

# Analysis of the Influence of the Use of Artificial Intelligence (AI) on Students' Critical Thinking Abilities in Learning

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**Abstract.** This study examines how Artificial Intelligence (AI) use affects students' critical thinking skills in learning. The study uses a quantitative, explanatory research design. The study population consisted of students in the Economics Education Study Program who used AI-based applications for learning. The study collected data through a five-point Likert-scale questionnaire from 64 respondents who met the research criteria. The researchers analyzed the data using validity and reliability tests, assumption tests, and simple linear regression in SPSS. The results show that using AI has a positive and significant effect on students' critical thinking skills. The t-test yielded  $t = 4.670$  ( $p = 0.000$ ), and the regression coefficient was 0.431. The R-square value of 0.260 indicates that AI use explains 26% of the variation in students' critical thinking skills, while other factors account for the remaining 74%. These findings suggest that appropriate AI use can support students' ability to analyze, evaluate, and solve problems.

**Keywords:** Artificial Intelligence; Critical Thinking; Student Learning.

## 1. Introduction

Education continues to evolve alongside technological advancements across various sectors. To enhance efficiency and improve education quality, higher education institutions are encouraged to integrate technology into teaching and learning as part of the digital transformation characterizing the eras of Industrial Revolution 4.0 and Society 5.0. Artificial Intelligence (AI) has advanced rapidly in recent years and has a significant impact on education. AI is a computer technology capable of thinking and learning much like a human (Dwivedi et al., 2023). In higher education, AI is used not only for academic administration but also to support learning through intelligent tutoring systems, educational chatbots, learning recommendation systems, and generative learning applications. ChatGPT, Gemini, Claude, Microsoft Copilot, and others are examples of artificial intelligence that exist today (Kasneci et al., 2023).

The emergence of generative AI has ushered in a new era of educational technology. This technology lets users quickly and efficiently obtain information, generate text, create summaries, translate documents, analyze data, and even write scientific papers. For students, AI has become a readily accessible learning resource used in various academic activities. Students use AI to understand lecture material, complete assignments, prepare presentations, find references, and even develop research ideas. This ease of use has made AI a technology with a very high adoption rate in higher education. According to Crompton and Burke (2023), AI has changed how students interact with information and knowledge, as they can now access what was previously a manual search process through interactive dialogue with AI systems. These changes demonstrate that AI has become a vital part of the 21st-century learning ecosystem.

The increasing use of AI in learning brings both advantages and disadvantages for users. On the positive side, AI can expand access to learning resources, enhance the learning process, and help students understand material in ways that suit their abilities. AI can also support personalized learning by tailoring responses to user needs. By using AI, users can improve learning quality, learn independently, and receive fast feedback that can continuously improve problem-solving skills (Tlili et al., 2023). On the other hand, the growing use of AI also raises several academic concerns. One issue widely discussed in the educational literature is the potential decline in students' critical thinking skills due to dependence on AI technology. When quick answers are constantly available, students ultimately engage less in deep thinking processes such as analyzing, evaluating, and synthesizing data.

The relationship between AI use and students' critical thinking skills can be explained through theory. According to constructivist theory, learning occurs when individuals actively construct knowledge through interaction with their environment (Schunk, 2020). From this perspective, AI can be a tool that enriches students' learning experiences by providing a variety of information and knowledge sources that can be explored independently. Students who actively use AI can gain a deeper understanding through exploration, reflection, and discussion facilitated by the technology.

The relationship between artificial intelligence and students' critical thinking skills is grounded in cognitive load theory. According to this theory, technology can reduce certain cognitive loads, allowing individuals to focus their mental capacity on higher-order thinking activities. AI allows students to obtain information more quickly and in a structured manner, thus saving time previously spent searching for basic information. By reducing cognitive load, students have more opportunity to analyze, evaluate, and synthesize the information they obtain.

Previous research has yielded varied findings regarding how artificial intelligence affects students' critical thinking skills. A study by Zhou et al. (2024) found that when generative AI is used in conjunction with strong self-regulation skills, students' critical thinking and problem-solving skills improve. Students who use AI reflectively show stronger analytical skills than those who use it only for instant answers. Another study by Crompton and Burke (2023) also showed that AI can enhance learning quality through personalization and rapid feedback.

Conversely, some studies indicate that AI use can also negatively affect students' critical thinking skills. Sullivan et al. (2024) found that excessive generative AI use can reduce students' critical thinking abilities, as students tend to rely on AI-generated answers. Liang et al. (2024) found that students who use AI too frequently are less inclined to evaluate AI-provided answers. These results indicate that artificial intelligence can be a useful learning tool, and vice versa. AI can enhance critical thinking skills and support the learning process; however, if used inappropriately, it can also diminish students' cognitive activity.

Research in Indonesia on AI use in learning is still relatively new and focuses mainly on user perceptions, technology acceptance, and the effectiveness of AI-based learning. Prasetyo and Wibowo (2024) found that students view AI as helpful for their learning, while Fiani et al. (2025) found that AI can enhance learning efficiency. Furthermore, Nurdiana et al. (2024) found that teachers hold diverse views on using AI in learning. They view AI as either an educational innovation or a threat to academic integrity.

A literature review reveals several research gaps that motivated the present study. First, most prior studies have focused on students' perceptions of AI, their acceptance of the technology, and the effectiveness of AI-based learning. Few studies have examined how AI use affects students' critical thinking skills. Second, previous studies yield inconsistent results. Some studies show that artificial intelligence can improve students' critical thinking abilities, while others show that it can

cause cognitive dependency and reduce students' critical thinking abilities. Third, because most research was conducted in developed countries, little empirical evidence explains the relationship between artificial intelligence use and students' critical thinking skills in Indonesia.

This research aims to evaluate the impact of using Artificial Intelligence (AI) on students' critical thinking abilities in the learning process, based on the background, empirical phenomena, theoretical studies, and research differences described above. This study specifically aims to determine the extent of AI use among students, students' critical thinking skills, and how AI use affects those skills. The findings are expected to inform the development of an AI-integrated learning model designed to enhance student learning and critical thinking skills in the era of digital transformation.

## 2. Method

This study employs a quantitative approach and an explanatory research design. The study aims to evaluate and explain how Artificial Intelligence (AI) affects students' critical thinking skills during learning. According to Creswell and Creswell (2023), a quantitative survey design effectively tests relationships between variables in relatively large populations using data collected with standardized instruments. Explanatory research also enables researchers to obtain empirical evidence regarding the nature and magnitude of the independent variable's influence on the dependent variable. This allows researchers to test research hypotheses more rigorously. This study uses artificial intelligence (X) as the independent variable and students' critical thinking skills in learning (Y) as the dependent variable. The study's conceptual model is based on the premise that using AI in learning activities can influence students' ability to analyze information, evaluate arguments, draw logical conclusions, and solve academic problems. (Zhou et al., 2024; Kasneci et al., 2023; Tlili et al., 2023).

The study sample consisted of active fourth-semester students from a single cohort, this group was selected because they were deemed to possess a mature level of digital literacy and actively utilized AI in their learning activities. The selected respondents included active students who had used AI applications such as ChatGPT, Gemini, Claude, or others in their academic work. These criteria were established to ensure that respondents had sufficient experience with AI to provide information relevant to the research objectives. Research questionnaires were distributed to 83 students, 64 students completed them in full, and all resulting data were utilized in the study.

The research instrument was a closed questionnaire with a five-level Likert scale (1-5). The variable of Artificial Intelligence usage was measured based on indicators adapted from research by Crompton and Burke (2023), Dwivedi et al. (2023), and Zhou et al. (2024), which include: Frequency of AI Use, Purpose of Use, Intensity/Depth of Use, Ability to Operate AI, Utilization of AI for Learning, and Evaluation of AI Results. Meanwhile, students' critical thinking abilities were measured using critical thinking indicators developed in recent higher education research, including analysis, Evaluation, Inference, Explanation, and Problem-Solving Ability (Almulla, 2023; Fitriani & Mulyadi, 2024).

In the initial stage of analysis, the instruments used were tested for validity and reliability. Subsequently, data from instruments found to be invalid or unreliable were excluded from the calculations. Next, to ensure the data met the assumptions of linear regression, we tested normality, heteroscedasticity, and linearity between variables. Because this study aimed to evaluate the effect of a single independent variable on a single dependent variable, the hypothesis was tested using simple linear regression analysis.

### 3. Result

#### a. Instrument Validity and Reliability Test

To ensure each statement item accurately and consistently measured the variables under study, the researchers first verified the instrument's validity and reliability before processing the data. The researchers used Pearson product-moment correlation for validity testing, with a calculated  $r$  value greater than the table  $r$  value at the 5% significance level. Additionally, the researchers used Cronbach's Alpha coefficient, with a minimum acceptable value of 0.70, to test instrument dependability. The main tool for gathering research data was instruments that met the validity and reliability requirements (Hair et al., 2022). The validity and reliability assessments of the instruments employed in this investigation yielded the following findings.

**Table 1.** Instrument Validity Test

| Variables                    | Number of Items | Information |
|------------------------------|-----------------|-------------|
| Use of AI(X)                 | 15              | Valid       |
| Critical Thinking Skills (Y) | 15              | Valid       |

**Table 2.** Reliability Test

| Variables                    | Cronbach's Alpha | Information |
|------------------------------|------------------|-------------|
| Use of AI(X)                 | 0.917            | Reliable    |
| Critical Thinking Skills (Y) | 0.928            | Reliable    |

#### b. Normality Test

To determine whether the study data were normally distributed, a normality test was performed. The One-Sample Kolmogorov-Smirnov method was used to test the normality of regression residuals.

**Table 3.** Data Normality Test

| One-Sample Kolmogorov-Smirnov Test                 |                    |                         |
|----------------------------------------------------|--------------------|-------------------------|
|                                                    |                    | Unstandardized Residual |
| N                                                  |                    | 64                      |
| Normal Parameters <sup>a,b</sup>                   | Mean               | .0000000                |
|                                                    | Standard Deviation | 8.60198525              |
| Most Extreme Differences                           | Absolute           | .078                    |
|                                                    | Positive           | .078                    |
|                                                    | Negative           | -.073                   |
| Test Statistics                                    |                    | .078                    |
| Asymp. Sig. (2-tailed)                             |                    | .200 <sup>c,d</sup>     |
| a. Test distribution is Normal.                    |                    |                         |
| b. Calculated from data.                           |                    |                         |
| c. Lilliefors Significance Correction.             |                    |                         |
| d. This is a lower bound of the true significance. |                    |                         |

The study's residual data is deemed normally distributed based on the test results, which show an Asymp. Sig. (2-tailed) value of 0.200, which is greater than the 0.05 significance level. This result shows that the regression model satisfies one of the fundamental assumptions of parametric analysis, meaning that the research data can be used in simple linear regression analysis to test the research hypothesis. The normal distribution of the data also indicates that the respondent data are relatively evenly distributed and that no deviations could affect the statistical analysis.

#### c. Linearity Test

The linearity test was undertaken to assess whether the link between the AI usage variable and students' critical thinking ability was linear.

**Table 4.** Data Linearity Test

| ANOVA Table                      |                |                          | Sum of Squares | df | Mean Square | F      | Sig. |
|----------------------------------|----------------|--------------------------|----------------|----|-------------|--------|------|
| Critical Thinking *<br>Use of AI | Between Groups | (Combined)               | 4872.511       | 28 | 174,018     | 4,262  | .000 |
|                                  |                | Linearity                | 1640.103       | 1  | 1640.103    | 40,164 | .000 |
|                                  |                | Deviation from Linearity | 3232.408       | 27 | 119,719     | 2,932  | .002 |
|                                  | Within Groups  |                          | 1429.224       | 35 | 40,835      |        |      |
|                                  | Total          |                          | 6301.734       | 63 |             |        |      |

The linearity component of the ANOVA study yielded a significance value of 0.000. This value is less than 0.05, indicating a significant linear link between students' critical thinking abilities and AI use. Furthermore, a strong and straight-line association between the two variables is indicated by the Linearity F value of 40.164. These findings suggest that students' critical thinking abilities tend to rise in tandem with growing AI use. Since the regression analysis's linearity assumption is satisfied, we can proceed with linear regression.

d. Heteroscedasticity Test

To assess whether residual variance differs across observations, we performed the heteroscedasticity test using the Glejser method.

**Table 5.** Data Heteroscedasticity Test

| Coefficients <sup>a</sup> |            | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|---------------------------|------------|-----------------------------|------------|---------------------------|--------|------|
| Model                     |            | B                           | Std. Error | Beta                      |        |      |
| 1                         | (Constant) | 20,835                      | 2,975      |                           | 7,003  | .000 |
|                           | Use of AI  | -.254                       | .051       | -.532                     | -4,943 | .000 |

a. Dependent Variable: Abs\_Res

The AI Usage variable has a significance value of 0.000, according to the test results. This score, which is less than 0.05, indicates heteroscedasticity in the model. This indicates that the residual variance is not constant across the data range. This result shows that the regression model still has drawbacks and needs to be interpreted carefully. To address this heteroscedasticity, researchers may consider using robust regression techniques or data transformation in future studies. The direction and degree of the influence between variables can still be ascertained using the analysis results, however.

e. Simple Linear Regression Analysis

The impact of artificial intelligence on pupils' critical thinking abilities was examined using a straightforward linear regression analysis.

**Table 6.** ANOVA Test

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 1640.103       | 1  | 1640.103    | 21,813 | .000 <sup>b</sup> |
|       | Residual   | 4661.631       | 62 | 75,188      |        |                   |
|       | Total      | 6301.734       | 63 |             |        |                   |

a. Dependent Variable: Critical Thinking

b. Predictors: (Constant), Use of AI

At a significance level of 0.000, the ANOVA test results revealed an F-value of 21.813. The regression model used in this study is viable and can explain the relationship between students' critical thinking abilities and AI use, as indicated by a significance value of less than 0.05. As a result, the regression model can forecast students' critical thinking abilities based on their AI use.

f. Hypothesis Test (t-Test)

To assess the significance of the AI use variable's impact on students' critical thinking skills, we conducted a t-test.

**Table 7. t-test**

| Coefficients <sup>a</sup> |            | Unstandardized |            | Standardized | t     | Sig. |
|---------------------------|------------|----------------|------------|--------------|-------|------|
| Model                     |            | Coefficients   |            | Coefficients |       |      |
|                           |            | B              | Std. Error | Beta         |       |      |
| 1                         | (Constant) | 36,398         | 5,349      |              | 6,805 | .000 |
|                           | Use of AI  | .431           | .092       | .510         | 4,670 | .000 |

a. Dependent Variable: Critical Thinking

The analysis indicates a regression coefficient of 0.431 and a constant of 36.398. The regression equation is derived from these findings:

$$Y=36.398+0.431X$$

According to the formula, pupils' critical thinking abilities rise by 0.431 units for every unit increase in AI usage. A unidirectional association between the two variables is indicated by a positive regression coefficient. Students' critical thinking abilities increase as classroom AI use increases.

The t-test results showed a significance value of 0.000 and a t-value of 4.670. The study hypothesis is accepted because the significance value is less than 0.05. Therefore, it can be said that students' critical thinking abilities in the classroom are positively and significantly impacted by the application of artificial intelligence. These results suggest that AI can be used as a teaching tool to improve students' knowledge gathering, comprehension, analysis, and critical thinking abilities.

g. Determination Test

**Table 8. Model Summary**

| Model | R                 | R Square | Adjusted R Square | Standard Error of the Estimate |
|-------|-------------------|----------|-------------------|--------------------------------|
| 1     | .510 <sup>a</sup> | .260     | .248              | 8,671                          |

a. Predictors: (Constant), Use of AI

The analysis indicates a correlation coefficient (R) of 0.510. This figure shows a moderately strong association between students' AI use and their critical thinking abilities. In other words, students' critical thinking abilities increase as their AI use increases.

The AI usage variable accounts for 26.0% of the variation in students' critical thinking skills, as indicated by the coefficient of determination (R-squared) of 0.260. However, other characteristics not included in this study, including learning motivation, digital literacy, academic aptitude, learning techniques, learning environment, and other psychological factors, account for 74.0% of the variation in students' critical thinking abilities. These findings show that while AI use is not the only factor influencing students' critical thinking skills, it does play a substantial role.

#### 4. Discussion

The study's findings show that students' critical thinking abilities in the classroom are positively and significantly impacted by the application of artificial intelligence (AI). A straightforward linear regression analysis yielded a positive regression coefficient of 0.431 and a significance value of 0.000 ( $<0.05$ ), supporting this conclusion. Furthermore, the correlation coefficient of 0.510 indicates a modest, positive association between students' critical thinking abilities and AI use. These results show that students' critical thinking abilities increase as they use AI during the learning process. The study's findings provide empirical evidence that artificial intelligence (AI) can enhance students' cognitive growth while also making information more accessible. Because critical thinking underpins decision-making, problem-solving, and knowledge acquisition, it is among the most important competencies to foster in higher education. The results of this study are therefore highly relevant to the demands of 21st-century education, which places a strong emphasis on mastering higher-order thinking abilities.

Constructivism, which holds that knowledge is created via active interaction between people and their learning environment, can theoretically explain the study's findings. Kasneci et al. (2023) argue that because generative AI technology, like ChatGPT, enables more personalized, participatory learning experiences, it has enormous potential to support constructivist-based learning. AI can also serve as a scaffold, providing students with clearer, more contextual explanations of difficult ideas. Therefore, students' opportunities to build analytical, assessment, and reflection abilities on learning materials can be increased by using AI appropriately. The results support the notion that, when applied carefully and responsibly, digital technology can be part of a learning ecosystem that fosters students' critical thinking.

The results also align with cognitive load theory, which suggests that technology can reduce specific cognitive burdens so people can devote mental resources to higher-order thinking tasks. According to Dwivedi et al. (2023), AI can improve learning efficacy by providing quick, adaptable information support based on user requirements. In this study, enhanced critical thinking abilities can be seen as a result of a more effective learning process made possible by AI. Consequently, this study's findings provide empirical evidence supporting the hypothesis that digital technology, when used to facilitate active learning, can enhance critical thinking abilities.

The findings align with other studies from the past five years. According to Zhou et al.'s (2024) research, students' critical thinking and problem-solving abilities improved when they used generative AI. The study found that pupils with stronger critical-thinking abilities used AI reflectively and maintained control over their learning process. Tlili et al. (2023) reported similar findings, claiming that AI-based chatbots can boost students' cognitive engagement through dialogic and adaptive interactions. Rather than passively absorbing knowledge, students are encouraged to ask questions, evaluate responses, and deepen their understanding of the subject matter. According to Crompton and Burke's (2023) research, AI can raise educational standards by offering more individualized instruction and responding to students' needs. This study's consistency with other international studies shows that AI has great promise for helping students strengthen their critical thinking abilities across a variety of educational settings.

This study's findings align with several recent investigations conducted in Indonesia. According to research by Rahmawati et al. (2024), using AI in the classroom can improve student engagement by making information and learning resources more accessible. Fitriani and Mulyadi (2024) also found that students with strong digital literacy can use technology to enhance their critical thinking abilities. According to Nurdiana et al. (2024), instructors are increasingly seeing AI as a tool that, when used ethically and aligned with learning goals, can foster innovative learning.

These results support the study's conclusion that AI can significantly improve student learning. The findings show that applying AI can enhance learning quality and increase student competencies in the context of Indonesian education, which is now undergoing a digital transition.

Nonetheless, the study's results also show that AI use explains only part of the differences in students' critical thinking abilities, as indicated by a coefficient of determination of 26%. Other factors not examined in this study account for up to 74% of the diversity in critical thinking abilities. These variables include learning motivation, academic aptitude, digital literacy, learning environments, lecturers' teaching strategies, self-regulated learning, and individual student traits. These results show that critical thinking abilities are a complicated concept that is impacted by several interrelated elements. Therefore, AI is not the only way to help students develop their critical thinking abilities. Instead, AI should be seen as part of a larger learning system that incorporates social, psychological, and pedagogical elements.

The study's findings matter because they offer an alternative view of the controversy over AI's effects on education. Some earlier research suggests that excessive AI use can lead to cognitive reliance, which may lower pupils' critical thinking abilities. According to Sullivan et al. (2024), pupils who rely too much on AI are more responsive to quick fixes and tend to assess material less. According to Liang et al. (2024), students' deep thought involvement may be diminished by the unsupervised application of generative AI. However, the study's findings show that students' critical thinking abilities are positively impacted by the employment of AI. These variations suggest that AI's impact depends heavily on how it is used. AI typically has a favorable effect when used as a learning tool that promotes critical thinking and knowledge exploration. On the other hand, critical thinking abilities are more likely to diminish when students use AI only for quick responses without any assessment.

The study's practical implications offer several key recommendations for academic institutions and instructors. Lecturers must incorporate AI into the teaching process in a methodical and focused way. AI should be used to help with higher-order thinking tasks, including case analysis, economic policy evaluation, issue solving, and decision-making, in addition to information retrieval. To help students use technology critically and responsibly, universities must also create AI literacy programs. Additionally, to help students understand the ethics and constraints of using AI in academic activities, universities must develop explicit academic policies governing its use. This strategy maximizes AI's advantages without sacrificing the quality of students' thinking.

It should be mentioned that this study has several limitations. First, because only one cohort of students from the Economic Education Study Program participated, the results cannot be applied to university students in other academic fields. Second, because the study examined only one independent variable, it could not account for additional variables that might affect students' critical thinking abilities.

## 5. Conclusion

The findings indicate that applying artificial intelligence (AI) has a favorable and significant impact on students' critical thinking skills in learning. The regression analysis shows that the AI use variable has a positive regression coefficient of 0.431 and a significance value of 0.000 ( $<0.05$ ). This result suggests that students' critical thinking abilities increase as AI use in educational activities increases. The application of AI improves students' critical thinking abilities by 26%, according to the coefficient of determination value of 0.260. Therefore, while AI is not the only factor influencing students' critical thinking abilities, it may be one variable that encourages their development. The study's findings also support the idea that students can acquire analytical, assessment,

interpretation, and problem-solving skills, all crucial components of advanced critical thinking in education, by using AI technology appropriately.

Based on the results, it is advised that future studies create a more thorough model by including additional factors, such as digital literacy, learning motivation, self-regulated learning, student involvement, and creativity, that may affect students' capacity for critical thought. In order to improve the generalizability of the results, it is also recommended that future research broaden the breadth of the research population and sample.

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