

environments. Family is the main basis in the formation of children's values and character, while school plays a role in developing students' academic abilities and social skills (Lestari et al., 2022). Therefore, education has an important role in shaping quality human resources, not only intellectually intelligent but also with good character and skills (Sumitro, 2020).

Along with the times, education is required to be able to adapt to technological advancements. The use of information technology in learning allows for a more flexible, interactive, and effective learning process. Various digital learning platforms and other technological tools make it easier for students to access information and develop skills relevant to the needs of the 21st century (Putra et al., 2022; Mustoip & Japar, 2018).

The development of the use of technology in education has been increasing since the Covid-19 pandemic, which has encouraged the implementation of distance learning through online systems. The government's work-from-home learning policy makes technology an important part of the learning process (Dewi & Sadjarto, 2021; Gusty S., 2020). After the pandemic ends, the use of technology continues and provides opportunities for more flexible learning and access to wider learning resources.

One of the technological developments that is currently widely used in education is artificial intelligence or Artificial Intelligence (AI). This technology is able to provide information quickly and assist students in completing learning tasks. However, the use of AI also poses challenges, especially related to students' critical thinking skills. The ease of obtaining answers instantly can make students tend to receive information without conducting in-depth analysis (T. N. Fitria, 2023).

In learning history, critical thinking skills are very important because students are required to analyze past events, understand cause-and-effect relationships, and interpret various historical sources. However, phenomena in the field show that some students use AI to complete assignments or answer questions, thus potentially reducing the process of analytical thinking in learning (I. Choiruhi et al., 2021). Therefore, this study aims to analyze

the influence of artificial intelligence-based literacy models in history learning on the critical thinking skills of high school students in Yogyakarta.

METHODOLOGY

This research applied a quasi-experimental approach using a non-equivalent control group design with pretest and posttest. The selection of this design was based on the fixed class grouping in schools, which made random assignment impractical (Sugiyono, 2020). The study consisted of two groups: an experimental group that integrated artificial intelligence (AI) into history learning activities, and a control group that relied solely on textbooks and conventional learning methods. To identify initial differences, both groups completed a pretest, followed by distinct learning treatments, and finally a posttest to assess changes in students' critical thinking skills. The study was conducted with tenth-grade students at SMA Negeri 1 Turi, Sleman, Special Region of Yogyakarta.

The population comprised all grade X students, totaling 180 learners distributed across five classes. Using the Slovin formula with a 5% margin of error, a sample of 124 students was obtained. In practice, however, two classes were selected through purposive sampling by considering comparable academic abilities and the availability of technology-based learning facilities. One class served as the experimental group and the other as the control group, each consisting of 36 students, resulting in 72 participants included in the analysis.

This study focused on two variables. The independent variable was the implementation of artificial intelligence in history learning, particularly its use in accessing information, organizing ideas, and completing assignments. The dependent variable referred to students' critical thinking skills, including the ability to analyze information, evaluate arguments, draw logical conclusions, and propose solutions based on rational reasoning.

The research instruments used included observation sheets and critical thinking ability tests. Observation sheets are used to record students' activities during learning, especially related to the frequency of AI use, learning independence, critical attitude towards the information obtained, academic

Table 1: Variable Operational Definition

Variabel	Operational Definition	How to Measure	Source
Use of Artificial Intelligence (AI) (Independent Variables)	The extent to which students utilize artificial intelligence technology in the learning process, including activities such as gathering information, developing ideas, and completing academic tasks through AI-based platforms like ChatGPT, Bing AI, or other similar tools. In this study, the use of AI is implemented under teacher guidance and supervision.	It was measured through observation sheets of learning activities and questionnaires on the use of AI which assessed the frequency, intensity, and type of activities of using AI (Likert scale 1-5). In addition, the experimental and control groups were differentiated by treatment (using AI vs. not using AI).	Adaptations of Chen et al. (2023); Wang & Lee (2024) on the use of AI in learning.
Critical Thinking Ability (Dependent Variables)	Students' capacity to process and examine information, assess the validity of arguments, formulate logical conclusions, and generate solutions grounded in evidence and rational thinking within the learning context.	The measurement was conducted using a critical thinking assessment comprising 20 multiple-choice items and 2 essay questions. Scores are given based on the assessment rubric which includes indicators of analysis, evaluation, inference, and conclusion drawn. The final result is a total numerical score (0-100).	Adapted from critical thinking indicators according to Facione (2015) and Ennis (2018).

ethics, and participation in discussions. The critical thinking test is designed to assess students' level of critical thinking through a combination of multiple-choice and essay questions, which are developed based on established critical thinking indicators and cognitive taxonomy frameworks. In addition, data collection techniques are also carried out through questionnaires to find out the use of AI by students and documentation as supporting data for research.

Prior to implementation, the research instrument was examined for validity and reliability. Validity was tested using Pearson's Product Moment correlation at a significance level of 0.05 to ensure alignment between the instrument and the measured variables. Reliability testing employed Cronbach's Alpha, with a coefficient above 0.6 indicating that the instrument was reliable.

Data analysis in this study involved descriptive statistical techniques, including the calculation of mean, median, mode, and standard deviation to summarize the data. A variable tendency analysis was also conducted to identify the distribution patterns of each research variable. Before proceeding to hypothesis testing, prerequisite tests were performed, namely normality and homogeneity tests, to confirm

that the data met the assumptions required for parametric analysis.

The hypothesis was tested using an Independent Sample t-Test with a significance level of 0.05 to compare the critical thinking skills of students who used artificial intelligence and those who did not. A significance value below 0.05 indicates that the use of artificial intelligence in history learning has a statistically significant effect on students' critical thinking abilities.

RESULTS AND DISCUSSION

Results of the Student Critical Thinking Ability Test

Pretest Statistical Analysis

a. Control Class

Table 2: Statistical Analysis of Control Class Pretest

Red	8.789
Median	8.50
Minimum Score	0.00
Maximum Value	17.00
Standard Deviation	4.595

The pretest analysis in the control class revealed a mean score of 8.789, with a median of 8.50, a minimum score of 0, a maximum of 17, and a standard deviation of 4.595. The relatively low mean value suggests that students' initial level of critical thinking was still in the low category prior to the implementation of the learning treatment. The proximity between the mean and median values shows that the data distribution tends to be stable and not too tight, although it is still centered on low scores.

The considerable gap between the minimum and maximum scores reflects notable differences in students' abilities. Furthermore, the relatively high standard deviation indicates that the distribution of critical thinking skills in the control class is quite heterogeneous. These findings suggest that the initial condition of the students still requires an appropriate learning strategy to both enhance and equalize their critical thinking abilities.

b. Experimental Classes

Table 3. Statistical Analysis Results of the Experimental Class Pretest

Red	8.111
Median	8
Minimum Score	3
Maximum Value	12
Standard Deviation	2.024

In the experimental class, the pretest results indicated a mean score of 8.111, with a median of 8, a minimum score of 3, a maximum score of 12, and a standard deviation of 2.024. When compared with the control class, the difference in average scores was relatively small, suggesting that the initial abilities of students in both groups were generally comparable. This is important in experimental research because it shows that the difference in results at the end of the study is more influenced by the treatment given.

In addition, the smaller standard deviation values in the experimental class showed that the students' abilities tended to be more homogeneous than the control class. The narrower range of grades also showed that students' initial abilities in the experimental class were relatively even. This

condition supports the implementation of research because students' responses to AI-based learning are expected to be more consistent.

Posttest Statistical Analysis Control Class

Table 4. Posttest Statistical Analysis Results of the Control Class

Mean	10.333
Median	10
Minimum Score	3
Maximum Value	15
Standard Deviation	3.763

The posttest results in the control class indicated a mean score of 10.333, with a median of 10, a minimum score of 3, a maximum score of 15, and a standard deviation of 3.763. Compared to the pretest findings, there was a noticeable increase in the students' average score. This shows that textbook-based conventional learning still contributes to improving students' critical thinking skills, although the increase is still moderate.

An increase in the minimum score from 0 to 3 indicates that students with low abilities experience improved comprehension after the learning process. However, the relatively unchanged maximum score indicates that conventional learning approaches still have limitations in promoting the optimal development of critical thinking skills. Moreover, the consistently high standard deviation suggests that disparities in students' abilities remain even after the learning process has been completed.

c. Experimental Classes

Table 5. Experimental Class Posttest Statistical Results

Mean	13.861
Median	14
Minimum Score	9
Maximum Value	16
Standard Deviation	2.015

The posttest findings in the experimental class demonstrated a greater improvement compared to

the control group, with a mean score of 13.861, a median of 14, a minimum score of 9, a maximum score of 16, and a standard deviation of 2.015. This average reflects a substantial increase from the pretest results, indicating that the integration of artificial intelligence in history learning contributes positively to the enhancement of students' critical thinking skills.

The notable rise in the minimum score, from 3 to 9, suggests that AI-supported learning effectively assists lower-performing students in achieving better understanding of the material. Furthermore, the relatively low standard deviation indicates that the improvement in critical thinking skills is more evenly distributed among students. Therefore, AI-based learning not only elevates overall academic performance but also helps minimize disparities in students' abilities.

Categorization of Critical Thinking Skills

Table 6. Classification of Experimental Class Pretest Scores on Critical Thinking

Category	Klasifikasi In %	Quantity	Percentage
Excellent	86 - 100	0	0%
Good	76 - 85	0%	0%
Enough	60 - 75	2	6%
Less	< 60	34	94%
Total		36	100%

The categorization of pretest results shows that most students in both groups were still within the low category. In the control group, 94% of students were classified at this level, while 69% of students in the experimental group fell into the same category.

Table 7: Categorization of Critical Thinking Values Posttest Control Class

Category	Klasifikasi In %	Quantity	Percentage
Excellent	86 - 100	12	33%
Good	76 - 85	0	0%
Enough	60 - 75	1	3%
Less	< 60	23	64%
Total		36	100%

This indicates that, prior to the learning intervention, students' critical thinking skills were generally at a low level.

Following the learning process, the posttest results revealed a shift in category distribution. In the control class, some improvement in students' critical thinking skills was observed; however, 64% of students remained in the low category. In contrast, the experimental class demonstrated a more substantial improvement, with the majority of students reaching the good and very good categories, and only a small proportion still classified as low. These findings indicate that AI-supported learning is more effective in enhancing students' critical thinking abilities.

Observation Results of the Use of AI in Learning

The observation results indicate that the level of artificial intelligence utilization in history learning falls within the high category, as reflected by an overall mean score of 3.86. The highest-scoring aspect was the frequency of use of AI and collaboration in discussions, which indicates that students are actively utilizing AI to help understand the material and support arguments in class discussions.

Meanwhile, critical aspects of AI results and academic ethics are still in the medium category. This shows that some students still need to be directed to verify the information obtained from AI and increase awareness in listing sources. Nonetheless, in general, the use of AI has helped increase students' learning independence in learning history.

Prerequisite Analysis

The validity test results indicated that all 17 items used in the study were valid, as their r-count values exceeded the r-table values. This confirms that the instrument is appropriate for accurately measuring students' critical thinking skills. Meanwhile, the reliability test produced a Cronbach's Alpha coefficient of 0.728, suggesting a good level of internal consistency and indicating that the instrument is reliable for measurement purposes.

The normality test showed that the data from both groups were normally distributed, as the significance values were above 0.05. Additionally,

Table 8: Experimental Class Observation Results

Yes	Observed Aspects	Behavioral Indicators	Average Score (1-5)	Category	Remarks
1	Frequency of AI use	Students use AI (e.g. ChatGPT or similar tools) in completing history learning tasks.	4.2	Height	AI is used regularly in learning tasks.
2	Learning independence	Students use AI to deepen understanding, not just copy answers.	4.0	Height	Students are quite independent in using AI as a learning tool.
3	Critical of AI outcomes	Students verify information from AI with other sources (textbooks, primary sources of history).	3.6	Medium	Students began to show a critical attitude, although it was not evenly distributed.
4	Academic ethics	Students list sources or acknowledge the use of AI in their work.	3.4	Medium	Ethical awareness still needs to be improved.
5	Collaboration in discussions	Students use AI as a means of sharing ideas or supporting arguments during historical discussions.	4.1	Height	AI helps enrich students' arguments and participation in discussions.
	Overall Average		3.86	Height	Students use AI positively in history learning.

Table 9: Data Normality Test Results

Tests of Normality							
	Classes	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Value	Free Class	.101	36	.200*	.962	36	.251
	Control Class	.133	36	.110	.960	36	.207

*. This value represents the lower bound of the actual significance level.
a. Significance values are adjusted using the Lilliefors correction.

Table 10: Homogeneity Test Results

Independent Samples Test			
		Equal variances assumed	Equal variances not assumed
F		4.757	
Sig.		0.073	
T		-7.332	-7.332
Df		70	60.147
Sig. (2-tailed)		0	0
Mean Difference		-5.1389	-5.1389
Std. Error Difference		0.70089	0.70089
95% Confidence Interval of the Difference		Lower	-6.5368
		Upper	-3.741

the homogeneity test revealed that the data had homogeneous variance, with a significance value of 0.073. Therefore, the dataset meets the assumptions required for further analysis using parametric statistical tests.

Testing Hypothesis

The Independent Samples T-test results revealed a significance value of 0.000, which is lower than 0.05, indicating a statistically significant difference in critical thinking skills between the experimental and control groups. The mean difference of -5.1389 suggests that the experimental class achieved a higher average score compared to the control class. Therefore, it can be concluded that the integration of artificial intelligence in history learning has a significant impact on enhancing students' critical thinking abilities.

DISCUSSION

The findings indicate that history learning at SMA Negeri 1 Turi has been implemented through well-structured stages, including introductory, core, and closing activities. Teachers have applied a variety of instructional methods, such as interactive lectures, group discussions, and the use of digital media to support students' understanding of historical content. However, prior to the integration of AI-based learning, technology functioned mainly as a supporting tool and had not been fully embedded in the learning process.

The introduction of artificial intelligence in the experimental class demonstrated a notable improvement in students' critical thinking skills. This is reflected in the increase in average scores, the shift in the distribution of critical thinking categories, and statistical test results indicating significant differences between the experimental and control groups. The use of AI enables students to access a wider range of information, utilize diverse learning resources, and engage in deeper analysis of historical topics.

Furthermore, AI integration promotes greater learner independence and active participation in the classroom. Students are not only passive recipients of information but are also involved in exploring sources,

engaging in discussions, and evaluating learning materials. These activities support the development of critical thinking, which is a key objective in history education. Nevertheless, the study also highlights the importance of teacher supervision in the use of AI. Without proper guidance, students may become overly dependent on technology. Therefore, teachers play a crucial role in guiding students to use AI responsibly, verify information, and uphold academic integrity throughout the learning process.

CONCLUSION

Based on the findings and discussion, it can be concluded that the integration of artificial intelligence (AI) in tenth-grade history learning contributes positively to both the learning process and student outcomes. The use of AI has been shown to enhance students' learning autonomy, strengthen their critical thinking abilities, and increase their awareness of academic ethics throughout the learning activities. Students do not merely rely on AI to access information quickly, but also utilize it as a tool to explore, analyze, and reflect on historical content more deeply, particularly in the topic of Hindu-Buddhist kingdoms in Indonesia.

Furthermore, the integration of AI in the learning process demonstrates that digital technology can facilitate the development of digital history literacy while enhancing students' analytical abilities. With teachers acting as facilitators, the implementation of AI contributes to creating a learning environment that is more interactive, contextual, and aligned with the characteristics of Generation Z. This shows that history learning that is adaptive to technological developments can increase students' involvement, motivation, and critical power towards historical events.

Therefore, the implementation of artificial intelligence in history learning can serve as an effective and innovative approach to support the development of students' critical thinking skills. The integration of AI technology in education is not only a trend, but also a strategic step in building a generation that has strong historical literacy, critical thinking, and is able to use technology wisely and responsibly in the digital era.

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