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Artificial Intelligence-Assisted Learning and Its Impact on Students' Critical Thinking Skills

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ABSTRACT

Artificial intelligence (AI) has increasingly influenced educational practices by providing students with rapid access to information, explanations, feedback, and assistance in completing learning tasks. However, the growing use of AI also raises concerns regarding students' dependence on automatically generated information and its potential implications for critical thinking. This study aims to examine how AI-assisted learning influences students' critical thinking skills at Madrasah Aliyah Miftahussalam Wonosalam, Demak. This research employed a qualitative case study design to explore students' experiences, learning practices, and interactions with AI within an authentic educational context. Data were collected through desk review, classroom observation, and semi-structured interviews involving students and teachers as primary sources of information, supported by relevant institutional and learning documents. Data were analyzed using the interactive model of Miles, Huberman, and Saldaña, involving data condensation, data display, and conclusion drawing and verification, supported by content, discourse, and interpretive analysis. The findings indicate that AI-assisted learning functions as a supplementary learning resource that helps students access information, understand difficult concepts, generate ideas, and explore alternative explanations. However, its contribution to critical thinking depends on students' patterns of engagement. Students who questioned, compared, verified, and reflected on AI-generated information demonstrated more active critical-thinking processes, whereas uncritical copying and excessive dependence created risks of cognitive offloading. Teacher guidance and information-verification practices were also found to be important in directing students toward responsible AI use. The study concludes that AI can support students' critical thinking when it functions as a cognitive scaffold rather than a substitute for independent reasoning.

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INTRODUCTION

Artificial Intelligence (AI) has increasingly become a significant part of contemporary education, transforming the ways students access information, complete academic tasks, and interact with learning materials (Azamuddin et al., 2024; Chan, 2023; Quach et al., 2022). The rapid emergence of generative AI applications, particularly conversational systems such as ChatGPT, has enabled students to obtain explanations, generate ideas, summarize information, receive feedback, and explore academic questions almost instantly. This development creates an important social and educational issue because the convenience of AI-assisted learning may simultaneously support students' learning autonomy and encourage dependence on automatically generated answers

(Dhananjaya et al., 2024; Zhai, 2021; Zhao et al., 2024). UNESCO has emphasized that the rapid development of generative AI has outpaced the ability of many educational institutions and regulatory systems to establish appropriate pedagogical, ethical, and safety frameworks. In educational practice, therefore, AI should not merely be understood as a technological instrument for accelerating task completion but as a tool whose educational value depends on how students interact with, question, evaluate, and verify its outputs. The central concern is that students may become passive recipients of AI-generated information when convenience replaces intellectual effort, while properly guided AI use may stimulate questioning, comparison, reflection, and problem solving. Recent discussions also indicate that students themselves increasingly recognize the possibility that excessive AI dependence can weaken independent thinking. Thus, the growing presence of AI in education creates a crucial gap between its theoretical potential as a learning facilitator and the social reality of whether students actually use it to develop, rather than substitute for, critical thinking.

From a theoretical perspective, AI-assisted learning can be positioned as a form of technology-enhanced learning that potentially provides personalized assistance, immediate feedback, adaptive explanations, and opportunities for inquiry-based learning. The educational value of AI, however, is not determined simply by the availability of sophisticated technology but by the cognitive activities that accompany its use. Critical thinking requires learners to interpret information, analyze arguments, evaluate evidence, make reasoned inferences, and reflect on conclusions rather than simply reproduce information provided by another source (Amin, 2024; Habash, 2024; Matta, 2022). Consequently, AI may function either as a cognitive scaffold or as a cognitive substitute depending on the learner's purpose, AI literacy, and level of engagement with the learning process. A systematic review of generative AI and critical thinking among undergraduates found that approximately half of the reviewed studies reported potential benefits, while other studies remained inconclusive, demonstrating that the relationship cannot be assumed to be uniformly positive. Similarly, research on AI-assisted learning emphasizes that structured interaction with AI can encourage students to formulate questions, compare perspectives, evaluate responses, synthesize information, and engage in reflection (Archambault et al., 2024; Hosaini et al., 2024; Soelistiono & Wahidin, 2023). These findings suggest that the theoretical relationship between AI-assisted learning and critical thinking is conditional rather than automatic. Therefore, the relevant educational question is not simply whether students use AI, but how AI-assisted learning shapes the quality, independence, and depth of students' thinking.

The issue becomes particularly important when AI-assisted learning is examined within the context of secondary education, where students are still developing intellectual independence, information-literacy skills, and the ability to evaluate competing claims. Madrasah Aliyah represents a distinctive educational context because students are expected to develop academic competencies while simultaneously engaging with religious, moral, social, and scientific dimensions of knowledge. In such an environment, AI-assisted learning may provide opportunities for students to explore complex questions, obtain alternative explanations, compare interpretations, and develop arguments across different subjects (Barua et al., 2022; Kim et al., 2024; Wang, 2021). At the same time, students may face difficulties in determining whether AI-generated information is accurate, sufficiently supported by evidence, contextually appropriate, or consistent with reliable academic sources. Research involving secondary-school students has demonstrated that AI can play a role in developing critical thinking, including in subject-specific learning such as physics. However, other research has identified concerns regarding students' ability to distinguish reliable information from AI-generated responses and the possibility that students may accept AI outputs without sufficient evaluation. These conditions make secondary-school and madrasah settings especially relevant for examining the relationship between AI-assisted learning and critical thinking. Accordingly, the present study

focuses on students at Madrasah Aliyah Miftahussalam Wonosalam, Demak, as a specific educational setting in which the opportunities and challenges of AI-assisted learning can be investigated in a contextualized manner.

The context of Madrasah Aliyah Miftahussalam Wonosalam, Demak, is important because the impact of AI-assisted learning cannot be separated from students' learning habits, teachers' instructional practices, technological access, and the educational culture of the institution. AI may be used by students for searching explanations, generating learning ideas, completing assignments, checking answers, translating materials, or discussing academic problems, but each form of use may produce different cognitive consequences. When students use AI to ask follow-up questions, challenge an answer, compare alternative explanations, and verify evidence, the technology may encourage higher-order thinking. Conversely, when students simply copy AI-generated responses and submit them as their own work, the technology may reduce opportunities for analysis, reasoning, and reflection. This distinction is consistent with research showing that AI-supported learning outcomes depend substantially on the manner in which students engage with AI rather than merely on technological availability. For example, a study of AI-augmented thinking in programming found that students who remained human-led spent more time developing and refining solutions, whereas AI-led students more frequently relied on directly generated solutions. Research in Indonesia has likewise reported positive relationships between AI learning tools, customized curricula, and students' critical thinking skills, suggesting that pedagogical design plays an important role in determining AI's educational effects. Therefore, examining AI-assisted learning in the specific classroom context of Miftahussalam Wonosalam is necessary to understand how technology interacts with actual student thinking rather than treating AI as an inherently beneficial or harmful educational innovation.

Previous studies provide important evidence concerning the relationship between AI and students' critical thinking, although their findings remain diverse. AI-based learning using Canva AI among 60 elementary students and reported that AI-supported learning could contribute to the development of critical thinking (Mudinillah & Rizaldi, 2021). AI learning tools, customized curricula, and critical thinking skills (Chang et al., 2023). The critical-thinking performance of ChatGPT with 240 Chinese university students and found differences across inference, deduction, evaluation, and inductive reasoning (Assalihee et al., 2024). These studies demonstrate that AI can support critical thinking under particular conditions but can also create dependency and cognitive offloading, establishing the need for further contextual research.

Despite these contributions, a significant research gap remains concerning how AI-assisted learning influences critical thinking among students at the madrasah-aliyah level, particularly within a specific local educational environment such as Madrasah Aliyah Miftahussalam Wonosalam, Demak. Much of the existing literature has concentrated on university students, general secondary education, elementary education, or broad quantitative relationships between AI use and learning outcomes, while comparatively less attention has been given to the lived educational context in which madrasah students encounter and use AI for learning. The existing evidence also tends to examine either the positive potential of AI as an instructional technology or the negative consequences of AI dependence, whereas fewer studies investigate the conditions under which the same technology can produce both outcomes. Recent Indonesian research has begun to address AI literacy, ethics, dependency, and critical thinking, but these studies predominantly involve university populations or particular school contexts. The novelty of the present study therefore lies in examining AI-assisted learning and critical thinking within a specific Madrasah Aliyah setting, where students' technological practices are embedded within a distinctive educational and cultural environment. This contextual approach allows the study to move beyond the simplistic question of whether AI is good

or bad for students and instead examine how AI-assisted learning is related to students' abilities to analyze information, evaluate evidence, formulate judgments, and reason independently. Thus, the research addresses both a contextual gap and a conceptual gap by connecting AI use with the quality of students' critical-thinking processes.

Based on the identified social phenomenon, theoretical discussion, and research gap, this study seeks to investigate the relationship between artificial intelligence-assisted learning and students' critical thinking skills at Madrasah Aliyah Miftahussalam Wonosalam, Demak. The central research question is: How does artificial intelligence-assisted learning affect the critical thinking skills of students at Madrasah Aliyah Miftahussalam Wonosalam, Demak? This primary question is further directed toward understanding how students use AI in learning, what forms of AI-assisted learning are most frequently employed, and whether the use of AI is associated with students' abilities to analyze, evaluate, infer, and reflect on information. The research also asks: To what extent does students' manner of using AI influence whether AI functions as a cognitive support or a substitute for independent thinking? These questions are important because measuring the frequency of AI use alone cannot adequately explain its educational consequences. Two students may use the same AI application with fundamentally different cognitive purposes, with one student critically evaluating AI-generated information and another accepting it without verification. The study therefore focuses not only on technological exposure but also on the learning behavior and cognitive engagement associated with AI-assisted learning. By formulating the investigation through these questions, the research seeks to clarify the relationship between AI-assisted learning and critical thinking within an authentic madrasah context. Consequently, the study positions critical thinking as the central educational outcome through which the quality of AI-assisted learning can be assessed.

The original contribution of this research is to provide empirical and contextual evidence concerning the conditions under which AI-assisted learning can support or potentially weaken students' critical thinking in a Madrasah Aliyah environment. The central argument of the study is that AI-assisted learning is expected to contribute positively to students' critical thinking when students use AI as a cognitive scaffold for questioning, exploring alternatives, evaluating information, and reflecting on conclusions, but excessive or uncritical dependence on AI is expected to weaken independent reasoning and analytical engagement. This argument is consistent with evidence that structured AI use can improve higher-level thinking while unstructured dependence may encourage students to rely on ready-made answers. The argument also responds to UNESCO's human-centered perspective, which emphasizes that AI in education should be integrated through meaningful, ethical, safe, and pedagogically appropriate practices rather than treated simply as an automated replacement for human learning. Accordingly, this research does not assume that AI itself determines students' cognitive outcomes; instead, it proposes that the educational effect of AI depends on the interaction between technology, students' AI literacy, learning behavior, teacher guidance, and critical engagement with information. The study is therefore expected to contribute theoretically by clarifying the conditional relationship between AI-assisted learning and critical thinking, empirically by providing evidence from a specific madrasah context, and practically by informing teachers about responsible strategies for integrating AI into learning activities. Ultimately, the study argues that the educational success of AI should be measured not by how quickly students obtain answers, but by how effectively AI helps them learn to question, evaluate, reason, and think independently.

RESEARCH METHOD

The unit of analysis in this study is the practice of artificial intelligence-assisted learning and its relationship with students' critical thinking skills at Madrasah Aliyah Miftahussalam Wonosalam, Demak, Central Java, Indonesia. The research specifically examines learning activities in which

students utilize artificial intelligence-based applications to support their academic learning, including searching for information, understanding learning materials, generating ideas, answering questions, completing assignments, and discussing academic problems. The school was selected as the research setting because it represents a Madrasah Aliyah educational environment in which students are increasingly exposed to digital technologies while continuing to participate in formal Islamic secondary education. The material object of the study is therefore not artificial intelligence technology itself, but the educational practices, experiences, and interactions that emerge when students employ AI as part of their learning activities. The study pays particular attention to how students interpret AI-generated information, verify information obtained from AI, formulate questions, compare alternative answers, develop arguments, and make conclusions. In addition, the research considers the role of teachers in guiding students' AI-assisted learning practices. By focusing on these activities, the study seeks to understand AI use as a social and educational phenomenon rather than merely as a technological innovation. Thus, Madrasah Aliyah Miftahussalam Wonosalam serves as the contextual setting through which the relationship between AI-assisted learning and critical thinking can be examined in depth.

This research employs a qualitative research design using a case study approach to obtain an in-depth understanding of artificial intelligence-assisted learning and its implications for students' critical thinking skills. A qualitative approach is considered appropriate because the study seeks to explore students' experiences, perceptions, behaviors, and interpretations concerning the use of AI in actual learning situations rather than measuring the phenomenon exclusively through numerical indicators. The case study design enables the researcher to investigate the phenomenon within its real-life educational context and to examine the interaction between students, teachers, learning activities, and AI-based technologies. The case is bounded by the institutional setting of Madrasah Aliyah Miftahussalam Wonosalam, Demak, and focuses specifically on AI-assisted learning practices conducted by students and supported or supervised by teachers. The study does not attempt to generalize statistical findings to all Madrasah Aliyah institutions but aims to develop a contextual and comprehensive understanding of the selected case. The researcher acts as the primary research instrument and is responsible for collecting, interpreting, comparing, and validating information obtained from different sources. Particular attention is given to the processes through which students use AI, respond to AI-generated information, and engage in independent reasoning. Accordingly, the qualitative case study design allows the research to capture both the observable learning practices and the meanings that students and teachers attach to AI-assisted learning.

The sources of information in this study consist primarily of students and teachers at Madrasah Aliyah Miftahussalam Wonosalam, Demak, supplemented by relevant institutional and textual documents. Students are selected as the main respondents because they directly experience and engage in AI-assisted learning activities, while teachers function as key informants who can provide information concerning classroom practices, student behavior, instructional strategies, and teacher perceptions of AI use. The researcher collects data through desk review, observation, and semi-structured interviews. The desk-review process involves examining relevant documents, including school learning programs, lesson materials, assignments, policies concerning technology use, and relevant academic literature concerning artificial intelligence and critical thinking. Observation is conducted during selected learning activities to identify how students interact with AI tools, how they use AI-generated information, and how teachers guide or respond to such practices. An observation guide is prepared to ensure systematic documentation of relevant behaviors and interactions. Semi-structured interviews are conducted using an interview guide containing open-ended questions concerning students' experiences, purposes, strategies, difficulties, verification practices, and perceptions of AI-assisted learning. Interviews with teachers address instructional objectives, student

engagement, perceived benefits, challenges, and potential risks of AI use. Interview and observation data are documented through field notes and, where appropriate, audio recordings with participants' consent. The combination of these techniques enables methodological triangulation and provides a more comprehensive understanding of the case.

The data are analyzed using the interactive model of Miles, Huberman, and Saldaña, which consists of data condensation, data display, and conclusion drawing or verification. In the first stage, data condensation is conducted by selecting, simplifying, organizing, and coding information obtained from desk review, observations, interviews, and supporting documents. The researcher identifies recurring themes related to students' patterns of AI use, information verification, analytical reasoning, evaluation of AI-generated responses, independent decision making, and teacher guidance. In the second stage, the condensed data are displayed in the form of thematic matrices, narrative descriptions, categories, and relationships among emerging themes so that patterns and contrasts within the case can be identified systematically. The third stage involves drawing and verifying conclusions by continuously comparing emerging interpretations with the original data and checking their consistency across different sources. The analytical techniques used within this interactive process include content analysis, discourse analysis, and interpretive analysis. Content analysis is applied to identify recurring meanings and themes in interview transcripts and documents, while discourse analysis is used to examine how students and teachers construct meanings concerning AI, learning, knowledge, and critical thinking. Interpretive analysis is subsequently employed to explain the significance of these patterns within the educational context of the madrasah. Data triangulation across students, teachers, observations, interviews, and documents is used to strengthen credibility. Therefore, the analysis produces a contextual interpretation of how AI-assisted learning may function as either a support for or a substitute for students' critical thinking.

RESULTS AND DISCUSSION

AI as a Learning Support for Accessing and Understanding Information

The first finding indicates that artificial intelligence-assisted learning functions primarily as a supporting resource that helps students access, understand, and organize learning information. Students reported using AI applications to obtain explanations of difficult concepts, find alternative explanations, summarize learning materials, generate examples, and clarify unfamiliar terminology. The use of AI was particularly visible when students encountered materials that they considered difficult to understand through textbooks or teacher explanations alone. Rather than using AI exclusively to obtain final answers, several learning activities involved asking AI to explain concepts using simpler language or provide additional examples. This pattern suggests that students perceive AI as an accessible supplementary learning resource that can respond immediately to their questions. However, the educational value of this practice depends on whether students subsequently process and evaluate the information obtained. Students who used AI merely to obtain completed answers demonstrated less evidence of independent cognitive engagement than those who used AI to explore explanations and compare information. Therefore, the first finding does not suggest that AI automatically improves learning, but rather that AI expands students' access to learning assistance. The central implication is that AI-assisted learning can become a meaningful cognitive support when students remain actively involved in interpreting and processing the information provided.

The observation data provide further evidence that students commonly integrated AI into their learning activities as an additional source of explanation and information. During observed learning activities, students were seen using digital devices to formulate questions related to assignments and learning materials. Some students entered relatively direct questions and immediately examined the responses generated by the AI application. Other students interacted more actively by reformulating

questions, asking for simpler explanations, requesting examples, or comparing AI responses with information from textbooks and teacher-provided materials. These different patterns demonstrated varying levels of cognitive engagement. Students who merely copied responses displayed limited observable discussion and reflection, whereas students who compared AI-generated information with other sources tended to engage in more discussion and revision. The observation also indicated that AI was particularly attractive because it provided immediate responses without requiring students to wait for additional explanations. Nevertheless, immediate access did not necessarily result in deeper learning. In several situations, students appeared satisfied after receiving a plausible answer, even when they had not visibly checked its accuracy. This observation is important because it illustrates the dual nature of AI-assisted learning: the same technology can facilitate exploration while simultaneously encouraging superficial information consumption. Thus, observation confirms that the educational consequences of AI depend strongly on students' patterns of interaction with the technology.

Table 1. Observed AI-Assisted Learning Activity

Observed AI-Assisted Learning Activity	Student Behavior	Cognitive Function	Potential Educational Meaning
Asking AI to explain difficult concepts	Students requested simpler explanations	Understanding and interpretation	AI acts as an explanatory scaffold
Requesting examples	Students asked AI for additional examples	Application and contextualization	Students connect concepts with situations
Summarizing learning materials	Students requested concise explanations	Organization of information	AI supports information processing
Generating answers to assignments	Students requested direct solutions	Retrieval and task completion	Risk of cognitive dependence
Comparing AI responses with textbooks	Students checked information across sources	Evaluation and verification	Supports critical thinking
Reformulating AI questions	Students modified prompts after reading responses	Reflection and inquiry	Encourages active engagement
Copying AI-generated responses	Students reproduced answers with limited modification	Minimal cognitive processing	May weaken independent reasoning
Discussing AI responses with peers	Students exchanged opinions about answers	Analysis and argumentation	Creates opportunities for collaborative thinking

The Table 1 demonstrates that AI-assisted learning was characterized by multiple forms of student engagement rather than a single uniform pattern. The most educationally productive practices involved explanation seeking, comparison, verification, and reformulation because these activities required students to interact cognitively with the information generated by AI. In contrast, direct answer generation and copying represented more passive forms of engagement that could reduce opportunities for students to construct their own reasoning. The finding can therefore be restated as follows: AI primarily served as a supplementary learning resource, but its contribution to learning depended on how students used the information it generated. From an interpretive perspective, AI can be understood as a cognitive scaffold when students use it to extend their understanding rather than replace their own intellectual work. This interpretation also explains why the presence of AI alone cannot be treated as evidence of improved critical thinking. The critical factor is the interaction between the technology and students' learning behavior. When students questioned, compared, and interpreted AI responses, the technology created opportunities for higher-order cognitive activity. When students accepted responses without examination, the same technology encouraged cognitive offloading. Therefore, the first finding emphasizes that AI-assisted learning should be evaluated

according to the quality of students' engagement with AI rather than the frequency of technology use alone.

In general, the first finding demonstrates that artificial intelligence has become a practical supplementary resource within students' learning activities at Madrasah Aliyah Miftahussalam Wonosalam, Demak. Students use AI because it provides rapid explanations, accessible information, alternative formulations, and assistance with academic tasks. The findings nevertheless show that accessibility should not be confused with educational effectiveness because students demonstrate different levels of cognitive engagement when interacting with AI (Huda et al., 2023; Jones et al., 2023). The most constructive use occurs when students treat AI responses as information that requires interpretation, comparison, and verification. Conversely, the least constructive pattern occurs when students regard AI as an automatic answer provider and reproduce its output without independent consideration. This distinction provides an important basis for understanding the relationship between AI-assisted learning and critical thinking. AI does not function as an independent educational agent capable of determining students' cognitive development; instead, it operates within learning practices shaped by students, teachers, tasks, and instructional expectations. The general pattern therefore suggests that AI-assisted learning has considerable potential to support students' learning processes, but that potential must be activated through active and reflective engagement. The finding ultimately supports the view that effective AI integration requires students to remain cognitively responsible for their learning. Thus, AI is most educationally valuable when it assists students in thinking rather than when it thinks on their behalf.

AI Use Creates Opportunities and Risks for Critical Thinking

The second finding concerns the relationship between AI-assisted learning and students' critical thinking skills. The research indicates that AI use creates opportunities for students to practice several dimensions of critical thinking, particularly interpretation, analysis, evaluation, inference, and explanation. Students can use AI to obtain alternative viewpoints, identify possible arguments, ask follow-up questions, and compare different explanations. These activities may encourage students to recognize that a single question can have multiple possible interpretations or solutions. At the same time, the findings reveal a significant risk when students accept AI-generated information without checking its accuracy or reasoning. Some students appeared to assume that AI responses were reliable simply because they were presented fluently and confidently. This creates a potential contradiction: AI can increase access to information while simultaneously reducing students' motivation to evaluate that information. The critical-thinking outcome therefore depends on whether AI-generated content becomes the object of critical examination or the endpoint of the learning process. Students who questioned, verified, and compared AI responses demonstrated stronger evidence of analytical engagement than students who simply copied responses. The second finding consequently establishes a conditional relationship between AI-assisted learning and critical thinking. AI can provide material for critical thinking, but it does not guarantee critical thinking. The quality of the cognitive process surrounding AI use determines whether technology becomes an instrument of intellectual development or a source of dependence.

AI provides students with opportunities to access alternative explanations and information, but these opportunities become cognitively meaningful only when students perform additional reasoning activities. Interpretation, analysis, and evaluation are particularly dependent on students' willingness to question the output rather than merely consume it. The findings therefore restate that AI-assisted learning does not have a uniformly positive or negative effect on critical thinking. Instead, its effect is mediated by the manner in which students interact with AI-generated information. From an interpretive perspective, the central issue is cognitive responsibility. When students remain

responsible for judging the validity of information, AI may expand the range of materials available for analysis and comparison. When responsibility is transferred entirely to the AI system, students may experience cognitive offloading, in which difficult intellectual operations are delegated to technology. This interpretation is consistent with the observed differences between students who verified information and students who immediately accepted AI responses. The result also suggests that critical thinking should be understood as a process rather than simply an outcome. The relevant question is not whether students can produce a correct answer after using AI, but whether they can explain why the answer is appropriate, identify evidence supporting it, recognize limitations, and consider alternatives. Therefore, AI-assisted learning contributes to critical thinking primarily when the learning process requires students to retain intellectual agency.

The second finding can be interpreted through the concept of AI as a potential cognitive scaffold. A scaffold provides temporary support that enables learners to perform tasks that they might find difficult independently, but the learner remains responsible for the underlying cognitive process. In the present context, AI can provide explanations, examples, alternative arguments, and feedback that stimulate students' reasoning. However, if the scaffold becomes a permanent substitute for reasoning, students may have fewer opportunities to develop independent cognitive abilities. The evidence from this study suggests that this distinction is visible in students' different patterns of AI interaction. Students who asked follow-up questions, compared sources, corrected AI responses, and formulated their own conclusions used AI in a manner consistent with cognitive scaffolding. In contrast, students who requested complete answers and reproduced them with minimal modification demonstrated a more substitutive pattern. This distinction is particularly important for educational practice because teachers cannot assume that students' use of AI automatically represents active learning. Instead, teachers need to design tasks that require students to explain, justify, verify, critique, and reflect upon AI-generated information. The interpretation therefore shifts attention from technological access to pedagogical use. AI becomes educationally productive when learning activities require students to exercise judgment. Consequently, the second finding suggests that the development of critical thinking depends less on whether AI is available and more on whether the surrounding learning environment requires students to think critically about what AI provides.

AI-assisted learning has a dual relationship with students' critical thinking skills. On the positive side, AI provides students with opportunities to explore multiple explanations, formulate additional questions, compare information, and receive immediate intellectual support (Jin et al., 2025; Kim et al., 2024). On the negative side, unrestricted dependence on AI can encourage students to accept information without verification and reduce their engagement in independent reasoning. The generalization that emerges is therefore conditional: AI-assisted learning can strengthen critical thinking when it is integrated into learning practices that emphasize questioning, evidence evaluation, comparison, reflection, and independent conclusions. Conversely, AI use may weaken critical-thinking opportunities when students rely on generated answers as replacements for their own reasoning. This finding has implications for both students and teachers. Students need to recognize that AI-generated information should be treated as a source requiring examination rather than as an unquestionable authority. Teachers, meanwhile, need to establish learning activities in which students must demonstrate their reasoning processes rather than merely submit final answers. The findings consequently support a pedagogical model in which AI is positioned as a learning partner or cognitive scaffold rather than an autonomous substitute for students' intellectual work. In this model, the central educational objective remains the development of independent judgment. Thus, the overall evidence indicates that the impact of AI on critical thinking is determined by the quality of human-AI interaction within the learning process.

Teacher Guidance and Student Verification Determine the Quality of AI-Assisted Learning

The third finding demonstrates that teacher guidance and students' information-verification practices play an important role in determining whether AI-assisted learning supports critical thinking. The presence of AI alone does not establish a meaningful learning process because students require guidance concerning how to formulate questions, evaluate AI responses, identify potentially inaccurate information, and compare generated content with credible sources. The findings suggest that teacher intervention can shift students from passive AI consumption toward more reflective use. Teachers can encourage students to explain their reasoning, verify information through textbooks and reliable references, identify inconsistencies, and revise answers after evaluating AI-generated material. This role becomes particularly important because students may not always recognize that AI systems can produce incomplete, inaccurate, or contextually inappropriate responses. The study therefore identifies teacher guidance as a mediating element between AI availability and students' critical-thinking development. In addition, students' own verification behavior represents an important indicator of cognitive engagement. Students who independently checked AI information demonstrated greater awareness of the difference between obtaining information and establishing its validity. This finding indicates that AI literacy and critical-thinking skills should develop together. Students need both the technical ability to interact with AI and the intellectual ability to question its outputs. Consequently, the third finding emphasizes that responsible AI-assisted learning requires an educational environment in which teachers actively cultivate verification, reflection, and independent judgment.

The observation findings indicate that teacher guidance was particularly visible when teachers directed students to examine the quality of information rather than simply complete assignments. During learning activities, students interacted with AI through their digital devices, while teachers remained responsible for monitoring the learning process and responding to questions. In situations where students encountered uncertain information, teacher intervention created opportunities for discussion and verification. For example, students could be encouraged to compare AI-generated explanations with textbooks, classroom materials, or other trusted references. Such activities changed the role of AI from an answer-producing tool into a source of material that students needed to evaluate. Observation also showed that the classroom environment influenced students' willingness to question AI responses. When learning activities emphasized explanation and justification, students were more likely to discuss why an answer was appropriate. When tasks focused primarily on completing assignments, AI could more easily become a shortcut for obtaining answers. This pattern demonstrates that critical-thinking development is connected to instructional design rather than technological availability alone. The observation further suggests that teacher supervision does not necessarily require teachers to prohibit AI use. Instead, teachers can establish boundaries and expectations that encourage responsible use. The observed classroom practices therefore support the interpretation that AI literacy must be embedded within pedagogy. Accordingly, the quality of AI-assisted learning is shaped by the interaction among students, teachers, learning tasks, and technological tools.

The third finding can consequently be restated as follows: the educational impact of AI-assisted learning is strongly influenced by teacher guidance and students' ability to verify AI-generated information. AI becomes more supportive of critical thinking when teachers create learning conditions that require students to question, compare, justify, and reflect. Students' verification practices then transform AI-generated information from a final answer into an object of inquiry. The interpretation of this finding suggests that the development of critical thinking in an AI-supported classroom is a shared responsibility. Students remain responsible for evaluating information and constructing their own conclusions, while teachers remain responsible for designing learning

experiences that make such evaluation necessary. This relationship is particularly significant in the context of Madrasah Aliyah because learning involves not only academic achievement but also the development of responsible intellectual behavior. Students need to understand that technological convenience does not eliminate the obligation to establish the validity and relevance of information. Similarly, teachers need to recognize that banning AI completely may not address the underlying challenge because students are already encountering AI as part of the broader digital learning environment (Chang et al., 2023). A more productive response is to teach students how to use AI critically, ethically, and purposefully. The findings therefore support an instructional approach that integrates AI literacy with critical-thinking instruction. Such an approach can include source comparison, fact verification, argument evaluation, reflective writing, and oral explanation of AI-assisted answers. Thus, teacher guidance functions not as a restriction on AI but as a mechanism for ensuring that AI use remains intellectually productive.

In general, the third finding demonstrates that responsible AI-assisted learning requires more than technological access because meaningful cognitive development depends on guidance, verification, and student responsibility. The evidence suggests that students are capable of using AI in productive ways when they are encouraged to question generated information, compare it with other sources, and construct their own conclusions. At the same time, students remain vulnerable to cognitive dependence when learning activities allow AI to provide complete solutions without requiring explanation or verification. Teacher guidance therefore emerges as an important contextual factor that can determine the direction of AI-assisted learning.

CONCLUSION

The three themes indicate that AI has the potential to function as a powerful educational support at Madrasah Aliyah Miftahussalam Wonosalam, Demak, but its contribution to critical thinking is conditional. First, AI expands students' access to explanations and learning resources. Second, AI creates opportunities for analysis and evaluation but also creates risks of cognitive offloading. Third, teacher guidance and student verification determine whether these opportunities become meaningful critical-thinking practices. The general conclusion is therefore that AI should be integrated into learning as a tool for stimulating inquiry rather than replacing intellectual effort. The most desirable learning pattern is one in which students ask questions, examine AI responses, verify evidence, compare perspectives, formulate independent judgments, and reflect on their conclusions. Accordingly, the study concludes that the educational value of AI depends fundamentally on maintaining students' cognitive agency within the learning process.

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