



Artificial intelligence and its effects on critical thinking and problem-solving abilities in higher education

Ide Aprianto¹, Sofyan^{2*}, Sophia Rahmawati³, Susanti Sufyadi⁴

¹Universitas Jambi, Jambi, Indonesia; idebagusputrajambi@gmail.com

²Universitas Jambi, Jambi, Indonesia; sofyanzaibaski@unja.ac.id

³Universitas Jambi, Jambi, Indonesia; sophia.rahmawati89@unja.ac.id

⁴Universitas Lambung Mangkurat, Banjarmasin, Indonesia; susanti.sufyadi@ulm.ac.id

^{*}Corresponding author: Sofyan; E-mail addresses: sofyanzaibaski@unja.ac.id

Article Info

Article history:

Received June 23, 2025

Revised October 08, 2025

Accepted October 09, 2025

Available online November 10, 2025

Keywords: Artificial intelligence, ChatGPT, Critical thinking skills, Education students, Problem-solving skills

Copyright ©2025 by Author. Published by Lembaga Penelitian dan Pengabdian kepada Masyarakat (LPPM) Universitas PGRI Mahadewa Indonesia

Abstract. The urgency of this research lies in the need to critically examine how the integration of Artificial Intelligence, particularly ChatGPT, influences the development of higher-order cognitive skills, ensuring that technological advancement in higher education aligns with the goals of meaningful and reflective learning. This study aims to analyze the impact of Artificial Intelligence (AI), particularly ChatGPT, on the critical thinking and problem-solving abilities of students in the Department of Education at the Faculty of Teacher Training and Education, Jambi University. A quantitative method with an ex post facto approach was employed. The research involved 855 students from the Department of Education at Jambi University, with a sample of 207 respondents selected using purposive sampling based on their active use of ChatGPT for more than two months. Data were collected through a structured questionnaire and analyzed using SmartPLS version 4.0.9.9 to test the validity, reliability, and research hypotheses. The results reveal that the use of AI-based ChatGPT has a significant

positive effect on both students' critical thinking and problem-solving skills, both individually and simultaneously. The study recommends that higher education institutions integrate AI tools like ChatGPT within reflective and guided learning frameworks to enhance students' cognitive engagement and critical inquiry.

Introduction

The development of digital technology has resulted in fundamental changes in various sectors of life, including the higher education system. In the context of the 21st century, the integration of information technology is seen as a strategic component in supporting adaptive learning that is oriented towards future needs. The Indonesian government, through Government Regulation No. 57 of 2021 concerning National Education Standards, emphasizes that improving the quality of education must be carried out systematically to address local and global challenges. In line with this policy, the Ministry of Education and Culture has adopted a 21st-century competency-based learning approach, which emphasizes four main skills (4C): communication, collaboration, critical thinking, and problem-solving (Sajidan et al., 2022). Of the four, critical thinking and problem-solving are the leading cognitive indicators in achieving meaningful and competitive learning outcomes.

By definition, critical thinking skills include skills in analyzing, evaluating, and drawing conclusions based on the available information (Paul & Elder, 2009), while problem-solving refers to the stages of systematic thinking in facing and solving problems (Duncker, 1945; Yunaeti et al., 2021; Zhafira et al., 2025). In higher education practice, these two skills are at the core of developing students' intellectual capacity to face complex challenges in the digital era. In line with these advances, artificial intelligence (AI) has become an integral part of learning transformation. AI is defined as the ability of a computer system to imitate human cognitive functions such as reasoning, decision-making, and natural language processing (Eriana et al., 2023). The use of AI in education includes various forms of applications, such as academic chatbots, learning recommendation systems, and algorithm-based writing assistants (Dwivedi et al., 2021; Popenici & Kerr, 2017; Shrivastava, 2023).

One of the most prominent AI implementations is ChatGPT, a transformer architecture-based generative language model from OpenAI. ChatGPT allows users, especially students, to access and generate academic information quickly and efficiently (Suharmawan, 2023; Tlili et al., 2023). However, several studies warn that excessive use of ChatGPT can reduce the quality of students' critical thinking, especially if it is not accompanied by a reflective evaluation of the content produced (Faiz & Kurniawaty, 2023; Kasneci et al., 2023; Lund & Wang, 2023). Suharmawan (2023) and Syehansyah (2023) show that although ChatGPT is widely used in education, limitations in the aspects of information verification and validation remain a challenge. Cotton et al. (2024) also highlight that academic assessment systems need to be adapted to remain relevant amidst the use of generative AI. In addition, Van Dis et al. (2023) propose five key research priorities to optimize the potential and mitigate the risks of using LLMs such as ChatGPT in higher education contexts.

Field findings from the Education Science Study Program at Universitas Jambi also confirmed that students intensively use ChatGPT for academic assignments but are concerned about the decline in independent thinking skills. Therefore, it is important to conduct a study that examines not only the cognitive aspects of AI use but also students' perceptions and acceptance of this technology. The Technology Acceptance Model (TAM) model is used to understand how perceived usefulness and perceived ease of use influence technology adoption by users (Yofeigo et al., 2022). The research gap raised in this study is the lack of in-depth exploration of the effect of ChatGPT use on the two main cognitive dimensions of critical thinking and problem-solving in the context of higher education in Indonesia. Most previous studies are still limited to the technical aspects or efficiency of AI use in general. Therefore, this study presents a new approach that integrates cognitive ability measurement and user perception analysis to comprehensively evaluate the role of AI in students' academic development. The primary focus of this study is to answer the critical question: To what extent does the use of ChatGPT-based Artificial Intelligence affect the critical thinking and problem-solving abilities of higher education students?

Method

This study uses a quantitative approach with an ex post facto (causal-comparative) design that aims to identify the relationship between the use of ChatGPT-based artificial intelligence (AI), critical thinking skills, and problem-solving skills among students. This design was chosen because it allows the analysis of causal relationships without direct intervention on the variables studied.

The research population consisted of active students from the Department of Education, Faculty of Teacher Training and Education, Jambi University, who came from three study programs: S1 Educational Administration, S1 Guidance and Counseling, and S2 Educational Management, with a range of intakes from 2021 to 2024. The total population was 855 students. The sampling technique used was purposive sampling, which is included in the nonprobability sampling category,

with the following inclusion criteria: (1) active students from the study programs and intakes mentioned; (2) registered as ChatGPT users; and (3) have been actively using ChatGPT for more than two months. The distribution of samples is shown in the following table.

Table 1. Population Distribution

No	Study program	Force	Amount	Total
1	Educational Administration	2021	87	365
		2022	95	
		2023	95	
		2024	88	
2	Counselling Guidance	2021	114	443
		2022	108	
		2023	112	
		2024	109	
3	S2 Educational Management	2023	28	47
		2024	19	
Total number				855

To ensure the sample size limit in this study, was used with a 10% error rate and a 95% confidence level as follows.

$$s = \frac{\lambda^2 \cdot N \cdot P \cdot Q}{d^2 \cdot (N - 1) + \lambda^2 \cdot P \cdot Q} \quad s = \frac{2,706 \times 855 \times 0,5 \times 0,5}{0,05^2 \times (855 - 1) + 2,706 \times 0,5 \times 0,5} \quad s = 206,729 \quad (1)$$

$s = 207$ sample (rounding)

Thus, for a population of 855 with a 10% error rate and a 95% confidence level, the recommended sample size can be determined to be 207 respondents. The distribution of the sample results of this calculation is as follows.

Table 2. Respondent Characteristics

Study program	Force	Amount	%	Total (%)
Educational Administration	2021	27	13%	54%
	2022	12	6%	
	2023	31	15%	
	2024	41	20%	
Counselling Guidance	2021	10	5%	34%
	2022	5	2%	
	2023	25	12%	
	2024	30	14%	
S2 Educational Management	2023	12	6%	13%
	2024	14	7%	
Total		207	100%	100%

The majority of respondents in this study came from the Educational Administration study program, covering 54% of the total sample, followed by Guidance and Counseling students at 34%, and the Master's in Educational Management at 13%. Although the number of respondents from the master's level is relatively small, their involvement still makes an important contribution to enriching the data analysis. This composition shows a sufficient representation of the three study programs that are the focus of the study. Data collection was carried out online through a Google

Form-based questionnaire distributed between November 17 and December 1, 2024. The research instrument was prepared in the form of a five-point Likert scale and has been tested through an initial trial on 30 respondents to ensure its validity and reliability. Validation was carried out using a unique identification code to maintain data accuracy while ensuring respondent anonymity.

The research construct is designed based on established theories and conceptual models. The variable of utilization of ChatGPT-based AI is measured by indicators in the framework of the Technology Acceptance Model (Davis, 1989), namely perceived usefulness and perceived ease of use. Critical thinking skills are measured using the (Paul & Elder, 2006) framework, which includes elements of thinking, intellectual standards, and contextual practices. Meanwhile, problem-solving skills are constructed based on John Dewey's reflective stages, which include identification to solution selection.

Table 3. Operational Variables

Variables	Indicator	Item Code
Utilization of AI based on ChatGPT (Y) Fred Davis in Yofeigo et al., (2022)	Perceived Usefulness	AC1, AC2
	Perceived Ease of Use	AC3, AC4, AC5, AC6, AC7, AC8, AC9, AC10
Critical Thinking Ability (X1) Richard Paul & Elder in Rahmatillah et al., (2017)	Element of Thought	CT1, CT2, CT3, CT4, CT5, CT6, C7
	Intellectual Standards	CT8, CT9, CT10, CT11
	Contextual Exercises	CT12, CT13, CT13
Problem Solving Ability (X2) John Dewey in (Yunaeti et al., 2021)	Recognizing the Problem	PS1, PS2, PS3
	Defining the Problem	PS4, PS5
	Developing a hypothesis	PS6, PS7, PS8
	Testing multiple hypotheses	PS9, PS10, PS11
	Taking the best hypothesis	PS12, PS13

Data analysis was performed using the SmartPLS application version 4.0.0.9, with the Partial Least Squares-Structural Equation Modeling (PLS-SEM) approach. The analysis process includes two main stages: first, evaluation of the measurement model with validity and reliability indicators such as factor loading (≥ 0.70), average variance extracted (AVE ≥ 0.50), composite reliability (CR ≥ 0.70), and Cronbach's alpha ($\alpha \geq 0.70$), as well as discriminant validity using the Fornell-Larcker criteria and the HTMT ratio. Second, the evaluation of the structural model was carried out using the bootstrapping technique of 5000 subsamples, which were analyzed through the t-statistic, p-value, and coefficient of determination (R^2) values to assess the predictive strength of the relationship between variables.

This study was conducted in accordance with applicable research ethics principles. Informed consent was obtained electronically before completing the questionnaire, and all data were collected anonymously and used for scientific purposes only. The authorized institutional ethics committee has approved this study.

Results and Discussion

Based on the results of filling in the validation criteria section in the questionnaire by respondents, data were obtained regarding the number and characteristics of respondents who met the research inclusion criteria as follows.

Table 4. Verification Criteria for Respondents of ChatGPT-Based AI Users

Study program	Force	Amount	%	Total (%)
Educational Administration	2021	27	13%	54%
	2022	12	6%	
	2023	31	15%	
	2024	41	20%	
Counselling Guidance	2021	10	5%	34%
	2022	5	2%	
	2023	25	12%	
	2024	30	14%	
S2 Educational Management	2023	12	6%	13%
	2024	14	7%	
Total		207	100%	100%

In this study, the distribution of respondents shows that students from the Educational Administration study program dominate the sample at 54%, followed by Guidance and Counseling (34%) and Master's in Educational Management (13%). Although the proportion of postgraduate students is lower, their contribution is still significant in strengthening the analytical dimension of the study. Data were collected through an online questionnaire based on Google Forms distributed between November 17 and December 1, 2024. The instrument was measured using a five-point Likert scale, and its validity and reliability were tested through an initial trial on 30 respondents. Identity validation was carried out through a unique code without sacrificing anonymity.

The variable constructs were developed based on a tested conceptual model. The utilization of ChatGPT-based AI was measured using the Technology Acceptance Model framework (Davis, 1989), while critical thinking skills refer to the theory of Paul & Elder (2006). The problem-solving ability is formulated through reflective stages, according to Dewey, which include the process of identification and solution selection.

Test Outer Model (Measurement Model) *Convergent Validity*

Outer Model Test Results (Measurement Model) Outer Model (Measurement Model) Convergent Validity Test as shown in the following image.

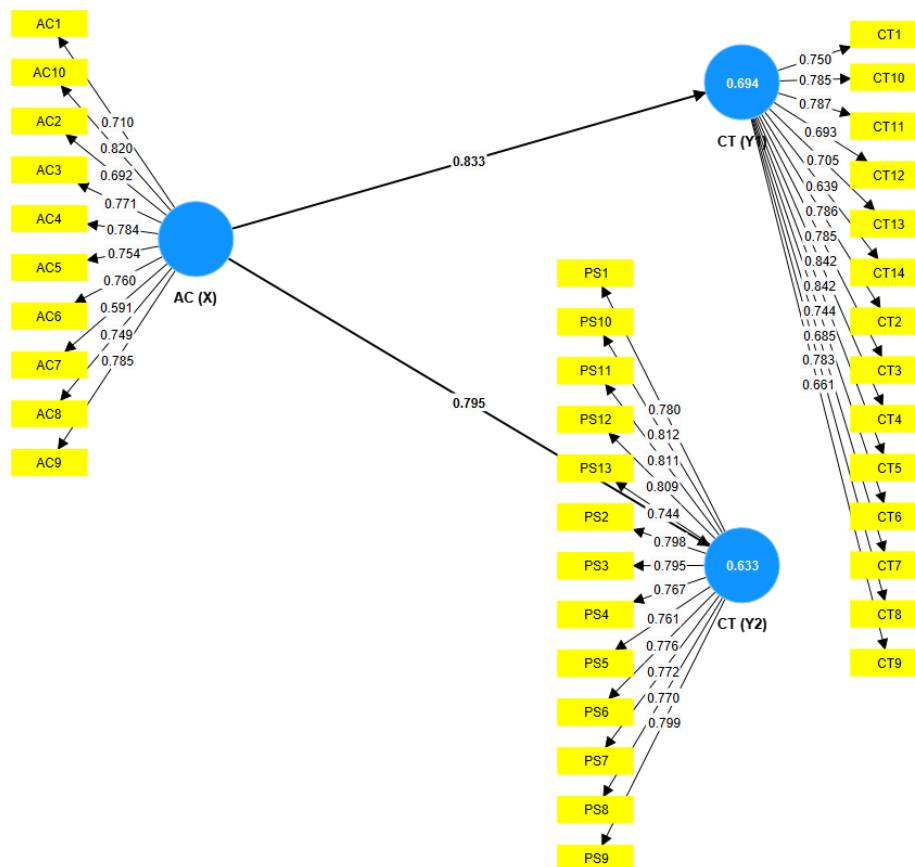


Image 1. Initial Measurement Model and Relationships Between Constructs in SmartPLS
Source: Data processed using SmartPLS 4.0.9.9

Convergent validity was analyzed to assess the extent to which the indicators were able to represent the construct consistently. Based on the analysis using SmartPLS 4.0.9.9, all indicators in the model showed loading values above the minimum threshold of 0.70, as suggested by [Hair et al. \(2021\)](#), with some minor exceptions that were still within the tolerance limit. The indicators in the ChatGPT Utilization (AC) construct had loading values between 0.591 and 0.820. Although AC6 showed a value below 0.60, the indicator was retained because of its substantial contribution to the construct's reliability. The Critical Thinking (CT) construct consisted of 14 indicators, with three of them (CT2, CT3, and CT4) being slightly below 0.70 but still considered statistically feasible. Meanwhile, the Problem Solving (PS) construct showed excellent measurement stability, with all indicators in the range of 0.744 to 0.812. This finding confirms that the overall construct has adequately met the convergent validity criteria.

Overall, the results of the outer model test indicate that all constructs meet the required convergent validity criteria. Thus, there is no need to delete indicators at this stage. These results also provide a strong basis for continuing to test construct reliability and discriminant validity at the next stage in the analysis of the measurement model, as shown in the following image.

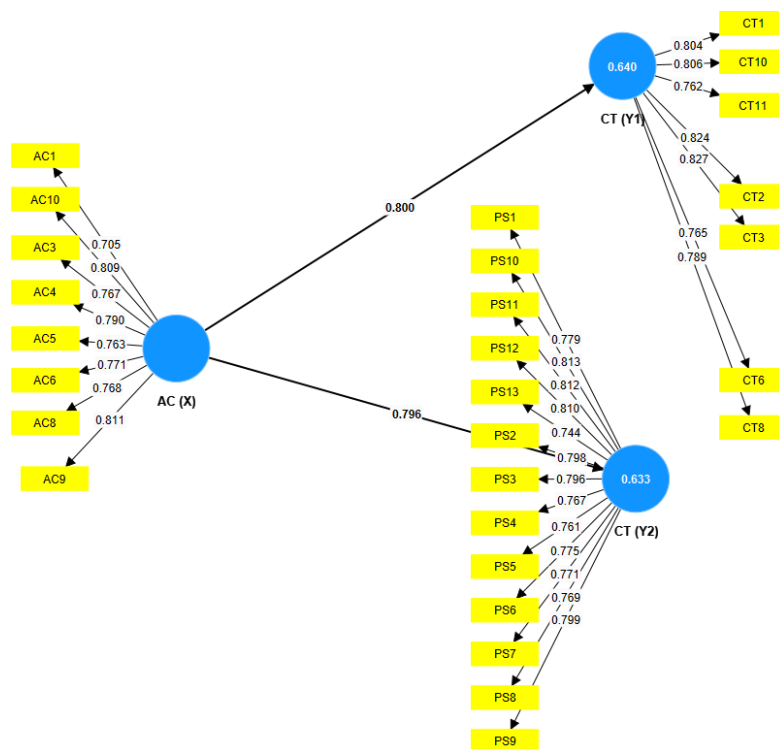


Image 2. Final Structural Equation Model (SEM) based on Partial Least Squares (PLS)
Source: Data processed using SmartPLS 4.0.9.9

Structural model analysis with the PLS-SEM approach estimated using SmartPLS version 4.0.9.9 showed adequate performance at both the measurement and structural levels. All indicators in the ChatGPT Utilization (AC) construct had loading values between 0.705 and 0.811, meeting the convergent validity requirements. The Critical Thinking (CT) construct with seven indicators and the Problem Solving (PS) construct with 13 indicators also showed high measurement quality, with loadings ranging from 0.762–0.827 and 0.744–0.813, respectively. At the structural model level, the path coefficient from AC to CT of 0.800 and to PS of 0.796 indicated a strong and positive influence. The R^2 value of 0.640 for CT and 0.633 for PS reflected substantial predictive power. These results emphasize the contribution of ChatGPT-based AI to the development of students' critical thinking and problem-solving skills in the context of higher learning.

Furthermore, the results of the validity test by looking at the Average Variance Extracted (AVE) value are shown in the following table.

Table 2. Convergent Validity Test Results Based on Average Variance Extracted (AVE) Values	
Variables	Average variance extracted (AVE)
Utilization of AI-based ChatGPT(X)	0.642
Critical Thinking Ability (Y1)	0.655
Problem Solving Ability (Y2)	0.630

Source: Data processed using SmartPLS 4.0.0.9

The Average Variance Extracted (AVE) value is used as the leading indicator to assess convergent validity in the PLS-SEM-based measurement model. AVE measures the extent to which the latent construct can substantially explain the indicator variance. Referring to [Hair et al. \(2021\)](#), the recommended minimum AVE value is 0.50. Based on the results of processing using SmartPLS 4.0.0.9, all constructs in this study meet these criteria: Utilization of ChatGPT-based AI (AVE =

0.642), Critical Thinking (AVE = 0.655), and Problem Solving (AVE = 0.630). These three values indicate a strong and stable contribution of indicators to their respective constructs. In addition, the internal reliability value, both through Cronbach's alpha and Composite Reliability, shows a number above the recommended minimum limit, confirming that the measurement model has adequate internal consistency. Thus, the model is declared feasible to proceed to the structural analysis stage.

Discriminant Validity

Table 3. Construct Discriminant Validity Value Based on Fornell-Larcker Criterion

	Utilizing AI based on ChatGPT(X)	Critical Thinking Ability (Y1)	Problem Solving Ability (Y2)
Utilization of AI-based ChatGPT(X)	0.801		
Critical Thinking Ability (Y1)	0.782	0.809	
Problem Solving Ability (Y2)	0.779	0.780	0.794

Source: Data processed using SmartPLS 4.0.0.9

Discriminant validity aims to ensure that each construct in the model has a clear empirical difference from other constructs. Based on the Fornell-Larcker (1981) criteria, the test results show that the square root of AVE for each construct is higher than the correlation between constructs. The $\sqrt{\text{AVE}}$ values for AI Utilization (0.801), Critical Thinking (0.809), and Problem Solving (0.794) all exceed their respective correlations, indicating that discriminant validity has been met. This finding supports the conceptual separation between constructs and strengthens the validity of the measurement model used.

Reliability Test

Table 4. Construct Reliability Test Results Based on Cronbach's Alpha and Composite Reliability

No	Variables	Cronbach's Alpha	Composite Reliability	Score	Criteria
1	Utilization of AI-based ChatGPT (X)	0.888	0.915	0.901	Very Reliable
2	Critical Thinking Skills (Y1)	0.894	0.919	0.906	Very Reliable
3	Problem-Solving Skill (Y2)	0.941	0.949	0.945	Very Reliable

Source: Data processed using SmartPLS 4.0.0.9

Reliability testing is carried out to assess the extent to which indicators in each construct are able to produce consistent measurements. The two main measures used are Cronbach's alpha and Composite Reliability (rho_c). According to [Hair et al. \(2019\)](#), a construct is declared reliable if Cronbach's alpha value is > 0.70 and the Composite Reliability value is > 0.70 , with the interpretation of a value > 0.90 as "very reliable".

As shown in Table 7, all constructs in this research model show a very high level of reliability. The ChatGPT-based AI Utilization construct (X) has an alpha value of 0.888 and a composite reliability of 0.915, indicating strong internal consistency between indicators. The Critical Thinking construct

(Y1) produces an alpha value of 0.894 and a CR of 0.919, while the Problem-Solving construct (Y2) records the highest value, with an alpha of 0.941 and a CR of 0.945.

All three constructs met the reliability criteria convincingly, with all CR values above 0.90 and alpha approaching or exceeding 0.90. These results confirm that the indicators in each construct can be relied upon to measure the latent construct consistently. Thus, there is no need to remove indicators, and the measurement model is stated to have excellent internal consistency, providing a solid foundation to proceed to the structural model analysis stage.

Inner Model Test (Structural Model)

R-Square

Table 5. R-Square and Adjusted R-Square Values in Structural Models

	R-Square	R-Square adjusted
Critical Thinking Ability (Y1)	0.611	0.609
Problem Solving Ability (Y2)	0.607	0.605

Source: Data processed using SmartPLS 4.0.0.9

The R-Square (R^2) value is used to evaluate the predictive power of exogenous constructs against endogenous constructs in the structural model (inner model). According to Hair et al. (2019), the R^2 value is categorized as weak (around 0.25), moderate (around 0.50), and strong (≥ 0.75). However, in the context of social sciences and education, an R^2 value ≥ 0.60 is considered to indicate substantial predictive power.

Based on the results of data processing using SmartPLS 4.0.0.9, the Critical Thinking construct (Y1) has an R^2 value of 0.611, with an adjusted R^2 of 0.609, which indicates that around 61.1% of the variation in critical thinking skills can be explained by the independent variables in the model, namely the Utilization of ChatGPT-based AI (X). Meanwhile, the Problem-Solving construct (Y2) has an R^2 value of 0.607 and an adjusted R^2 of 0.605, which means that the exogenous construct explains more than 60% of the variation in problem-solving skills.

These two values indicate that the model has good predictive power and supports the structural validity of the model in explaining the influence of AI on students' cognitive competence. Thus, the structural model is considered worthy of further interpretation in hypothesis testing and path analysis.

Path Coefficient and T-Statistic (Bootstrapping)

The calculated values of the Path Coefficient and T-Statistic (Bootstrapping) can be seen in the following table.

Table 6. Path Coefficient and T-Statistic Values

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T Statistic	P values
AI based ChatGPT (X) → Critical Thinking Skills (Y1)	0.782	0.784	0.043	18.25	0.000
AI based ChatGPT (X) → Problem Solving Skill (Y2)	0.779	0.781	0.03	28.82	0.000

AI based ChatGPT (X) →	0.781	0.783	0.04	22.03	0.000
Critical Thinking Skills (Y1) → Problem Solving Skill (Y2)					

The results of the structural model test indicate that the utilization of ChatGPT-based AI technology significantly affects two main cognitive aspects of students, namely critical thinking and problem-solving skills. The path coefficient of the ChatGPT Utilization variable (X) to Critical Thinking (Y1) is 0.782 ($t = 18.248$; $p < 0.001$), and to Problem Solving (Y2) is 0.779 ($t = 25.816$; $p < 0.001$), indicating a strong and significant relationship. It indicates that ChatGPT not only supports students' academic activities technically but also strengthens their capacity to carry out high-level thinking processes analytically and reflectively.

In addition, the relationship between Critical Thinking (Y1) and Problem Solving (Y2), with a coefficient of 0.781 ($t = 22.032$; $p < 0.001$), confirms the mediating role of critical thinking in strengthening the influence of ChatGPT on problem-solving skills. This relationship supports the theoretical framework that critical thinking skills are the foundation for formulating solutions to complex problems faced by students in an academic context.

The Q-Square value of 0.848 confirms the predictive power of the model, indicating a high level of accuracy in projecting endogenous constructs. This validity is reinforced by various international studies, such as [Lee et al. \(2024\)](#), who found that ChatGPT can improve self-directed learning and higher-order thinking skills, and [Mesiono et al. \(2024\)](#), who emphasized the importance of integrating ChatGPT into active learning strategies to stimulate reflective and synthetic thinking. A meta-analysis by [Wang & Fan \(2025\)](#) also supports these findings, showing a positive relationship between the use of generative AI and improved cognitive learning outcomes for students.

Overall, these results provide strong justification for the implementation of ChatGPT as a strategic pedagogical tool in higher education to develop critical thinking and problem-solving competencies simultaneously in the 21st-century context.

ChatGPT-Based AI: Its Impact on Critical Thinking Ability

The structural analysis in this study shows that the use of ChatGPT-based artificial intelligence has a significant and positive impact on the development of students' critical thinking skills. It is indicated by the path coefficient value of 0.782, accompanied by a t-statistic of 18.284 and a p-value < 0.001 , which statistically indicates significance at a 99% confidence level. Thus, the first hypothesis (H1) is accepted, confirming that ChatGPT contributes significantly to improving critical thinking skills in higher education environments. These results are consistent with the findings of [Ruiz-Rojas et al. \(2024\)](#), which emphasize that the integration of AI in learning can substantially strengthen students' critical thinking aspects. In line with this, [Dmitrenko et al. \(2025\)](#) also noted the positive impact of AI on critical thinking skills in the context of language learning, strengthening ChatGPT's position as a pedagogical tool that supports the achievement of high-level cognitive abilities.

Conceptually, this study refers to the theory of [Birgili \(2015\)](#), which views critical thinking as a process that involves understanding the elements of thinking and applying intellectual standards such as accuracy, logic, and depth. Critical thinking activities are assessed not only from the results but also from the reflective process of evaluating information and building arguments ([Purnadewi & Widana, 2023](#)). In line with that, [Hakim et al. \(2020\)](#) emphasized the relationship between critical thinking and critical reading in interpreting information in depth. This finding also resonates with

UNESCO (2019), which underlines the potential of AI in improving the quality of learning and equalizing access to education, although its success still depends on the readiness of infrastructure, educator competence, and inclusive and ethical regulations. In this context, Faiz & Kurniawaty (2023) emphasized that educators have a central role in ensuring the use of AI reflectively and ethically. Previous studies, such as Habibi et al. (2023) and Lai et al. (2024), also show that students widely accept ChatGPT and are effective in supporting the process of academic exploration and the development of independent thinking skills. Thus, ChatGPT has a strategic role as a cognitive partner in higher education.

ChatGPT-Based AI: Its Impact on Problem-Solving Skills

The results of the structural path analysis show that the use of ChatGPT as a form of implementation of artificial intelligence (AI) has a significant and substantial influence on improving students' problem-solving skills. With a path coefficient value of 0.779, a t-statistic of 25.816, and a p-value <0.001, these results statistically indicate that 79% of the variation in problem-solving ability can be explained by the use of ChatGPT, so that the second hypothesis (H2) is stated to be empirically accepted. This finding is in line with the research of Borchers et al. (2023), which states that AI provides a more flexible and contextual problem-solving approach than conventional methods. Dogan et al. (2023) also support this by emphasizing that AI enables a personalized learning environment and encourages learning independence. Similar support was expressed by Syehansyah (2023), who showed that students actively use ChatGPT to understand the material and complete academic assignments efficiently.

Theoretically, this study refers to John Dewey's problem-solving model (Yunaeti et al., 2021), which emphasizes the process of systematic and reflective thinking in solving problems. Luckin and Cukurova's theory reinforces this view, as does UNESCO (2019), which emphasizes the importance of strategic, ethical, and inclusive AI integration in higher education. Furthermore, Orrù et al. (2023) confirmed that ChatGPT can mimic the human problem-solving process when given a clear academic context. Overall, ChatGPT contributes as a relevant cognitive partner in developing students' problem-solving abilities in the digital era.

ChatGPT-Based AI: Its Impact on Critical Thinking and Problem Solving

The results of the structural model estimation show that the use of ChatGPT-based AI (X) has a strong and significant influence simultaneously on two important variables, namely students' critical thinking and problem-solving skills. The combined path coefficient reached 0.781 (78%), with a t-statistic of 22.816 ($p < 0.001$), indicating that the use of ChatGPT makes a significant contribution to both skills, so that the third hypothesis (H3) is declared accepted.

This finding is in line with Sallam's (2023) research, which emphasizes ChatGPT's ability to support problem-based learning and critical intelligence through customized and reflective information processing. Research by Serdianus & Saputra (2023) strengthens this finding by showing that ChatGPT enriches the analytical process that is at the heart of critical thinking and systematic problem-solving. Similar implications are seen in the 2024 study, which showed an increase in student performance in completing creative and complex tasks after using ChatGPT in a centralized experiment.

In addition, the results of Qawqzeh (2024) indicate that direct interaction between students and ChatGPT strengthens both cognitive dimensions as well as students' creative abilities. Mustofa et al. (2024) concluded that AI, such as ChatGPT, successfully presents a practical physics problem-solving approach through structured examples and step-by-step support. Zhai et al. (2024) also found that generative AI models, including ChatGPT, are even able to surpass human performance on scientific problem-solving tasks that require high cognitive levels.

The theoretical relevance of these findings can be understood based on John Dewey's framework (Yunaeti et al., 2021), which states that problem-solving should follow a series of logical stages from recognition to selection of the best solution (Suhardita et al., 2025). The participation of AI in this process helps students systematically evaluate problems, formulate and test hypotheses with richer information. Sharma (2024) complements this evidence that reflective activities such as bibliotherapy and blogging with ChatGPT support the development of 'critical thinking' and holistic problem-solving.

Practically, Dmitrenko et al. (2025) showed that the use of ChatGPT in English for Specific Purposes (ESP)-based classes helped students reconstruct mathematical problem-solving with a clear critical framework (Evi Yupani & Widana, 2023). This finding confirms that AI integration does not merely facilitate information translation but also encourages meta-cognitive qualities needed in higher education.

Overall, the statistically tested inter-variable relationships supported by current literature strengthen the argument that ChatGPT acts as an effective catalyst in improving both critical thinking and problem-solving. The combination of high path value, statistical significance, and empirical support from various fields provides a strong foundation for the application of AI in curriculum design and teaching strategies in the digital age. Despite its significant findings, this study has several limitations that should be acknowledged. The research relied solely on quantitative data obtained through self-reported questionnaires, which may not fully capture the depth of students' cognitive processes during their interaction with ChatGPT. The sample was also limited to education students from a single university, potentially constraining the generalizability of the results to other academic disciplines or institutional contexts. Additionally, the study did not include longitudinal data to observe changes in critical thinking and problem-solving abilities over time. Future research should consider incorporating mixed-method approaches, broader participant demographics, and longitudinal designs to provide a more comprehensive understanding of the cognitive and pedagogical impacts of AI-based learning tools.

Conclusion

ChatGPT has been empirically proven to enhance students' critical thinking and problem-solving abilities through its role in facilitating analytical reasoning, evaluation, and reflection. This finding aligns with Paul and Elder's critical thinking framework, which underscores the importance of intellectual standards in achieving deep learning, and with John Dewey's model of systematic problem-solving. The simultaneous improvement of both cognitive dimensions demonstrates that ChatGPT functions not merely as a digital assistant but as a transformative pedagogical tool capable of promoting higher-order thinking in higher education settings. These results reaffirm the strategic role of AI-based learning environments in cultivating intellectual autonomy and reflective judgment among students.

Based on these findings, it is recommended that higher education institutions adopt a structured and reflective approach to integrating ChatGPT and similar AI tools into their pedagogical design. Educators should be equipped with the competencies to guide students in using AI not solely for content generation but as a catalyst for inquiry-based learning and creative problem resolution. Furthermore, policymakers and curriculum developers need to establish ethical and pedagogical frameworks that ensure the responsible use of AI while safeguarding academic integrity. Future studies are encouraged to broaden the scope across disciplines and employ mixed or longitudinal research designs to explore the sustained cognitive and pedagogical impacts of AI integration in education.

Acknowledgments

With complete respect and appreciation, the author would like to express his deepest gratitude to all students of the Department of Education, University of Jambi, especially from the Undergraduate Programs of Educational Administration, Undergraduate Guidance and Counseling, and Master's Programs in Educational Management, who have actively participated in this study. Contribution, enthusiasm, and openness in the data collection process are important parts of the success of this study. The author would also like to thank the Editorial Team of the Indonesian Journal of Educational Development (IJED) Universitas PGRI Mahadewa Indonesia for their dedication, constructive input, and professional support in the editing and publication process of this article. Hopefully, this collaboration will continue and provide benefits for the development of science and educational practices in Indonesia.

Bibliography

- Birgili, B. (2015). Creative and critical thinking skills in problem-based learning environments TT - creative and critical thinking skills in problem-based learning environments. *Journal of Gifted Education and Creativity*, 2(2).
- Borchers, C., Carvalho, P. F., Xia, M., Liu, P., Koedinger, K. R., & Aleven, V. (2023). What makes problem-solving practice effective? Comparing paper and ai tutoring. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 14200 LNCS, 44–59. https://doi.org/10.1007/978-3-031-42682-7_4/TABLES/6
- Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2024). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*, 61(2), 228–239. <https://doi.org/10.1080/14703297.2023.2190148;Page:String:Article/Chapter>
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, 13(3), 319–339. <https://doi.org/10.2307/249008>
- Dmitrenko, N., Fedyk, T., Franchuk, N., Shakhina, I., & Podzygun, O. (2025). Leveraging chatgpt to develop critical thinking through mathematical problem-solving in ESP classes. *Environment. Technology. Resources. Proceedings of the International Scientific and Practical Conference*, 3, 91–98. <https://doi.org/10.17770/ETR2025VOL3.8540>
- Dogan, M. E., Goru Dogan, T., & Bozkurt, A. (2023). The use of Artificial Intelligence (AI) in online learning and distance education processes: A systematic review of empirical studies. *Applied Sciences* 2023, Vol. 13, Page 3056, 13(5), 3056. <https://doi.org/10.3390/APP13053056>
- Duncker, K. (1945). On problem-solving. *Psychological Monographs*, 58(5), i–113. <https://doi.org/10.1037/H0093599>
- Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Duan, Y., Dwivedi, R., Edwards, J., Eirug, A., Galanos, V., Ilavarasan, P. V., Janssen, M., Jones, P., Kar, A. K., Kizgin, H., Kronemann, B., Lal, B., Lucini, B., ... Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 57. <https://doi.org/10.1016/J.IJINFOMGT.2019.08.002>
- Eriana, E. S., Kom, S., Kom, M., & Zein, D. A. (2023). Artificial Intelligence (AI). *Angewandte Chemie International Edition*, 6(11), 951–952. <https://repository.penerbiteureka.com/publications/567027/>
- Evi Yupani & Widana, I. W. (2023). The impacts of the stem-based inquiry learning models on critical thinking and concept mastery. *Indonesian Research Journal in Education*, 7(1), 171-184.

<https://doi.org/10.22437/irje.v7i1.24227>

- Faiz, A., & Kurniawaty, I. (2023). Tantangan penggunaan ChatGPT dalam pendidikan ditinjau dari sudut pandang moral (The challenges of using ChatGPT in education are reviewed from a moral perspective). *EDUKATIF: Jurnal Ilmu Pendidikan*, 5(1). <https://doi.org/10.31004/edukatif.v5i1.4779>
- Habibi, A., Muhaimin, M., Danibao, B. K., Wibowo, Y. G., Wahyuni, S., & Octavia, A. (2023). ChatGPT in higher education learning: Acceptance and use. *Computers and Education: Artificial Intelligence*, 5, 100190. <https://doi.org/10.1016/J.CAEAI.2023.100190>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R*. <https://doi.org/10.1007/978-3-030-80519-7>
- Hakim, L. N., Rachmawati, E., & Purwaningsih, S. (2020). Teachers' strategies in developing students' critical thinking and critical reading. *Pedagogia: Jurnal Pendidikan*, 10(1). <https://doi.org/10.21070/pedagogia.v10i1.1036>
- Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., ... Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, 102274. <https://doi.org/10.1016/J.LINDIF.2023.102274>
- Lai, C. Y., Cheung, K. Y., Chan, C. S., & Law, K. K. (2024). Integrating the adapted UTAUT model with moral obligation, trust and perceived risk to predict ChatGPT adoption for assessment support: A survey with students. *Computers and Education: Artificial Intelligence*, 6, 100246. <https://doi.org/10.1016/J.CAEAI.2024.100246>
- Lee, H. Y., Chen, P. H., Wang, W. S., Huang, Y. M., & Wu, T. T. (2024). Empowering ChatGPT with guidance mechanism in blended learning: Effect of self-regulated learning, higher-order thinking skills, and knowledge construction. *International Journal of Educational Technology in Higher Education*, 21(1). <https://doi.org/10.1186/s41239-024-00447-4>
- Lund, B. D., & Wang, T. (2023). Chatting about ChatGPT: How may AI and GPT impact academia and libraries? *Library Hi Tech News*, 40(3), 26–29. <https://doi.org/10.1108/LHTN-01-2023-0009/FULL/XML>
- Mesiono, M., Fahada, N., Irwansyah, I., Diana, D., & Siregar, A. S. (2024). SWOT analysis of ChatGPT: Implications for educational practice and research. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*, 9(1), 181–196. <https://doi.org/10.31851/JMKSP.V9I1.14137>
- Orrù, G., Piarulli, A., Conversano, C., & Gemignani, A. (2023). Human-like problem-solving abilities in large language models using ChatGPT. *Frontiers in Artificial Intelligence*, 6, 1199350. <https://doi.org/10.3389/FRAI.2023.1199350/BIBTEX>
- Paul, R., & Elder, L. (2006). *Critical thinking: Tools for taking charge of your learning and your life* (2nd ed.). Pearson/Prentice Hall.
- Paul, R., & Elder, L. (2009). *The miniature guide to critical thinking : Concepts and tools*. 23. Peran Artificial Intelligence Chatgpt Dalam Perencanaan Pembelajaran Di Era Revolusi Industri 4.0 | Masokan Ilmu Sosial dan Pendidikan. (n.d.). Retrieved June 22, 2025, from <https://masokan.iakn-toraja.ac.id/index.php/ojsdatamasokan/article/view/100>
- Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(1), 1–13. <https://doi.org/10.1186/S41039-017-0062-8/METRICS>
- Purnadewi, G. A. A., & Widana, I. W. (2023). Improving students' science numeration capability through the implementation of the PBL model based on local wisdom. *Indonesian Journal of Educational Development (IJED)*, 4(3), 307-317. <https://doi.org/10.59672/ijed.v4i3.3252>
- Qawqzeh, Y. (2024). Exploring the influence of student interaction with ChatGPT on critical

- thinking, problem solving, and creativity. *International Journal of Information and Education Technology*, 14(4), 596–601. <https://doi.org/10.18178/IJiet.2024.14.4.2082>
- Ruiz-Rojas, L. I., Salvador-Ullauri, L., & Acosta-Vargas, P. (2024). Collaborative working and critical thinking: adoption of generative artificial intelligence tools in higher education. *Sustainability* 2024, Vol. 16, Page 5367, 16(13), 5367. <https://doi.org/10.3390/SU16135367>
- Sajidan, Suranto, Atmojo, I. R. W., Saputri, D. Y., & Etviana, R. (2022). Problem-Based Learning-Collaboration (PBL-C) Model in elementary school science learning in the industrial revolution Era 4.0 and Indonesia society 5.0. *Jurnal Pendidikan IPA Indonesia*, 11(3). <https://doi.org/10.15294/jpii.v11i3.30631>
- Sallam, M. (2023). ChatGPT utility in healthcare education, research, and practice: systematic review on the promising perspectives and valid concerns. *Healthcare* 2023, Vol. 11, Page 887, 11(6), 887. <https://doi.org/10.3390/HEALTHCARE11060887>
- Sharma, D. (2024). Critical thinking and problem-solving in the age of ChatGPT: Experiential-Bibliotherapy-blogging project. *Business and Professional Communication Quarterly*. <https://doi.org/10.1177/23294906241254780>
- Shrivastava, R. (2023). Role of artificial intelligence in future of education. *International Journal of Professional Business Review*, 8(1), e0840. <https://doi.org/10.26668/businessreview/2023.v8i1.840>
- Suhardita, K., Widana, I. W., Degeng, I. N. S., Muslihati, M., & Indreswari, H. (2024). Sharing behavior in the context of altruism is a form of strategy for building empathy and solidarity. *Indonesian Journal of Educational Development (IJED)*, 5(3), 316–324. <https://doi.org/10.59672/ijed.v5i3.4145>
- Suharmawan, W. (2023). Pemanfaatan Chat GPT dalam dunia pendidikan (Utilization of GPT Chat in the world of education). *Education Journal: Journal Educational Research and Development*, 7(2), 158–166. <https://doi.org/10.31537/EJ.V7I2.1248>
- Syehansyah, M. (2023). Pengaruh penggunaan Artificial Intelligence (AI) text based -chatgpt terhadap efisiensi belajar mahasiswa di lingkungan kampus Universitas Nasional (The effect of using Artificial Intelligence (AI) text based -chatgpt on student learning efficiency in the National University campus environment). *Jurnal Statistik Sosial*. https://www.academia.edu/105409415/Pengaruh_Penggunaan_Artificial_Intelligence_AI_Text_Based_Chatgpt_terhadap_Efisiensi_Belajar_Mahasiswa_di_Lingkungan_Kampus_Universitas_Nasional
- Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments*, 10(1), 1–24. <https://doi.org/10.1186/S40561-023-00237-X/FIGURES/13>
- UNESCO. (2019). *Artificial intelligence in education: Challenges and opportunities for sustainable development*. <https://unesdoc.unesco.org/ark:/48223/pf0000366994>
- Urban, M., Dëchtërenko, F., Lukavský, J., Hrabalová, V., Svacha, F., Brom, C., & Urban, K. (2024). ChatGPT improves creative problem-solving performance in university students: An experimental study. *Computers & Education*, 215, 105031. <https://doi.org/10.1016/J.COMPEDU.2024.105031>
- Van Dis, E. A. M., Bollen, J., Zuidema, W., van Rooij, R., & Bockting, C. L. (2023). ChatGPT: Five priorities for research. *Nature* 2023 614:7947, 614(7947), 224–226. <https://doi.org/10.1038/d41586-023-00288-7>
- Wang, J., & Fan, W. (2025). The effect of ChatGPT on students' learning performance, learning perception, and higher-order thinking: insights from a meta-analysis. *Humanities and Social Sciences Communications* 2025 12:1, 12(1), 1–21. <https://doi.org/10.1057/s41599-025-04787-y>
- Yofeigo, A. E., Tiara, T., & Kantun, S. (2022). Persepsi siswa terhadap penggunaan google classroom dalam pembelajaran akuntansi dengan pendekatan Technology Acceptance

- Model (TAM) (Students' perceptions of the use of Google Classroom in accounting learning using the Technology Acceptance Model (TAM) approach). *Manajemen Pendidikan*, 17(1), 12–21. <https://doi.org/10.23917/JMP.V17I1.14951>
- Yunaeti, N., Arhasy, E. A., & Ratnaningsih, N. (2021). Analisis kemampuan pemecahan masalah matematik peserta didik menurut Teori John Dewey ditinjau dari gaya belajar (Analysis of students' mathematical problem-solving abilities according to John Dewey's theory viewed from the learning style perspective). *Journal of Authentic Research on Mathematics Education (JARME)*, 3(1), 10–21. <https://doi.org/10.37058/JARME.V3I1.2212>
- Zhai, X., Nyaaba, M., & Ma, W. (2024). Can generative AI and ChatGPT outperform humans on cognitive-demanding problem-solving tasks in science? *Science and Education*, 34(2), 649–670. <https://doi.org/10.1007/S11191-024-00496-1/METRICS>
- Zhafira, Hamdiyati, Y., & Nuraeni, E. . (2025). Development of E-VIRA (e-module virus integrated reality-augmented): Enhance mental models and problem-solving skills. *Indonesian Journal of Educational Development (IJED)*, 6(2), 351–366. <https://doi.org/10.59672/ijed.v6i2.4857>