



The Impact of Generative AI Use, AI Literacy, and AI Usage Ethics On Critical Thinking Skills Among Students at Universitas Negeri Semarang

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ABSTRACT

Technological advancements, particularly generative AI, have brought about significant changes in the learning process at universities. The use of AI makes it easier for students to access information quickly, construct arguments, and understand course material more efficiently; however, there are concerns that it may reduce cognitive engagement. This study aims to analyze the influence of the use of generative AI, AI literacy, and AI ethics on the critical thinking skills of UNNES students. The study employed a quantitative associative design with a survey method and used purposive sampling. Data were collected through a Likert-scale questionnaire from a sample size of 180 students from the Office Administration Program (UNNES), drawn from a population of 325 students from the 2023–2025 cohorts using the Slovin formula ($e = 0.05$) and analyzed using instrument testing, classical assumption tests, and multiple linear regression with SPSS 26. The findings show that Generative AI use, AI literacy, and AI ethics each have a positive and significant effect on critical thinking skills, both partially and simultaneously. AI literacy emerged as the most dominant predictor among the three variables. These results indicate that students' critical thinking is strengthened not only by using AI tools, but also by understanding how AI works and applying responsible academic ethics in their use. However, given the study's cross-sectional design, reliance on self-reported metrics, and narrow focus on a single program at one institution, the generalizability of these outcomes requires cautious interpretation.

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Introduction

The critical thinking skills of every individual in Indonesia remain a key concern in higher education, particularly amidst changes in the nature of learning, which is now increasingly influenced by developments in digital technology. The transformations of the

modern era require every individual to master 21st-century skills, particularly critical thinking skills, in order to communicate effectively, solve problems, and master specific academic disciplines (Utami et al., 2022). In many academic situations, students still tend to accept information quickly without undergoing a process of in-depth examination, meaning that their ability to analyse, evaluate, and draw logical conclusions has not yet developed optimally (Risky Handayani & Amirul Adha, 2026). According to research by Ni'mah, critical thinking is a deep reflective process involving the analysis, evaluation, and testing of the truth of information, thereby leading to appropriate decisions and solutions (Ni'mah, 2022). Educational organisations and institutions now regard 21st-century skills, including critical thinking, creativity, collaboration, and communication, as key competencies that graduates must possess to compete in the global workplace. Redana states that the National Education Association prioritises four main competencies in contemporary education, known as the 4Cs: communication, critical thinking, collaboration, and creativity (Yudha et al., 2022).

Critical thinking is not merely about the ability to understand information, but also encompasses the processes of clarification, interpretation, analysis, inference, evaluation, and self-efficacy in thinking (Sudirman, 2023). Critical thinking can also be defined as a cognitive ability that enables individuals to analyse and evaluate information rationally before making decisions (Suciono, 2021). In line with this, Gruwell asserts that critical thinking is an intellectual habit that demands in-depth examination of an issue before accepting a truth (Gruwell & Ewing, 2022). Within the dimension of critical thinking, self-efficacy is the most decisive factor in determining whether a person possesses high self-confidence in tackling difficult tasks and is able to generate intrinsic motivation in carrying out those tasks (Puji et al., 2023). However, the reality in Indonesia shows that this ability has not yet developed optimally, a situation also influenced by low literacy levels and a lack of reflective learning habits among students.

This is further supported by findings indicating that stage of critical thinking among students in Indonesia remains relatively low, with the Trends in International Mathematics and Science Study (TIMSS) of 397 points, which has not yet reached international standards, thereby raising concerns regarding the Indonesia Emas 2045 vision (Lestari & Julia Lingga, 2024). Furthermore, the quality of human resources in Indonesia remains a major issue (Puspa et al., 2024). This is evidenced by PISA 2022 data showing that Indonesia ranked 69th out of 80 participating countries verified by the OECD (Prasastisiwi, 2024). Indonesia's cumulative score of 1.108 still lags behind South Korea's 1.570, Japan's 1.599, Taiwan's 1.599, China's 1.605, and Singapore's 1.679. These results indicate that students in Indonesia still face challenges in interpreting complex texts, applying mathematical skills, and applying scientific principles in more real-world contexts.

Although numerous studies have examined students' critical thinking skills in the context of technology use, empirical evidence from the Office Administration Education Study Program at Universitas Negeri Semarang (UNNES) indicates that students' critical

thinking skills still require considerable attention. Based on the researcher's preliminary classroom observations across several courses, classroom discussions were not conducted optimally. The discussions tended to be less interactive, with students demonstrating passive participation, showing reluctance to express their opinions or ask questions, and often choosing to remain silent even when opportunities for discussion were provided. These conditions suggest that students have not yet fully demonstrated the characteristics of critical thinking, such as the ability to formulate questions, analyze information, and present logical arguments.

These observations were further supported by the findings of a preliminary survey involving 69 students from the Office Administration Education Study Program at Universitas Negeri Semarang. The survey revealed that approximately 43–45% of the respondents selected the “Moderately Agree (MA)” category, indicating uncertainty regarding several indicators of critical thinking skills, particularly their ability to identify the main problem and explain concepts clearly. This lack of confidence in their critical thinking abilities suggests that the development of students' critical thinking skills remains an important concern, especially amid the increasing integration of Artificial Intelligence (AI)-based technologies into the learning process.

Based on these empirical findings, the Office Administration Education Study Program at UNNES was selected as the research site because it provides a relevant context for examining the relationships among Generative AI use, AI literacy, AI usage ethics, and students' critical thinking skills. In addition to the widespread use of AI technologies in students' academic activities, the preliminary findings indicating students' uncertainty regarding their critical thinking abilities further justify the selection of this setting for investigation through a quantitative approach. It is expected that the findings of this study will provide empirical evidence to support the development of learning strategies that promote the responsible use of AI while simultaneously strengthening students' critical thinking skills.

The advancement of technology, especially Generative Artificial Intelligence (GenAI), has significantly transformed the learning process in higher education. The implementation of AI allows students to obtain information rapidly, develop arguments, and comprehend learning materials more effectively (Haris & Kusumawardani, 2024). Research by Putri and Panduwinata indicates that AI can assist students in analysing and verifying information in a more systematic manner (Panduwinata & Setiawati, 2024). Furthermore, the use of AI can act as a cognitive stimulus that encourages students to think more analytically when solving problems (Sunarjo et al., 2024). However, on the other hand, uncontrolled use of AI can lead to dependency and reduce students' cognitive engagement in the thinking process.

There are several previous studies that the use of AI has varied effects on critical thinking skills. Research findings indicate that AI can have a positive influence on critical thinking skills when supported by good digital literacy (Hidayat et al., 2025). However,

other studies suggest that high intensity of AI use can diminish critical thinking skills, leading to dependence on technology (Vernanda et al., 2025). Moreover, other findings suggest that some students experience a decline in critical thinking skills due to over-reliance on AI when completing academic tasks (Taufani et al., 2025). This highlights inconsistencies in research findings that warrant further investigation.

In addition, AI literacy and ethical use of technology are important factors in determining how AI influences critical thinking skills (Santiago et al., 2023). Several studies state that strong literacy can improve an individual's critical and analytical abilities (Hafifah & Sulisty, 2021). On the other hand, effective use of Generative AI must be accompanied by digital literacy so that students can critically evaluate information (Ernalina et al., 2025). Ethical considerations are equally important, because without ethical understanding, the use of AI may encourage plagiarism and weaken academic integrity (Essien et al., 2024). Therefore, the integration of AI in education requires not only technical competence, but also critical awareness and academic responsibility.

Based on these various findings, there remains a research gap regarding the correlation the use of Generative AI, AI literacy, and the ethics of AI use on students' critical thinking skills. Most previous studies have been partial in nature and have not comprehensively examined the relationships between variables within a single research model. Consequently, this study aims to analyse the relationship between the use of Generative AI, AI literacy, and AI usage ethics on students' critical thinking skills using a quantitative approach via a survey method. Data analysis is conducted statistically to identify patterns of relationships between variables, thereby hopefully providing an empirical contribution to the development of technology-based learning strategies that are more critical, adaptive, and responsible.

Methods

This research used a quantitative associative-causal design. A quantitative approach was selected because of the study intended to test relationships and influences between variables through numerical data analysed using statistics. Associative quantitative research uses statistical data analysis and research instruments to examine a particular population or sample in order to test predetermined hypotheses (Sugiyono, 2022). An associative research design was used because this study sought to determine the influence of the use of Generative AI (X1), AI literacy (X2), and AI usage ethics (X3) on students' critical thinking skills (Y). The research design employed was a survey involving the distribution of questionnaires to respondents. This approach was chosen as it is capable of describing the relationships between variables objectively and measurably.

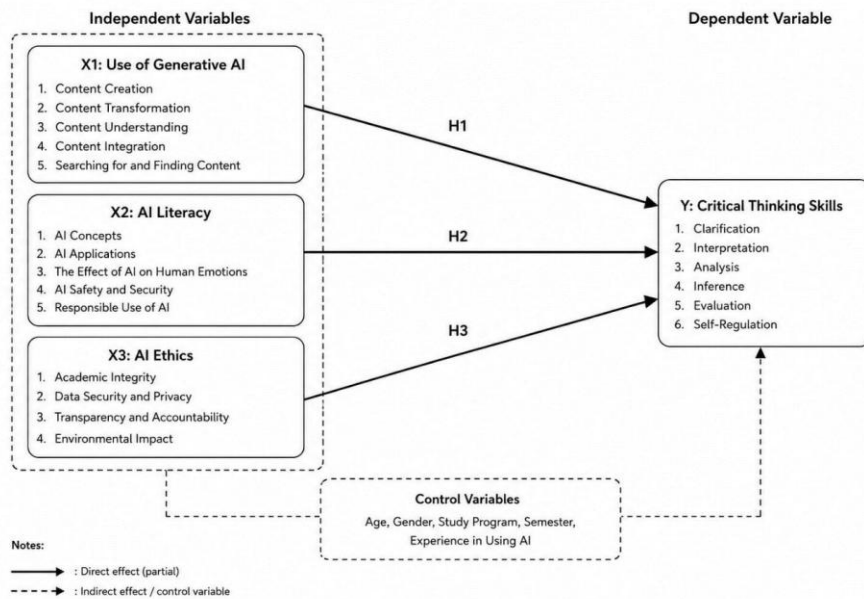


Figure 1. Conceptual Framework

The research procedure was carried out in several stages, namely:

- (1) Identification of the research problem.
- (2) Preparation of the theoretical review and research instruments.
- (3) Testing the validity and reliability of the instruments.
- (4) Distribution of questionnaires to respondents.
- (5) Data collection and processing using SPSS version 26.
- (6) Data analysis and drawing of research conclusions.

The population consists of all research subjects possessing specific characteristics. The definition of a population is the domain of generalization comprising objects or subjects possessing specific qualities and characteristics defined by the researcher for study, from which conclusions are subsequently drawn (Sugiyono, 2022). The population in this study comprises all active students of the Office Administration Education Study Program, Faculty of Economics and Business, Semarang State University, from the 2023, 2024, and 2025 cohorts, totaling 325 students.

The sample is a subset of the population, sharing the same characteristics. The sample was selected using purposive sampling, namely a non-probability technique in which respondents are chosen based on specific criteria relevant to the study. The sample size was determined using the Slovin formula with a 5% margin of error ($e = 0,05$). As a result, the sample size was 180 students. The criteria for this study were: (1) active students of the Office Administration Education Study Program at UNNES; (2) students who had used Generative AI in their learning activities; and (3) students willing to participate as respondents.

- 1) Data were collected using a structured questionnaire distributed to 180 respondents.

The instrument was prepared based on the indicators of each variable and used a 1–5 Likert scale ranging from Strongly Disagree to Strongly Agree. In this study, questionnaire data were used as the primary source; triangulation through interviews

or academic records was not conducted, so the findings should be interpreted within the scope of the measured responses.

- 2) The data analysis technique used was multiple linear regression, supported by validity and reliability tests, classical assumption tests (normality, heteroscedasticity, and multicollinearity), and hypothesis testing using SPSS 26.
- 3) Validity testing was performed using Pearson's Product-Moment correlation between item scores and total scores. An item was deemed valid when the calculated r value exceeded the table r value at a significance level of 0.05 with degrees of freedom ($df = n - 2$). The table r value in this study was 0.1455.

The data collection technique used in this study was a questionnaire distributed to the respondents. A total of 180 students were surveyed in this study. The questionnaire was designed based on the indicators of each research variable and used a 1–5 Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree' to measure the respondents' perceptions. Although critical thinking is a higher-order cognitive construct that is ideally assessed through performance tasks, this study operationalized it through self-reported responses because the research aimed to capture students' perceived tendencies to analyze, evaluate, and draw conclusions in the context of AI use. This approach is suitable for a survey involving a relatively large sample, but the results should be interpreted as perception-based evidence rather than direct measurement of critical-thinking performance. The researchers acknowledge that cognitive measurement methods using questionnaires are still relatively weak and constitute a limitation of this study.

The data analysis technique used was regression analysis. In this study, tests were conducted on the research instruments (validity and reliability), classical assumptions (normality test, heteroscedasticity test, and multicollinearity test), and hypothesis testing with the aid of SPSS 26 software.

Result

1. Research Instrument

1.1. Validity Test

Variable	no	R calculation	R Table	Explanation
Critical Thinking Skills	1	0,753	0,1455	Valid
	2	0,666	0,1455	Valid
	3	0,728	0,1455	Valid
	4	0,636	0,1455	Valid
	5	0,745	0,1455	Valid
	6	0,583	0,1455	Valid
Variable	no	R Calculated	R Table	Explanation
Use of <i>Generative AI</i>	1	0,698	0,1455	Valid

	2	0,669	0,1455	Valid
	3	0,660	0,1455	Valid
	4	0,643	0,1455	Valid
	5	0,706	0,1455	Valid
Variable	no	R Calculated	R Table	Explanation
AI Literacy	1	0,728	0,1455	Valid
	2	0,678	0,1455	Valid
	3	0,745	0,1455	Valid
	4	0,657	0,1455	Valid
	5	0,689	0,1455	Valid
Variable	no	R Calculated	R Table	Explanation
AI usage ethics	1	0,741	0,1455	Valid
	2	0,683	0,1455	Valid
	3	0,704	0,1455	Valid
	4	0,674	0,1455	Valid

Validity testing was performed using Pearson's Product-Moment correlation between item scores and total scores. The testing criterion was that an item was deemed valid if the calculated r value was greater than the table r value at a significance level of 0.05 with degrees of freedom ($df = n - 2$). Based on the analysis results in the table above, the table r value was found to be 0.1455. All items in the research variables showed calculated r values $>$ table r , so all items were deemed valid. In detail:

- The Critical Thinking Ability variable had a range of calculated r values from 0.583 to 0.753

- 1) The Generative AI Usage variable has a calculated r range of 0.643–0.706
- 2) The AI Literacy variable has a calculated r range of 0.657–0.745
- 3) The Ethical Considerations in AI Use variable has a calculated range of 0.674–0.741

Consequently, all instruments met the validity criteria and are suitable for use in the study.

1.2. Reliability Test

Variable	Cronbach Alpha	R Table	Explanation
Critical Thinking Skills	0,774	0,6	Reliabel
Usage of GenAI	0,697	0,6	Reliabel
AI Literacy	0,738	0,6	Reliabel
AI Usage Ethics	0,654	0,6	Reliabel

Reliability testing was conducted using Cronbach's Alpha. The instrument is deemed reliable if the alpha value is $>$ 0.60. The test results show that all variables have a Cronbach's Alpha value above the minimum threshold, namely:

- 1) Critical Thinking Skills = 0.774
- 2) Use of Generative AI = 0.697
- 2) AI Literacy = 0.738
- 3) Ethics of AI Use = 0.654

These results indicate that all variables possess good internal consistency, thus the research instrument is deemed reliable.

2. Classical Assumption Test

2.1. Normality Test

The basis for the normality test decision was taken from Kolmogorov Smirnov's statement:

- 1) If the significance value is > 0.05 , the residuals are normally distributed
- 2) If the significance value is < 0.05 , then the residuals are not normally distributed

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		180
Normal Parameters^{a,b}	Mean	,0000000
	Std. Deviation	1,73721747
Most Extreme Differences	Absolute	,054
	Positive	,043
	Negative	-,054
Test Statistic		,054
Asymp. Sig. (2-tailed)		,200 ^{c,d}

Based on the normality results above, the significance value for this study is 0.200. It can therefore be concluded that the residuals are normally distributed.

2.2. Heteroscedasticity Test

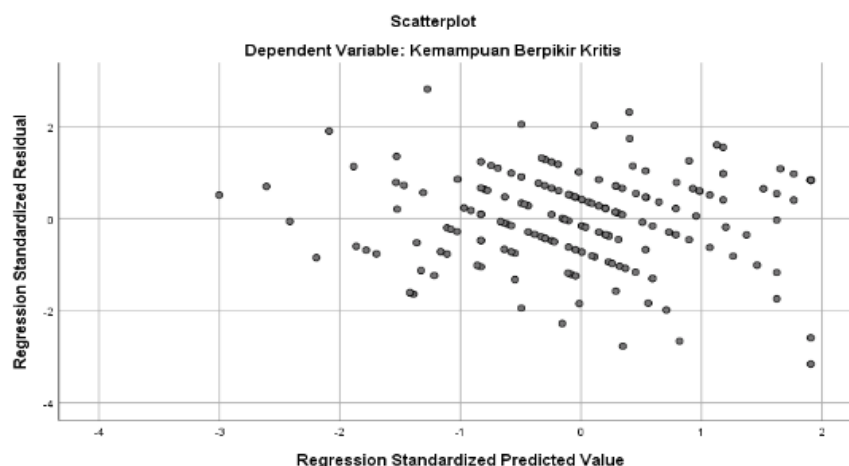


Figure 2. Heteroscedasticity Test Analysis Result

Based on the results of the heteroscedasticity test plot, no specific pattern was found as the scatter of points was abstract. It can therefore be concluded that heteroscedasticity was not found.

2.3. Multicollinearity Test

Coefficients ^a								
Model				Standardized	t	Sig.	Collinearity	VIF
				Coefficients			Statistics	
				Beta			Tolerance	
1	(Constant)	5,020	1,570		3,196	0,002		
	Usage of GenAI	0,242	0,083	0,200	2,930	0,004	0,610	1,639
	AI Literacy	0,432	0,091	0,373	4,756	0,000	0,462	2,163
	AI Usage Ethics	0,333	0,102	0,238	3,253	0,001	0,529	1,892

Based on the results of the table analysis above, the tolerance values for X1 (0.610), X2 (0.462), and X3 (0.529) are > 0.100 , whilst the VIF values for X1 (1.639), X2 (2.163), and X3 (1.892) < 10.00 ; it is therefore concluded that the data is free from multicollinearity.

3. Hypothesis Testing

3.1. Coefficient of Determination Test

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,703 ^a	0,495	0,486	1,752
a. Predictors: (Constant), AI Usage Ethics, using GenAI, AI Literacy				

Based on the results above, the percentage of variance in the expenditure variable (y) that can be explained by the independent variables (x) is 49.5%, whilst the remaining 50.5% is explained by other variables outside the regression model.

3.2. Linear Regression Test

Coefficients ^a						
Model				Standardized Coefficients	t	Sig.
				Beta		
1	(Constant)	5,020	1,570		3,196	0,002
	Usage of GenAI	0,242	0,083	0,200	2,930	0,004
	AI Literacy	0,432	0,091	0,373	4,756	0,000
	AI Usage Ethics	0,333	0,102	0,238	3,253	0,001
a. Dependent Variable: Critical Thinking Skills						

Based on the data in the table above, it shows that:

- 1) The constant of 5.020 indicates that if X1, X2, and X3 are set to 0, the value of Y remains 5.020.
- 2) Result of variable X1, the regression test results show that the X1 variable has a positive regression coefficient with a value of $b = 0.242$. This implies that variable Y will grow by 0.242 if the value of variable X1 increases by one point.
- 3) The findings of variable X2, the result of regression test can be interpreted that variable X1 has a positive regression coefficient with a value of $b = 0.432$. This means that if there is an increase in the value of variable X2 by 1 unit, there will also be an increase in variable Y by 0.432.
- 4) The regression test findings indicate that variable X3 has a positive regression coefficient with a value of $b = 0.333$ based on variable X3. This implies that variable Y will grow by 0.333 if the value of variable X3 increases by one unit.

This means that all three X variables have a significant effect on critical thinking skills.

3.3. F Test

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	534,618	3	178,206	58,071	,000 ^b
	Residual	546,244	178	3,069		
	Total	1080,863	181			
a. Dependent Variable: Critical Thinking Skills						
b. Predictors: (Constant), AI Usage Ethics, Usage of GenAI, AI Literacy						

Statistical analysis reveals that the calculated F-value of 58.071 exceeds the table F-value of 2.66, with a significance level of 0.000 ($p < 0.05$). These results demonstrate that the use of GenAI (X1), AI literacy (X2), and AI usage ethics (X3) simultaneously exert a positive and significant effect on the critical thinking skills of UNNES students (Y). Consequently, H_0 is rejected and H_4 is accepted.

3.4. T Test

Coefficients ^a						
Model				Standardized Coefficients	t	Sig.
				Beta		
1	(Constant)	5,020	1,570		3,196	0,002
	Usage of GenAI	0,242	0,083	0,200	2,930	0,004
	AI Literacy	0,432	0,091	0,373	4,756	0,000
	AI Usage Ethics	0,333	0,102	0,238	3,253	0,001

According to the analysis in the table above, all three independent variables individually exert a positive and significant influence on students' critical thinking skills, resulting in the rejection of H_0 in all cases. First, the use of GenAI yields a calculated t-value of 2.930, which exceeds the critical t-value of 1.653, with a significance level of 0.004 ($p < 0.05$); thus, H_1 is accepted. Second, AI literacy demonstrates a significant impact with a calculated t-value of 4.756 ($t_{critical} = 1.653$) and a significance value of 0.000, meaning H_2 is accepted. Lastly, AI Ethics also significantly affects critical thinking, as evidenced by a calculated t-value of 3.253 ($t_{critical} = 1.653$) and a significance level of 0.001, thereby accepting H_3 .

Discussion

The research results indicate that the use of Generative AI, AI literacy, and the ethics of AI use have a positive and significant influence on students' critical thinking skills. These findings suggest that the use of AI in learning is not only related to easier access to information, but also to students' ability to process, interpret, and evaluate that information more rationally. In higher education, this means that AI can support the thinking process when it is used purposefully, critically, and in line with academic responsibility.

Based on the results of the research instrument testing, the validity test showed that all items had a significant correlation with the total score, indicating that each statement item was able to represent the construct being measured. The high calculated r values for each variable indicate that the instrument possesses good discriminatory power in measuring differences in respondents' characteristics. Reliability tests reinforce these findings, with all variables exhibiting Cronbach's Alpha values above 0.60. The Critical Thinking Ability and AI Literacy variables demonstrated higher reliability (>0.70), meaning they possess strong internal consistency. Meanwhile, the Generative AI Usage and AI Usage Ethics variables fell into the 'moderately reliable' category, which is still acceptable in social research.

The normality test yielded a significance value of 0.200, confirming that the residuals follow a normal distribution. Additionally, multicollinearity diagnostics revealed that all independent variables surpassed the standard thresholds, maintaining tolerance values

above 0.100 and Variance Inflation Factor (VIF) values below 10. Consequently, the regression model is confirmed to be free from multicollinearity issues. The heteroscedasticity test also revealed no specific pattern in the scatter of data points, so it can be concluded that the regression model meets the required classical assumptions. With these assumptions met, the regression test results can be interpreted more accurately and are statistically reliable.

Partially, the use of Generative AI has a positive and significant effect on students' critical thinking skills, with a significance value of 0.004. This finding suggests that the more effectively students utilize Generative AI, the greater their chances of improving their critical thinking skills. In this context, AI appears to act as a tool that facilitates students' access to information, comparison of sources, and formulation of initial arguments. However, this positive influence must still be understood contextually, as AI will only strengthen critical thinking if students continue to verify, analyze, and reason independently regarding the information obtained.

The AI literacy variable was also found to have a positive and significant effect on critical thinking skills, with a significance value of 0.000, whilst also being the variable with the largest beta coefficient among the three independent variables. This indicates that AI literacy is the most dominant factor in shaping students' critical thinking skills in this study. In substantive terms, students who have a better understanding of how AI works, its limitations, benefits, and risks tend to be better able to critically assess information, distinguish between relevant and irrelevant data, and use technology more reflectively. Thus, AI literacy is not merely a technical skill, but also a cognitive ability that underpins the process of in-depth information evaluation.

Furthermore, the ethics of AI use have a positive and significant influence on critical thinking skills, with a p-value of 0.001. This finding reinforces the view that the use of AI in learning must be accompanied by an ethical understanding to prevent dependency, manipulation of information, or breaches of academic integrity. Students who understand the ethics of AI use are likely to be more responsible in utilizing the technology, ensuring that AI is not used as a means to bypass the thinking process, but rather as a supportive tool to enrich reasoning.

Therefore, the ethical aspect of AI use can be understood as a crucial foundation that safeguards the quality of critical thinking whilst ensuring the responsible use of technology. The results of the simultaneous test also indicate that the combined use of Generative AI, AI literacy, and the ethics of AI usage has a positive and significant effect on students' critical thinking skills, with a calculated F-value of 58.071 and a significance level of 0.000. These findings confirm that students' critical thinking skills are not shaped by a single factor, but rather by a combination of the intensity of AI use, understanding of AI, and ethical awareness in utilizing it. In other words, AI will make a more optimal contribution if students not only actively use it, but also understand how it works and the academic responsibilities inherent in its use.

At the managerial level, these findings imply that university leaders should not treat GenAI merely as a technical tool, but as part of a learning ecosystem that requires clear governance. Deans, study program heads, and lecturers need to formulate academic guidelines on permissible AI use, citation standards, and the boundaries between assistance and academic dishonesty. Such policy direction is important so that AI use remains aligned with learning objectives and does not weaken students' independent reasoning.

From a curriculum perspective, AI literacy should be integrated systematically into learning activities through courses, modules, or workshops that train students to verify information, evaluate AI outputs, and use technology responsibly. In parallel, lecturers should be supported through professional development and assessment designs that value reasoning processes, not only final answers. With this institutional support, AI can function as a scaffold for critical thinking rather than a substitute for it.

This study has several limitations. First, the critical thinking variable was measured through self-reported questionnaire responses, so the findings may be influenced by subjective bias and do not fully capture students' actual critical-thinking performance. Second, the study used a cross-sectional design and involved only one study program at one university; therefore, the results should be generalized with caution.

Conclusion

In conceptual terms, this study shows that Generative AI does not automatically strengthen critical thinking. The quality of students' thinking depends on how they understand, control, and ethically apply the technology. Students with stronger AI literacy and clearer ethical awareness are better able to use AI as support for reasoning rather than as a substitute for it. The central message of this study is that technology contributes to critical thinking only when it is accompanied by literacy, reflection, and academic responsibility.

Accordingly, students are advised to use Generative AI in moderation and to maintain independent thinking so that the technology functions as a tool for developing critical reasoning. Lecturers and higher education institutions need to strengthen AI literacy through learning, training, and academic policies that emphasize both technical and ethical understanding in the use of AI. Future research is encouraged to expand the variables, increase the sample size, or use mixed methods so that the relationship between AI use and critical thinking can be examined more comprehensively.

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