Effectiveness of Using Artificial Intelligence Learning Tools and Customized Curriculum on Improving Students' Critical Thinking Skills in Indonesia

Nanny Mayasari[1], Achmad Harristhana Mauldfi Sastraatmadja[2], Tarpan Suparman[3], Imas Indah Mutiara[4], Poetri AL-Viany Maqfirah[5]

[1] Universitas Nusa Cendana
[2] Universitas Singaperbangsa Karawang
[3] Universitas Buana Perjuangan Karawang
[4] Universitas Buana Perjuangan Karawang
[5] UIN Syarif Hidayatullah Jakarta

Article Info

ABSTRACT

This study investigates the effectiveness of using artificial intelligence (AI) learning tools and customized curricula in enhancing the critical thinking skills of students in Indonesia. A quantitative research design was employed, involving a sample of 250 students. Data were collected using a Likert scale ranging from 1 to 5 and analyzed using Structural Equation Modeling - Partial Least Squares (SEM-PLS 3). The findings indicate that all relationships between AI learning tools, customized curricula, and critical thinking skills are positive and significant. The results suggest that the integration of AI in education, combined with tailored educational content, significantly improves students' critical thinking abilities. These insights provide valuable guidance for educators and policymakers aiming to foster higher-order thinking skills in the educational system.d distance learning, guiding future studies and practical applications.n.

Corresponding Author:

Name: Nanny Mayasari
Institution: Universitas Nusa Cendana
Email: nanny.mayasari@gmail.com

1. INTRODUCTION

The rapid advancement of technology, particularly artificial intelligence (AI), has revolutionized the education sector by offering personalized learning experiences and transforming teaching methodologies [1]–[3]. AI-powered adaptive learning systems analyze student performance data to create customized learning paths, enhancing student engagement and academic performance [3]. Moreover, AI tools automate administrative tasks, provide real-time feedback to students, and enable educators to focus on critical thinking skills development [3]. The integration of AI in education also extends to optimizing administrative functions like student enrollment and resource allocation, leading to more efficient management of educational institutions [3]. Despite challenges such as data privacy concerns and the digital divide, the potential benefits of AI in enhancing educational outcomes, particularly in developing countries, are substantial [4].

In the contemporary educational landscape, critical thinking stands out as a

vital competency for navigating complex challenges and fostering independent thought [5]–[7]. Traditional teaching methods have often struggled to effectively cultivate these skills, prompting a quest for innovative pedagogical approaches [6]. The integration of AI learning tools into education emerges as a promising solution, offering real-time feedback and personalized learning experiences that cater to individual learning paces [8]. Furthermore, the customization of curricula to align with students' specific needs and interests not only enhances engagement but also facilitates deeper learning experiences, ultimately nurturing students' critical thinking abilities in a more effective and tailored manner [5]. By leveraging AI tools and customized curricula, educators can create dynamic learning environments that empower students to develop essential critical thinking skills essential for success in the 21st century [8], [9].

In Indonesia, the educational landscape encounters distinctive hurdles such as large class sizes, resource discrepancies, and diverse student profiles [10], [11]. To tackle these challenges, integrating AI learning tools and tailoring curricula could provide scalable and flexible solutions. Research emphasizes the significance of aligning educational frameworks with twenty-first-century competencies, technological integration, and stakeholder collaboration to enhance curriculum quality and credibility [11]. Additionally, leveraging AI in education has shown promising results, with AI-based learning significantly boosting academic achievement and improving the efficiency of scientific language learning in higher education [12]. Moreover, addressing the gap between students' abilities and industry demands through cost-effective AI applications like Google Colab and Teachable Machine can enhance practical skills and prepare students for real-world applications in various fields [13]. By embracing AI tools and adaptive curricula, Indonesia can navigate the complexities of its educational dynamics and better equip students for future challenges. This study focuses on examining the effectiveness of these tools in enhancing

critical thinking skills among Indonesian students, providing empirical evidence through a quantitative analysis.

2. LITERATURE REVIEW
2.1 *AI Learning Tools in Education*

These findings suggest that AI learning tools have the potential to enhance critical thinking skills by fostering an adaptive and supportive learning environment. Artificial Intelligence (AI) learning tools, as highlighted in multiple research papers [3], [14]–[17], have shown significant potential to revolutionize education by providing personalized feedback, adaptive learning environments, and tailored exercises to enhance student engagement and improve learning outcomes. These AI tools leverage machine learning algorithms to analyze student performance data, cater to individual learning needs, and offer scalable solutions to accommodate diverse learning styles and speeds, thereby promoting inclusivity and effectiveness in education. Studies have demonstrated the positive impact of AI-based tutoring systems on student performance in mathematics through tailored exercises and instant feedback [14], as well as the benefits of AI-driven formative assessment in deepening students' understanding of complex scientific concepts [17]. The integration of AI in education holds promise for transforming teaching methodologies, optimizing learning experiences, and fostering equitable access to quality education for all. These studies indicate that a customized curriculum can play a crucial role in developing critical thinking skills by providing relevant and meaningful learning experiences.

2.2 *Customized Curriculum*

A customized curriculum plays a crucial role in engaging students in relevant and meaningful learning activities, ultimately fostering deeper understanding and independent thinking. By utilizing systems like the

customized curriculum generation system [18], which allows for the management and adaptation of teaching resources to tailor learning experiences, students can benefit from personalized learning paths. Additionally, the concept of curriculum development in decentralized education governance [19] emphasizes the importance of customizing curriculum content to suit the characteristics and needs of each region, further enhancing the relevance of learning activities. Moreover, the use of a customized learning device [20]and method can aid in providing tailored vocabulary learning experiences based on individual progress and performance. Overall, these approaches highlight the significance of customization in education to promote student engagement, understanding, and critical thinking skills.

2.3 Critical Thinking Skills

Critical thinking is indeed a vital skill for academic success and lifelong learning, encompassing the abilities to analyze, evaluate, synthesize information, reason logically, and make informed decisions [6]–[8]. Traditional educational methods often face challenges in effectively nurturing these skills, highlighting the need for innovative approaches. The integration of AI learning tools and tailored curricula emerges as a promising strategy to enhance critical thinking abilities [8]. AI tools can play a significant role in fostering critical thinking by presenting students with complex problems, offering immediate feedback, and encouraging reflection on their problem-solving processes, ultimately improving their analytical and decision-making skills [8]. This symbiosis between AI tools and educational frameworks holds immense potential in empowering learners to navigate intricate problems and make sound judgments across various contexts, thereby enriching their intellectual capabilities and adaptability in the digital era. Similarly, a customized curriculum can engage students in meaningful and relevant learning activities, fostering their ability to think critically and independently.

2.4 Empirical Evidence and Gaps in the Literature

While there is substantial evidence supporting the effectiveness of AI learning tools and customized curricula in improving various educational outcomes, research specifically focusing on their impact on critical thinking skills is limited. Most studies have primarily examined academic performance and engagement, with fewer addressing the development of higher-order thinking skills. Furthermore, the majority of research has been conducted in Western contexts, with limited studies exploring the applicability of these tools in diverse educational settings such as Indonesia.

3. RESEARCH METHODS

3.1 Research Design

The study adopts a cross-sectional research design to examine the relationships between the use of AI learning tools, customized curricula, and critical thinking skills. A survey methodology is employed to gather data from a sample of students, using a structured questionnaire. The survey instrument includes items measuring the use of AI learning tools, the customization of the curriculum, and the critical thinking skills of the students. A Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) is used to capture the responses.

3.2 Sample and Sampling Technique

The sample for this study consists of 250 students from various educational institutions in Indonesia. The participants are selected using a stratified random sampling technique to ensure a representative distribution across different demographic groups, including age, gender, and educational background. This approach helps to minimize selection

bias and enhances the generalizability of the findings.

3.3 Data Analysis

The collected data are analyzed using Structural Equation Modeling - Partial Least Squares (SEM-PLS 3), chosen for its ability to handle small to medium sample sizes and model relationships among latent constructs. The analysis includes Descriptive Statistics (means, standard deviations, frequencies), Measurement Model Assessment (reliability and validity via Cronbach's alpha, composite reliability, and AVE), Structural Model Assessment (examining relationships between AI learning tools, customized curricula, and critical thinking skills using path coefficients, t-values, and p-values), and Model Fit Evaluation (R^2, Q^2, and GoF).

4. RESULTS AND DISCUSSION

4.1 Results

a. Descriptive Statistics

The descriptive statistics provide an overview of the sample characteristics and the distribution of responses for the key variables. The sample consisted of 250 students, with a balanced representation of gender (52% female, 48% male) and a diverse range of educational backgrounds.

The key variables analyzed in this study include the use of AI learning tools, the customization of the curriculum, and critical thinking skills. The responses for these variables were measured using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Table 1. Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Use of AI Learning Tools	4.12	0.65	1	5
Customized Curriculum	4.05	0.72	1	5
Critical Thinking Skills	4.20	0.58	1	5

The mean score for the use of AI learning tools was 4.12 with a standard deviation of 0.65, indicating that students generally reported high levels of engagement with AI-based educational tools. The mean score for the customized curriculum was 4.05 with a standard deviation of 0.72, suggesting that students perceived their curricula as being well-tailored to their individual needs and interests. The mean score for critical thinking skills was 4.20 with a standard deviation of 0.58, reflecting a high level of self-reported critical thinking ability among the students.

Table 2. Demographic Characteristics of the Sample

Demographic Variable	Category	Frequency	Percentage
Gender	Male	120	48%
	Female	130	52%
Age	18-22	100	40%
	23-27	90	36%
	28-32	60	24%
Educational Background	High School	150	60%
	Undergraduate	80	32%
	Graduate	20	8%

The demographic characteristics of the sample indicate a balanced representation of gender, with slightly more females (52%) than males (48%). The age distribution shows that the majority of participants were between 18 and 27 years old (76%), with a smaller proportion in the 28-32 age range (24%). In terms of educational

background, most participants were high school students (60%), followed by undergraduates (32%) and graduates (8%).

b. **Measurement Model Assessment**

The measurement model assessment focuses on evaluating the reliability and validity of the constructs, including the use of AI learning tools, customized curricula, and critical thinking skills. This involves examining internal consistency, convergent validity, and discriminant validity. High loading factors, all above the threshold of 0.70, indicate strong indicators of their respective constructs, supporting the validity and reliability of the measurement model. Internal consistency is confirmed with Cronbach's alpha values ranging from 0.787 to 0.853 and composite reliability values from 0.835 to 0.898. Convergent validity is assessed using average variance extracted (AVE), with all constructs exceeding the threshold of 0.50. Discriminant validity is evaluated using the Fornell-Larcker criterion, where the square root of the AVE for each construct is greater than the correlations with other constructs, indicating good discriminant validity.

c. **Structural Model Assessment**

The structural model assessment evaluates the hypothesized relationships between the constructs: Use of AI Learning Tools, Customized Curriculum, and Critical Thinking Skills. The analysis includes examining path coefficients, t-values, p-values, and the overall model fit.

d. **Path Coefficients and Significance Levels**

The path coefficients indicate the strength and direction of the relationships between the constructs. T-values and p-values are used to determine the statistical significance of these relationships.

Table 3. Path Coefficients and Significance Levels

Hypothesized Path	Path Coefficient (β)	t-value	p-value
Use of AI Learning Tools -> Critical Thinking Skills	0.355	5.123	< 0.001
Customized Curriculum -> Critical Thinking Skills	0.402	5.755	< 0.001
Use of AI Learning Tools -> Customized Curriculum	0.308	4.982	< 0.001

The structural model assessment confirms that the hypothesized relationships between the constructs are statistically meaningful. The path coefficients indicate strong positive relationships between the Use of AI Learning Tools and Critical Thinking Skills ($\beta = 0.355$, $p < 0.001$), between the Customized Curriculum and Critical Thinking Skills ($\beta = 0.402$, $p < 0.001$), and between the Use of AI Learning Tools and Customized Curriculum ($\beta = 0.308$, $p < 0.001$). The results show that all path coefficients are positive and statistically significant ($p < 0.001$), indicating strong positive relationships between the constructs.

The coefficient of determination (R^2) measures the proportion of variance in the dependent variable explained by the independent variables, with an R^2 value of 0.56 for Critical Thinking Skills indicating that 56% of its variance can be explained by the Use of AI Learning Tools and Customized Curriculum, and an R^2 value of 0.30 for Customized Curriculum indicating that 30% of its variance can be explained by the Use of AI Learning Tools. The predictive relevance (Q^2) assesses the model's ability to predict endogenous constructs, with Q^2 values of 0.42 for Critical Thinking Skills and 0.25 for

Customized Curriculum, both indicating good predictive relevance. The goodness-of-fit (GoF) index evaluates the overall fit of the model, with a GoF value of 0.67 indicating a good overall fit.

4.2 Discussion

The findings of this study provide strong evidence that the use of AI learning tools and customized curricula significantly enhances critical thinking skills among students in Indonesia. The positive and significant relationships between these variables highlight the potential of these educational innovations in fostering higher-order thinking skills.

a. AI Learning Tools

The significant positive relationship between AI learning tools and critical thinking skills suggests that AI can play a crucial role in improving students' ability to think critically. AI tools provide personalized feedback, adaptive learning pathways, and immediate support, which can help students develop their critical thinking abilities. This finding aligns with previous research by [3], [14]–[17], which demonstrated the effectiveness of AI in enhancing various educational outcomes.

b. Customized Curriculum

The strong positive relationship between the customized curriculum and critical thinking skills indicates that tailoring educational content to individual student needs and interests can significantly improve their critical thinking abilities. A customized curriculum engages students in relevant and meaningful learning activities, promoting deeper understanding and independent thinking. This result is consistent with the findings of [18]–[20], who emphasized the benefits of differentiated instruction in fostering higher-order thinking skills.

c. Interplay Between AI Learning Tools and Customized Curriculum

The positive and significant relationship between AI learning tools and the customized curriculum suggests that these educational approaches can complement each other. AI tools can facilitate the implementation of a customized curriculum by providing real-time data on student performance and preferences, enabling educators to tailor their instructional strategies more effectively. This synergy between AI and customized curricula can create a more dynamic and responsive learning environment, further enhancing critical thinking skills.

4.3 Implications for Educators and Policymakers

The findings of this study have important implications for educators and policymakers. Integrating AI learning tools and customized curricula into the educational system can provide scalable and effective solutions to enhance critical thinking skills. Educators should consider adopting these innovations to create more engaging and personalized learning experiences for students. Policymakers should support the development and implementation of AI-based educational tools and customized curricula to improve educational outcomes and prepare students for the challenges of the 21st century.

4.4 Limitations and Future Research

While this study provides valuable insights, it is important to acknowledge its limitations. The cross-sectional design captures data at a single point in time, which may not reflect long-term effects. The use of self-reported measures may also introduce response biases. Future research could benefit from longitudinal designs and the incorporation of objective measures of critical thinking skills. Additionally, exploring the impact of AI learning tools and customized curricula in different

educational contexts and with larger samples would further validate the findings and provide a more comprehensive understanding of their effectiveness.

5. CONCLUSION

This study explored the impact of AI learning tools and customized curricula on the critical thinking skills of Indonesian students. The findings show that both significantly enhance critical thinking skills. AI learning tools provide personalized feedback and adaptive learning, while customized curricula boost engagement and cognitive processing. The structural model assessment confirmed strong positive relationships between these tools and critical thinking skills, and a complementary interaction between AI tools and customized curricula. High R^2 and Q^2 values affirm the model's robustness and predictive relevance, and the GoF index indicates a good overall fit. These results suggest that integrating AI learning tools and customized curricula can effectively enhance critical thinking skills. Educators should adopt these methods to create engaging, personalized learning environments, and policymakers should support their development to improve educational outcomes and prepare students for future challenges.

REFERENCES

[1]   م. عاجب, *The Role of Artificial Intelligence in Enhancing the Processes of Learning and Teaching*. 2024.

[2]   Y. J. Kwon, "The rise of artificial intelligence in design," *Turkish Online J. Educ. Technol.*, vol. 2017, no. December Special Issue ITEC, pp. 880–884, 2017.

[3]   O. Onesi-Ozigagun, Y. J. Ololade, N. L. Eyo-Udo, and D. O. Ogundipe, "Revolutionizing education through AI: a comprehensive review of enhancing learning experiences," *Int. J. Appl. Res. Soc. Sci.*, vol. 6, no. 4, pp. 589–607, 2024.

[4]   M. Sarkar, *Artificial Intelligence In Education: Transforming Learning In The Digital Age*. 2023. doi: 10.13140/RG.2.2.28322.20160.

[5]   H. N. Truong, "Students' Perspectives on the Use of Teacher Questions to Promote Critical Thinking inEFL Classrooms," *Available SSRN 4818211*, 2024.

[6]   L. Tsui, "Fostering critical thinking through effective pedagogy: Evidence from four institutional case studies," *J. Higher Educ.*, vol. 73, no. 6, pp. 740–763, 2002.

[7]   L. R. Sharma, R. Bhattarai, A. Humagain, S. P. Subedi, S. Thapa, and H. Acharya, "Exploring the Underlying Ways of Enhancing Critical Thinking Skills," *Int. Res. J. MMC*, vol. 4, no. 4, pp. 83–96, 2023.

[8]   S. Moustaghfir and H. Brigui, "Navigating Critical Thinking in the Digital Era: An Informative Exploration," *Int. J. Linguist. Lit. Transl.*, vol. 7, no. 1, pp. 137–143, 2024.

[9]   W. Rosmawati, "Efektifitas Penggunaan E-Book untuk Melatih Kemampuan Berpikir Kritis Peserta Didik," *J. Didakt. Pendidik. Dasar*, vol. 7, no. 3, pp. 979–1002, 2023.

[10]   F. Reza, Z. Rohmah, and N. N. Abdullah, "Challenges in implementing Kurikulum Merdeka for EFL teachers," *JEELS (Journal English Educ. Linguist. Stud.*, vol. 10, no. 2, pp. 439–469, 2023.

[11]   B. Hutahaean, S. Telaumbanua, L. Tamba, R. G. N. Hutabarat, and S. Sumani, "Analysis of Innovative and Adaptive Higher Education Curriculum Development to Education 5.0 Based Challenges in Indonesia," *Int. J. Learn. Teach. Educ. Res.*, vol. 23, no. 4, pp. 76–98, 2024.

[12]   Sugianti and I. Rosidah, "The Use of Artificial Intelligence (AI) in Learning Results for Scientific Indonesian Language Courses at PGRI Wiranegara University," *Int. J. Appl. Res. Sustain. Sci.*, vol. 2, pp. 1–10, Jan. 2024, doi: 10.59890/ijarss.v2i1.1174.

[13]   H. Herlawati, "Learning Tools for Artificial Intelligence Implementation," *PIKSEL Penelit. Ilmu Komput. Sist. Embed. Log.*, vol. 12, no. 1, pp. 79–88, 2024.

[14]   H. Strohmier, V. Langner, F. Mohamed, and E. Wood, "Examination of Artificial Intelligence Integration and Impact on Higher Education," in *2024 12th International Symposium on Digital Forensics and Security (ISDFS)*, 2024, pp. 1–6.

[15]   H. Suntharalingam, "Enhancing Digital Learning Outcomes Through the Application of Artificial Intelligence: A Comprehensive Review," *Int. J. Innov. Sci. Res. Technol.*, vol. 9, no. 4, pp. 718–727, 2024, doi: 10.38124/ijisrt/ijisrt24apr530.

[16]   S. Triberti, R. Di Fuccio, C. Scuotto, E. Marsico, and P. Limone, "'Better than my professor?' How to develop artificial intelligence tools for higher education," *Front. Artif. Intell.*, vol. 7, p. 1329605, 2024.

[17]   C. A. Eden, O. O. Adeleye, and I. S. Adeniyi, "A review of AI-driven pedagogical strategies for equitable access to science education," *Magna Sci. Adv. Res. Rev.*, vol. 10, no. 2, pp. 44–54, 2024.

[18]   S. Narvekar, J. Sinapov, and P. Stone, "Autonomous Task Sequencing for Customized Curriculum Design in Reinforcement Learning.," in *IJCAI*, 2017, pp. 2536–2542.

[19]   G. Niesler and A. Niesler, "Methodological Apparatus and Instruments for Personalization in Adaptive Tutoring Systems," *Inform. Ekon.*, vol. 2019, Nov. 2019, doi: 10.15611/ie.2019.4.05.

[20]   S. Sutjipto, "Diversifikasi kurikulum dalam kerangka desentralisasi pendidikan," *Divers. Kurikulum Dalam Kerangka Desentralisasi Pendidik.*, vol. 21, no. 3, pp. 317–338, 2015.