students. In Proceedings of the 5th International Seminar of Public Health and Education, ISPHE (pp. 126-135). https://doi.org/10.4108/eai.22-7-2020.2300264

Umam, N. A. (2022). Art Activities as A Medium for Critical Thinking in the "Let's Share the Art" Program. *Biopsikososial.* 6 (2), 131-149.
http://dx.doi.org/10.22441/biopsikososial.v6i2.17286.

Voyer, D., & Voyer, S. D. (2014). Gender differences in scholastic achievement: a meta-analysis. *Psychological bulletin*, 140(4), 1174. https://doi.org/10.1037/a0036620.

Wajcman, J. (2010). Feminist theories of technology. *Cambridge journal of economics*, 34(1), 143-152. https://doi.org/10.1093/cje/ben057.

Wing, J. M. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33–35. https://doi.org/10.1145/1118178.1118215.

Zhou, M. et al. (2010) 'Work and Family Stress is Associated with Menstrual Disorders but not with Fibrocystic Changes: Cross-Sectional Findings in Chinese Working Women'. *Journal of Occupational Health*, 52(6), pp. 361–366. https://doi.org/10.1539/joh.L10057

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators?. *International journal of educational technology in higher education*, 16(1), 1-27. https://doi.org/10.1186/s41239-019-0171-0

Zimmerman, B. J. (2002). *Becoming a self-regulated learner: An overview.* Theory into practice, 41(2), 64-70. https://doi.org/10.1207/s15430421tip4102_2