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The Effect of the Frequency of Artificial Intelligence (AI) Use on the Critical Thinking Ability of Junior and Senior High School Students in Medan City

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Abstract

The development of generative artificial intelligence has transformed the way learners interact with information in educational contexts; however, its impact on critical thinking skills remains debated. This study aimed to analyze the effect of artificial intelligence (AI) use frequency on the critical thinking abilities of junior and senior high school students in Medan City. This study employed a quantitative approach with a correlation-regression survey design. The sample consisted of 50 students from 16 schools in Medan City who were selected using purposive sampling, comprising 25 junior high school students and 25 senior high school students with a balanced gender composition. The frequency of AI use was measured using the Technology Acceptance Model (TAM) framework developed by Davis (1989), consisting of six statements, while critical thinking ability was measured using Facione's (1990) six dimensions through 18 statements on a 5-point Likert scale. Data analysis was conducted using the Shapiro–Wilk normality test, linearity test, Pearson correlation test, and simple linear regression analysis. The results showed a positive and significant effect of AI use frequency on students' critical thinking abilities ($r = 0.888$, $p < .001$, $R^2 = 0.789$), indicating that AI use frequency explained 78.9% of the variance in students' critical thinking abilities. Among the six dimensions of critical thinking, the explanation dimension recorded the lowest mean score (3.07), indicating that students still experienced difficulties in reinterpreting information generated by AI using their own words. This study concluded that active and reflective AI use has the potential to support the development of critical thinking abilities among students at the secondary education level.

INTRODUCTION

The development of generative artificial intelligence based on large language models (LLMs), such as ChatGPT, has transformed the way learners interact with information in educational contexts. The adoption of this technology has shown an increasing trend across age groups; among adolescents aged 12–16 years, approximately 14.8% use generative AI for academic purposes, while among those aged 15–19 years, the proportion increases significantly to 52.6% (Klarin et al., 2024). This high adoption rate is not limited to university students but has also become increasingly evident at the secondary education level (Klarin et al., 2024). The accessibility of generative AI technology has further contributed to its widespread use in academic activities, including task completion, information retrieval, and subject-matter comprehension. The application of AI in education has expanded to include adaptive learning, intelligent assessment, and personalized feedback, which collectively support more efficient learning processes (Wang et al., 2024).

The rapid adoption of generative AI among learners has raised fundamental questions regarding its impact on critical thinking skills, which represent one of the four key

competencies in the 21st-century 4C framework alongside creativity, collaboration, and communication (Thornhill-Miller et al., 2023). The accessibility of generative AI has introduced concerns regarding learners' tendency to accept AI-generated information without verification, potentially limiting their ability to evaluate and process information critically and independently (Melisa et al., 2025). This condition may reduce the quality of critical thinking if AI use is not accompanied by adequate cognitive awareness, causing AI to function as a substitute rather than a support tool for higher-order thinking skills (Jose et al., 2025).

These concerns are increasingly relevant in the context of Medan City, the third-largest city in Indonesia, which recorded economic growth of 5.04% in 2023 and contributed 28.86% to North Sumatra's gross domestic product (GDP) (BPS Medan City, 2024). As a metropolitan city, Medan has an extensive secondary education infrastructure, with hundreds of junior and senior high schools distributed across its sub-districts (BPS Medan City, 2024). Nationally, a report from the Indonesian Internet Service Providers Association indicated that Generation Z, including the age group of junior and senior high school students, represented the largest proportion of internet users, accounting for 34.40% of Indonesia's 221.5 million internet users in 2024 (Indonesian Internet Service Providers Association, 2024). The high level of internet penetration among students highlights both the potential and risks associated with integrating artificial intelligence into secondary education, including in Medan City (Indarti et al., 2024; Manurung, 2025; Panjaitan et al., 2025; Rahmah et al., 2025; Tarani et al., 2025).

To systematically examine this phenomenon, this study referred to the Technology Acceptance Model (TAM) developed by Davis (1989) to analyze patterns of artificial intelligence (AI) use among students. The TAM framework explains that technology acceptance is influenced by two primary constructs: perceived usefulness, referring to the belief that technology improves performance, and perceived ease of use, referring to the perception that technology can be used with minimal effort (Davis, 1989). These constructs serve as important determinants of technology adoption and actual usage behavior. Meanwhile, critical thinking skills in this study were measured using Facione's conceptual framework, which identifies six core dimensions: interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 1990). The integration of the TAM framework and critical thinking theory enables this study to examine the relationship between technology use patterns and students' cognitive abilities. Both theoretical approaches have been applied in technology-based education research to investigate the relationship between technology adoption behavior and cognitive learning outcomes (Xue et al., 2026).

Several previous studies have examined the relationship between artificial intelligence use and critical thinking skills. Siallagan et al. (2024) found that excessive AI use among Indonesian students may reduce critical thinking quality due to increased reliance on immediate answers. Similarly, Tampubolon et al. (2024) reported that dependence on AI may limit students' ability to think independently when solving academic problems. Firdaus et al. (2025) also found that reliance on AI for academic assignments may weaken students' critical and creative thinking skills simultaneously. Meanwhile, Susilo and Widayanti (2024) demonstrated that ChatGPT use among high school students was associated with plagiarism behavior and reduced independent thinking. However, these studies primarily focused on general student contexts or employed qualitative approaches; therefore, limited quantitative evidence exists

regarding the effect of AI use frequency on Facione's six dimensions of critical thinking among junior and senior high school students, particularly in Medan City.

Based on this background, this study aimed to analyze the effect of artificial intelligence use frequency on the critical thinking abilities of junior and senior high school students in Medan City. The study employed the TAM framework developed by Davis (1989) to measure AI use frequency and Facione's (1990) six dimensions of critical thinking to assess students' critical thinking abilities. The hypotheses proposed in this study were as follows: H_0 stated that AI use frequency had no significant effect on the critical thinking abilities of junior and senior high school students in Medan City, while H_1 stated that AI use frequency had a significant effect on students' critical thinking abilities.

METHOD

This study employed a quantitative approach with a correlation-regression survey design to examine the effect of artificial intelligence use frequency on the critical thinking abilities of junior and senior high school students in Medan City (Creswell, 2014). Data were collected through an online questionnaire distributed via Google Forms in April 2026 without experimental intervention.

The research population consisted of junior and senior high school students in Medan City who had used AI for learning activities. The sample was selected using purposive sampling based on the following criteria: (1) active junior or senior high school students in Medan City and (2) having used at least one generative AI platform for academic purposes (Sugiyono, 2019). A total of 50 respondents from 16 schools participated in the study, consisting of 25 junior high school students and 25 senior high school students, with an equal gender distribution of 25 males and 25 females.

The independent variable (X) was AI use frequency, measured using indicators based on the Technology Acceptance Model (TAM) framework developed by Davis (1989), while the dependent variable (Y) was critical thinking ability, measured using Facione's (1990) six dimensions: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Data were collected using a 5-point Likert scale questionnaire consisting of 24 statements, including six items for AI use frequency and 18 items for critical thinking ability. Reliability testing using Cronbach's alpha produced coefficients of 0.909 for variable X and 0.946 for variable Y, indicating that both instruments had high internal consistency (Ghozali, 2018).

Data analysis was conducted through four stages: the Shapiro–Wilk normality test, linearity test, Pearson correlation test, and simple linear regression analysis to examine the effect of AI use frequency on critical thinking ability using the coefficient of determination (R^2) (Sugiyono, 2019). Although the Shapiro–Wilk test indicated that the dependent variable was not normally distributed, parametric analysis was retained based on the sample size and the assumption that the sampling distribution approaches normality with sufficiently large samples (Field, 2018). Hypothesis testing was based on the significance value with a threshold of $\alpha = .05$.

RESULTS AND DISCUSSION

Description of Respondent Data

This study involved 50 junior and senior high school students from 16 schools spread across the city of Medan. Respondents consisted of two groups of education levels with a balanced number. The distribution of respondents by level of education is presented in the following table.

Table 1. Distribution of Respondents by Education Level

Levels	Quantity	Percentage (%)
Junior High School	25	50,0
High School	25	50,0
Total	50	100,0

Source: Primary data, processed by researchers (2026)

Table 1 shows that respondents are evenly divided between junior high and high school levels, 50.0% each. In addition to the level of education, the composition of respondents was also reviewed based on gender. The distribution of respondents by gender is presented in the following table.

Table 2. Distribution of Respondents by Gender

Gender	Quantity	Percentage (%)
Male	25	50,0
Women	25	50,0
Total	50	100,0

Source: Primary data, processed by researchers (2026)

Table 2 shows that the composition of respondents based on gender is also evenly divided, so the results of the study are not biased towards certain gender groups.

Furthermore, respondents were identified based on the AI platforms that were most frequently used in academic activities. The distribution of AI platform usage is presented in the following table.

Table 3. Distribution of Respondents Based on the AI Platform Used

Platform AI	Quantity	Percentage (%)
ChatGPT	21	42,0
Copilot	12	24,0
Gemini	11	22,0
Bing AI	6	12,0
Total	50	100,0

Source: Primary data, processed by researchers (2026)

Table 3 shows that ChatGPT is the most dominant AI platform used by respondents with a proportion of 42.0%, followed by Copilot at 24.0%, Gemini at 22.0%, and Bing AI at 12.0%.

Furthermore, the respondents' critical thinking skills were analyzed based on the six dimensions of Facione to find out which dimensions were the strongest and weakest. The average score per dimension is presented in the following table.

Table 4. Average Score Per Dimension of Critical Thinking Ability

Dimensions	Average	Remarks
Interpretasi	3,23	Highest
Inference	3,22	
Self-Regulation	3,21	
Analysis	3,19	
Evaluation	3,11	
Explanation	3,07	Lowest

Source: Primary data, processed by researchers (2026)

Table 4 shows that the interpretation dimension obtained the highest average of 3.23, while the explanatory dimension recorded the lowest average of 3.07. This indicates that students are quite capable of understanding and drawing conclusions from the information obtained through AI, but still have difficulty in explaining the information using their own words independently.

Furthermore, the average comparison of the frequency of use of AI and critical thinking skills is reviewed by education level is presented in the following table.

Table 5. Average Variable Score X and Y Based on Education Level

Jenjang	Average X	Average Y
SMP	19,64	59,84
SMA	18,28	54,28

Source: Primary data, processed by researchers (2026)

Table 5 shows that junior high school students have an average frequency of AI use of 19.64 and an average critical thinking ability of 59.84, both higher than high school students with an average frequency of AI use of 18.28 and critical thinking skills of 54.28.

Validity and Reliability Tests

The validity test was conducted using Pearson's Product Moment correlation with a table r of 0.279 (n=50, α=0.05) and a reliability test using Cronbach Alpha with a threshold of 0.700 (Ghozali, 2018). The results of the validity and reliability test of the two variables are presented in the following table.

Table 6. Instrument Validity and Reliability Test Results

Variabel	Item	r Count	r Table	Cronbach Alpha	Remarks
Frequency of AI Use (X)	X1	0,756	0,279		Valid
	X2	0,709	0,279		Valid
	X3	0,780	0,279		Valid
	X4	0,765	0,279		Valid
	X5	0,717	0,279		Valid
	X6	0,768	0,279	0,909	Valid
Critical Thinking Skills (Y)	Y1	0,657	0,279		Valid
	Y2	0,663	0,279		Valid
	Y3	0,630	0,279		Valid
	Y4	0,648	0,279		Valid
	Y5	0,572	0,279		Valid
	Y6	0,673	0,279		Valid
	Y7	0,736	0,279		Valid
	Y8	0,769	0,279		Valid
	Y9	0,734	0,279		Valid
	Y10	0,723	0,279		Valid

Variabel	Item	r Count	r Table	Cronbach Alpha	Remarks
	Y11	0,661	0,279		Valid
	Y12	0,675	0,279		Valid
	Y13	0,695	0,279		Valid
	Y14	0,707	0,279		Valid
	Y15	0,623	0,279		Valid
	Y16	0,643	0,279		Valid
	Y17	0,752	0,279		Valid
	Y18	0,739	0,279	0,946	Valid

Source: Primary data, processed by researchers (2026)

All 24 instruments were declared valid and both variables had a very high level of reliability, making the data suitable for further analysis.

Normality Test

The normality test was carried out using the Shapiro-Wilk test to find out whether the data was normally distributed, considering that the number of samples in this study was 50 respondents (Shapiro and Wilk, 1965). The decision-making criterion is that the data is declared to be normally distributed if the significance value is greater than 0.05. The results of the normality test are presented in the following table.

Table 7. Shapiro-Wilk Normality Test Results

Variabel	Statistic	df	Say.	Remarks
Frequency of AI Use (X)	0,955	50	0,053	Normal
Critical Thinking Skills (Y)	0,877	50	0,000	Abnormal

Source: Primary data, processed by researchers (2026)

Table 7 shows that variable X is normally distributed with a significance value of 0.053 greater than 0.05, whereas variable Y is not normally distributed with a significance value of 0.000 less than 0.05.

Linearity Test

The linearity test was carried out to find out whether the relationship between the variable frequency of AI use (X) and critical thinking ability (Y) is linear as a prerequisite for regression analysis (Sugiyono, 2019). The decision-making criterion is that the relationship is stated linear when the significance value of Linearity is less than 0.05 and the significance value of Deviation from Linearity is greater than 0.05. The results of the linearity test are presented in the following table.

Table 8. Linearity Test Results

	F	Sig.	Remarks
Linearity	894,019	0,000	Linear significant
Deviation from Linearity	12,254	0,000	There are nonlinear components

Source: Primary data, processed by researchers (2026)

Table 8 shows that the significance value of Linearity of 0.000 is smaller than 0.05, which means that the linear component between variables X and Y is significant. Although the Deviation from Linearity value is also significant (p = 0.000), the values of $Eta^2 = 0.973$ and

$R^2 = 0.789$ indicate that the linear component still dominates the relationship between the two variables, so the simple linear regression analysis can still be continued.

Pearson Correlation Test

The Pearson correlation test was conducted to determine the strength and direction of the relationship between the variable frequency of AI use (X) and critical thinking ability (Y). The decision-making criterion is that there is a significant relationship if the significance value is less than 0.05 (Sugiyono, 2019). The results of the Pearson correlation test are presented in the following table.

Table 9. Pearson Correlation Test Results

Variabel	r	Sig. (2-tailed)	N	Remarks
TOTAL X with TOTAL Y	0,888	0,000	50	Signifikan

Source: Primary data, processed by researchers (2026)

Table 9 shows that the value of the Pearson correlation coefficient is 0.888 with a significance of 0.000 is less than 0.05. This means that there is a very positive and strong relationship between the frequency of AI use and students' critical thinking skills.

Simple Linear Regression Test

A simple linear regression analysis was carried out to determine the magnitude of the influence of the frequency of the use of AI (X) on critical thinking skills (Y). The results of the Model Summary test are presented in the following table.

Table 10. Summary Model Test Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,888	0,789	0,784	5,155

Source: Primary data, processed by researchers (2026)

Table 10 shows an R value of 0.888 which indicates a very strong relationship between variables X and Y. An R-Square value of 0.789 means that the frequency of use of AI is able to explain 78.9% of the variation in students' critical thinking skills, while the remaining 21.1% is explained by other factors outside of this study. Furthermore, the results of the regression model significance test are presented in the following table.

Table 11. ANOVA Test Results

Model	Sum of Squares	df	Mean Square	F	Say.
Regression	4765,216	1	4765,216	179,311	0,000
Residual	1275,604	48	26,575		
Total	6040,820	49			

Source: Primary data, processed by researchers (2026)

Table 11 shows an F value of 179.311 with a significance of 0.000 less than 0.05, which means that the regression model is significant and feasible to use to predict students' critical thinking skills. Furthermore, the results of the regression coefficient test are presented in the following table.

Table 12. Test Coefficients Results

Model	B	Std. Error	Beta	t	Say.
(Constant)	22,029	2,716		8,112	0,000
TOTAL X	1,848	0,138	0,888	13,391	0,000

Source: Primary data, processed by researchers (2026)

Table 12 shows a t-value of 13.391 with a significance of 0.000 less than 0.05, so H1 is accepted and H0 is rejected. Based on the value of the coefficient, the regression equation $\hat{Y} = 22.029 + 1.848X$ was obtained, which means that every one unit increase in the frequency of using AI would increase students' critical thinking skills by 1.848 units.

The results showed that the frequency of use of artificial intelligence had a positive and significant effect on the critical thinking skills of junior and senior high school students in Medan City, with a Pearson correlation coefficient of 0.888 and a significance value of 0.000 ($p < 0.05$). The value of the determination coefficient $R^2 = 0.789$ means that the frequency of AI use is able to explain 78.9% of the variation in students' critical thinking skills, while the remaining 21.1% is influenced by other factors outside of this study. The regression equation $\hat{Y} = 22.029 + 1.848X$ means that every one unit increase in the frequency of AI use will be followed by an increase in critical thinking skills by 1.848 units. These findings are in line with the results of research by Zhao et al., (2025) who concluded that generative AI has significant potential in encouraging students' high-level thinking skills through the provision of rich and contextual learning materials. Research by Wu and Zhang (2025) also confirmed that the use of generative AI exerts a substantial positive influence on critical thinking and creative problem-solving abilities ($\beta = 0.862$, $p < 0.001$).

The findings can be explained through the framework of TAM Davis (1989) where students who perceive AI as a useful and easy-to-use technology tend to use it with higher frequency, which in turn encourages more intense cognitive engagement in the learning process. Active engagement with AI outputs encourages students to repeatedly evaluate, question and verify the information generated, so that the process indirectly trains critical thinking skills (Mansoor et al., 2026). Research by Li et al., (2024) confirms that cognitive factors and human-computer interaction are significantly related to perceived usefulness and perceived ease of use as the main drivers of AI adoption at the secondary education level. Thus, the high frequency of AI use in this study is not just an indicator of dependence, but reflects high acceptance of technology and correlates with more active and reflective learning activities, so that AI plays a role as a tool to support students' critical thinking (Li & Low, 2024).

Analysis per dimension of Facion's critical thinking showed that the interpretation dimension obtained the highest average (3.23), followed by inference (3.22), self-regulation (3.21), analysis (3.19), and evaluation (3.11), while the explanatory dimension recorded the lowest average (3.07). This pattern indicates that students are sufficiently capable of understanding information from AI and drawing conclusions from it, but have difficulty recommunicating the results of their thinking independently and in a structured manner. The explanatory dimension in the framework of Facione (1990) refers to the ability to present the results of reasoning clearly and convincingly, including justifying the procedures and arguments used. This low dimension is in line with the research of Melisa et al., (2025) that

generative AI has the potential to make students passively receive information without being able to re-decipher their thought process. This condition is also consistent with the research of Zhai et al., (2024) which states that excessive reliance on AI can hinder students' ability to explain and reason independently because cognitive processes that should be built internally are instead transferred to the AI system.

The results of this study are different from Siallagan et al., (2024) who stated that the use of AI tends to weaken critical thinking skills. Siallagan et al. stated that the excessive use of AI resulted in a critical thinking crisis for Indonesian students. Tampubolon et al., (2024) who found that AI inhibits students' independent thinking skills, while Firdaus et al., (2025) revealed that dependence on AI weakens students' critical and creative thinking skills simultaneously. This difference can be explained from several points of view. First, all of the research uses student subjects, while this study focuses on junior high and high school students who are in the stage of forming learning habits so that AI is more used as an exploration tool. Second, Gerlich's (2025) research involved finding that the negative impact of AI on critical thinking is mediated by excessive cognitive offloading which suggests that the impact of AI is conditional and depends on how it is used, not just its frequency.

Comparative analysis based on education level showed interesting results, namely junior high school students had a higher average critical thinking score (59.84) than high school students (54.28), although the average frequency of AI use of junior high school students (19.64) was also higher than high school students (18.28). These findings contradict the common assumption that cognitively mature high school students should have better critical thinking skills. One explanation that can be put forward is that junior high school students tend to use AI with a more exploratory and inquisitive approach, so that their interaction process with AI is more dialogical and encourages follow-up questions (Braz̃ ao & Tinoca, 2025). In contrast, high school students who face higher academic demands may tend to use AI more pragmatically to complete tasks efficiently without doing much critical evaluation of the output received, as confirmed by Sok et al.'s research on high school students (Sok et al., 2025).

This study has a number of limitations that need to be considered in interpreting the results. The sample size of 50 respondents from one city has not allowed the generalization of results to a wider population. The results of the Shapiro-Wilk normality test showed that the Y variable was not normally distributed ($p = 0.000$), so even though the parametric approach was still used based on the Central Limit Theorem with $n \geq 30$, the results of the study needed to be interpreted carefully (Field, 2018). In addition, the significance value of Deviation from Linearity of 0.000 indicates the presence of nonlinear components that have not been fully captured by the simple linear regression model used. The measurement of the frequency of AI use is also based on respondents' perceptions through questionnaires, rather than on actual usage log data, so there is a possibility of response bias. Other variables that have the potential to affect critical thinking skills such as digital literacy, learning motivation, and students' learning styles need to be further researched in subsequent research (Zhai, et al., 2024).

CONCLUSION

This study concluded that artificial intelligence use frequency had a positive and significant effect on the critical thinking abilities of junior and senior high school students in Medan City, as indicated by the Pearson correlation coefficient ($r = 0.888$), significance value

($p < .001$), and coefficient of determination ($R^2 = 0.789$). These findings supported the acceptance of H_1 and rejection of H_0. Among Facione's six dimensions of critical thinking, the explanation dimension recorded the lowest mean score (3.07), indicating that students required further encouragement to reinterpret and evaluate AI-generated information independently. Based on these findings, teachers and schools were encouraged to promote reflective AI use by developing students' habits of verifying, evaluating, and reformulating information obtained from AI systems. Future research should consider larger samples, additional moderating variables such as digital literacy, and nonlinear analytical approaches to provide a more comprehensive understanding of the relationship between AI use frequency and critical thinking abilities.

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