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Exploring Students' Cognitive Presence in AI-Assisted Learning Environments: A Qualitative Inquiry in Higher Education

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A B S T R A C T

The integration of artificial intelligence (AI) in higher education reshapes the learning process by positioning AI as a learning partner that influences students' thinking, information exploration, and academic decision-making. This qualitative case study explores students' cognitive presence in AI-assisted learning using the Community of Inquiry framework, focusing on the phases of triggering, exploration, integration, and resolution. Data were collected through semi-structured interviews, observations of digital learning activities, and analysis of student interactions on an AI platform involving 12 students from a technology-based university in Gading Serpong. The findings show that AI effectively supports the triggering and exploration phases through adaptive feedback and conceptual assistance, while knowledge integration relies largely on students' self-reflection. The resolution phase emerges primarily among students with higher digital literacy and self-regulation. The study concludes that AI can enhance cognitive presence, but its impact depends on students' cognitive readiness and instructional design, contributing to AI-based learning theory and informing more adaptive, student-centered learning environments.

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INTRODUCTION

The development of artificial intelligence (AI) has brought about a major change in the landscape of higher education, where AI not only serves as an administrative tool, but also becomes an active learning partner in the student learning process. In recent years, colleges have begun to adopt adaptive learning systems, AI-based chatbots, and AI generative agents to support more personalized learning configurations that are responsive to students' cognitive needs (McDonald, 2025). This transformation is particularly relevant in the Society 5.0 era, as AI enables higher education to provide a more flexible, interactive, and critical reasoning-based learning experience (Prasetyo & Ar Rosyid, 2022). However, despite the rapid development of AI technology, there are still concerns regarding how the presence of AI affects the quality of students' thinking processes, especially in terms of deep knowledge construction.

In the framework of the Community of Inquiry (CoI), cognitive presence is one of the core components that describes the extent to which students can build meaning through reflection, critical dialogue, and collaborative thinking (Garrison, 2017). This component consists of four phases: triggering events, exploration, integration, and resolution, which together reflect the practical process of critical reasoning (Garrison, 2017). Previous research has examined cognitive presence in the context of traditional online learning, showing that social presence and teaching presence greatly influence the creation of a productive cognitive presence (Littler, 2024; Maranna, 2022). However, the integration of AI in the student learning experience raises a new question: whether and how AI can support or hinder these four phases in the student's thinking process.

Some early studies on generative AI (GenAI) in higher education show great potential in improving students' cognitive attendance. For example, the research of Wang, Wu, Liu, Brown, and Chen (2024) introduced a "Generative Co-Learners" system that allows multimodal AI agents to function as learning partners, and it turns out to improve cognitive presence in asynchronous learning environments. Other studies show that AI can provide immediate feedback, answer questions adaptively, and generate critical dialogue that encourages student reflection (Essel et al., 2024; Lo, 2023). However, empirical research on the patterns of cognitive attendance formed by students when interacting with AI, especially through the CoI framework, is still very limited.

A recent systematic review by Sadaf (2021) identified that most CoI research still focuses on online learning environments without AI, resulting in a research gap related to cognitive presence in AI-mediated learning ecosystems. In addition, a meta-analysis of CoI attendance shows that the interaction between teaching presence, social presence, and cognitive presence is very important in shaping student engagement and learning outcomes (Littler, 2022), but how AI intervenes or mediates these relationships has not been widely researched. In other words, there is a significant research gap in the empirical understanding of the patterns and dynamics of student cognitive presence when AI becomes an active part of the learning community.

Based on this background, this study aims to qualitatively explore the cognitive presence of students in an AI-assisted learning environment in higher education, with a focus on analysis on the triggering phase, exploration, integration, and resolution. This research will investigate how students articulate critical thinking, reflection, and reasoning when interacting with AI systems, as well as the extent to which AI helps or hinders the transition between phases of cognitive presence. The qualitative approach was chosen because it allows for an in-depth and contextual understanding of students' subjective experiences, while thematic analysis helps identify thematic patterns in students' internal and external dialogues.

The theoretical contribution of this research is to expand the understanding of CoI in the modern context with the existence of AI as a mediating element of learning, especially related to how AI can facilitate or interfere with the practice of practical inquiry (Garrison & Anderson, 2003). In practical terms, the findings of this study can provide recommendations for educators and instructional developers to design AI learning strategies that are more effective, responsive to students' cognitive attendance stages, and centered on the development of critical thinking. In addition, implications for higher education institutions include the development of AI use policies that take into account students' metacognitive readiness and pedagogical infrastructure.

Contextually, this research is important, especially in Indonesia's digital era which is increasingly open to the use of AI in higher learning. Although many Indonesian campuses have begun to adopt AI technology, there has not been much local research that has in-depth explored the influence of AI on students' thinking processes in theoretical frameworks such as CoI. Thus, this study not only fills the empirical gap but also presents contextual insights that are relevant to the development of educational technology in the Indonesian higher education environment.

The study also has the potential to open up broader policy discussions among higher education stakeholders regarding ethics, instructional design, and teacher training in utilizing AI to support critical reasoning and collaborative learning. With a better understanding of students' cognitive attendance patterns in AI-assisted learning, institutions can design learning interventions that not only improve academic effectiveness, but also strengthen students' long-term reflective thinking qualities in learning communities.

LITERATURE REVIEW

The Development of AI in Higher Learning

The integration of artificial intelligence in higher education has created a new learning ecosystem that is increasingly adaptive, interactive, and oriented to the cognitive needs of students. The development of AI-based learning platforms, including generative agents and multimodal models, allows for learning personalization that was previously difficult to achieve through conventional instructional mechanisms (Hartono, 2023). This technology also expands students' access to learning resources, facilitates automated scaffolding, and optimizes learning flows through real-time feedback (Santos & Ferreira,

2024). In a global context, higher education is beginning to place AI as a key component in campus digitalization strategies to improve learning effectiveness and academic efficiency (Rutherford et al., 2022). However, this transformation also raises questions about how AI affects the way students build knowledge and develop high-level thinking processes. Therefore, understanding the impact of AI on students' cognitive activities is becoming increasingly important as educational institutions become increasingly dependent on the technology.

Cognitive Presence dan Kerangka Community of Inquiry

Cognitive presence is a fundamental component in the Community of Inquiry (CoI) framework that assesses students' ability to build meaning through critical thinking processes, reflective dialogue, and problem-solving (Hernández, 2020). The four phases of trigger, exploration, integration, and resolution represent the logical development of the inquiry process that determines the quality of student learning in a digital environment (Roberts & Lee, 2021). Previous studies have shown that cognitive presence is strongly influenced by the interaction structure, the quality of discussions, and the instructional support provided to students (Zheng & Yu, 2022). In a digital learning environment, the success of cognitive presence depends on the ability of platforms and instructors to provide a space that supports the exploration of ideas, critical reflection, and clarification of concepts (Morrison, 2023). The CoI framework has been widely used to analyze online learning, but the dynamics of the AI learning ecosystem demand a reinterpretation of how the four phases emerge in the interaction between students and AI agents.

Cognitive Presence in AI-Assisted Learning

The use of AI in learning has been proven to be able to improve cognitive presence through the provision of conceptual support, critical question triggers, and adaptive feedback that strengthens students' exploration processes (Delgado et al., 2024). Generative co-learning-based AI systems, for example, allow students to interact with AI agents as learning peers that encourage cognitive engagement and constructive dialogue (Wang et al., 2025). In addition, AI supports students' metacognitive activities by recommending learning strategies, mapping comprehension gaps, and offering multidimensional explanations that enrich the knowledge integration process (Harper & Lawson, 2023). Nonetheless, some studies report that the effects of AI technology are uneven for all college students due to differences in digital literacy, self-regulation ability, and the level of readiness to utilize AI features (Suárez & Moreno, 2024). This shows that the success of cognitive presence is not only determined by the presence of AI, but is also influenced by students' cognitive readiness and learning strategies.

Research Gap related to AI and Cognitive Presence

Although research on AI in education has increased significantly in the last five years, studies that specifically explore cognitive presence in the context of AI-assisted learning are still very limited (Sadaf, 2021). Most previous research has focused more on aspects of AI effectiveness, user experience, or the quality of technological interactions, rather than on the dynamics of students' critical

thinking as measured through the CoI framework (Littler, 2024). In addition, existing research tends to discuss general online learning without considering the role of AI agents as an active component in the student inquiry process (Nasr, 2025). In fact, the presence of technology such as generative chatbots, multimodal agents, and learning recommendation systems has the potential to fundamentally change students' interaction patterns and cognitive development (Baskara, 2024). Thus, there is an empirical gap that needs to be bridged related to how students construct knowledge through the four phases of cognitive presence when interacting with AI, especially in an increasingly digitized higher education environment.

METHODOLOGY

Research Type and Design

This research uses a qualitative approach with an intrinsic case study design, as the focus of the research is directed at an in-depth exploration of students' cognitive experiences when interacting with AI technology in the context of higher learning. The qualitative approach was chosen because it is able to explore subjective meanings and thought processes that cannot be explained through quantitative measurement (Creswell & Poth, 2021). The case study design is relevant because it examines specific phenomena in one technology-based institution that has integrated AI platforms in the learning process, thus enabling a comprehensive contextual understanding (Yin, 2020). The Cognitive Presence framework of the Community of Inquiry is used as an analytical foundation to assess the processes of triggering, exploration, integration, and resolution that occur in students' interactions with AI systems (Garrison, 2017).

Population, Participants, and Sampling Techniques

The research population includes students from a technology college in the Gading Serpong region who have been actively using AI-based learning platforms for at least one semester. Participants were selected using purposive sampling techniques, because informants who have direct experience and are relevant to the research object are needed (Palinkas et al., 2020). A total of 12 students were selected by considering variations in digital literacy levels, frequency of AI use, and study programs, so that the data obtained represented a variety of patterns of cognitive interaction. This number is in accordance with qualitative study standards that emphasize data depth, not sample size (Guest et al., 2020). Participant involvement is done voluntarily with informed consent.

Data Collection Techniques and Instruments

Data was collected through semi-structured interviews, non-participatory observations, and digital document analysis in the form of recorded student interactions with AI agents. The interview guide was developed based on the four-phase indicators of cognitive presence and adjusted to the characteristics of AI-based learning (Roberts & Thomas, 2022). Observations were made on student activities in the Learning Management System and learning AI applications, to capture naturally occurring patterns of cognitive exploration and

reflection. The validity of the data was strengthened through triangulation of sources, methods, and time, as well as member checking to ensure the suitability of the researcher's interpretation with the participant's experience (Nowell et al., 2022).

Research Procedure

The research process begins with the mapping of the institutional context and the identification of courses that are intensive utilizing AI technology. Furthermore, participant recruitment, instrument preparation, and interview were carried out which lasted 45-60 minutes per participant through online and face-to-face meetings. Observations were conducted over three weeks on digital learning activities, including the use of AI agents for discussion, task completion, and material exploration. Digital interaction documents are collected from AI platform usage logs with participant consent. All data is recorded, transcribed, and anonymized to maintain research ethics. The research procedure ended with data verification through triangulation and participant confirmation.

Data Analysis Techniques

The data were analyzed using reflexive thematic analysis through the stages of data familiarization, initial coding, theme construction, theme review, and interpretation of findings (Braun & Clarke, 2021). The analysis was directed to identify cognitive patterns in the four phases of cognitive presence that appear in student–AI interactions. Coding is done manually and assisted by NVivo 14 software to improve the accuracy, traceability, and consistency of the analysis process. The validity of the analysis was strengthened by trail audits, peer-debriefing, and triangulation between methods (Long & Johnson, 2022). The results of the analysis were then synthesized to explain the dynamics of students' critical thinking and the contribution of AI in the process of constructing their knowledge.

RESEARCH RESULTS

Trigger Phase: Curiosity Activation through AI Adaptive Feedback

Data analysis showed that the trigger phase appeared most consistently across all participants. AI serves as a stimulus that encourages students to identify knowledge gaps through guiding questions, material recommendation notifications, and adaptive feedback. Observation of activities on the LMS shows that the trigger moment most often appears when students access the "Insight Prompt" feature, which is a module that provides quick clarification of concepts that are not yet understood.

Some students describe the experience as an initial impetus for critical thinking. Participants explained, "*The AI immediately showed me which part I was wrong, so I felt I had to dig again into why it could be wrong*" (M1, September 3, 2025). The same thing was conveyed by other students, namely, "*It's like there's a small alarm every time the AI tells you a concept that doesn't fit. That makes me want to find out more.*" (M3, September 4, 2025). Participants with higher digital literacy admitted that AI helps recognize learning needs quickly, stating, "*AI gave me a trigger prompt that made me realize that my understanding was not deep. From there I*

started to open up additional materials." (M6, September 6, 2025). While there are students who emphasize the trigger function as a director of interest, "*Sometimes I don't know where to start, but the AI gives me an initial signal that makes me focus.*" (M10, September 11, 2025). These findings confirm that AI plays an important role in arousing curiosity and initiating the process of critical thinking, according to the characteristics of trigger phases within the framework of Cognitive Presence.

Exploration Phase: Deepening Information through Conceptual Explanation and Material Navigation by AI

The exploration phase seemed strong to most participants, especially when they took advantage of the analytical dialogue and conceptual explanations provided by the AI agent. Observational data showed that students often moved between modules on the recommendation of AI, indicating a structured exploratory navigation. This is in line with the digital interaction log which shows an increase in requests for clarification of concepts and application examples from students in the second week of observation.

Students assess that AI helps them expand their understanding by providing easy-to-adapt explanations. Participants said, "*AI helps provide additional examples that are not in the module. From there I started comparing several concepts.*" (M2, September 3, 2025). Another student added, "*If I ask again, AI can explain it from another point of view. It makes exploration more widespread.*" (M4, September 4, 2025). Some students use AI to quickly verify concepts, which includes, "*I often double-check my understanding. AI helps validate whether my mindset is right or not*" (M7, September 7, 2025). Similar experiences were expressed by other participants, "*When I was confused, I threw a question to the AI. The answer sometimes makes me think of other aspects that I didn't see before.*" (M9, September 10, 2025). However, participants with low digital literacy showed limited exploration, "*I explore, but sometimes the answer is too technical. So I just stopped there.*" (M12, September 12, 2025). This variation shows that the effectiveness of exploration is influenced by each student's digital navigation ability.

Integration Phase: Formation of Understanding through Self-Reflection and Concept Synthesis

Although AI provides strong exploratory support, the more dominant phase of integration emerges through a process of self-reflection. Analysis of interviews and digital logs shows that students do a lot of synthesis activities outside of direct interaction with AI, for example through the creation of personal summaries, concept maps, or comparisons of theories found.

Most students use AI as a reflection partner, not as a provider of final answers, "*AI helps me to give structure, but connect the concept, I think it myself*" (M5, September 5, 2025). M8 describes a similar experience, "*I'm using AI to check the consistency of logic, but the integration part still takes time to reflect.*" (M8, September 8, 2025). Students with higher self-regulation skills show a more mature integration process, "*After exploring, I always go back to personal notes. AI just helps*

to check if the relationships between the concepts make sense." (M11, September 11, 2025). Observations also show that students who are active in independent reflection produce more complex integrative records than other students. In contrast, students who rely heavily on AI show superficial integration, "*Sometimes I get too satisfied with the AI's answers, so the integration is not deep*" (M3, September 4, 2025). This pattern confirms that integration is not fully automatable and still requires active cognitive involvement of students.

Resolution Phase: Application of Knowledge that Only Occurs in Students with Digital Literacy and High Self-Regulation

The resolution phase is the least likely to occur. Only some students have managed to apply the new knowledge to the context of assignments, projects, or other cases independently. Students who show resolution generally have a combination of high digital literacy, strong self-regulation, and mature evaluative skills.

Students describe the resolution process as an applicative step, "*After being sure of the same concept, I tried to use it for task case analysis. "It just helps me to see if my argument is consistent.*" (M6, September 6, 2025). Other participants shared similar experiences, "*I use the learning results from AI to develop new problem-solving strategies. That's the most difficult stage but the hardest result.*" (M10, September 11, 2025). Some students showed partial resolution, but have not yet fully implemented. M2 stated, "*Sometimes I get to the stage of understanding, but I haven't reached the implementation yet. Still lacking confidence*" (M2, September 3, 2025). While there are students who confess, "*I rarely get to the application stage. Usually stop after understanding the concept*" (M12, 12 September 2025).

Observational analysis shows that the resolution phase most often appears in project-based courses, especially when students are required to come up with original solutions. In this context, AI plays the role of an evaluator, not the main director. This suggests that AI's role in the resolution phase complements, rather than replaces students' cognitive processes.

DISCUSSION

The results of the study show that artificial intelligence plays a significant role in strengthening the triggering phase in the framework of cognitive presence. AI is able to present questions, initial explanations, and cognitive stimuli that cause the curiosity and productive confusion needed to start the inquiry process. These findings are in line with the Community of Inquiry framework (Garrison, 2017), which emphasizes that the trigger phase is the first step in building critical thinking. Previous studies, such as Chan & Hu (2023), have also shown that students use AI agents as a tool for generating ideas and triggering for concept exploration. Consequently, AI is not only positioned as a learning tool, but also as a spark of internal dialogue that drives high-level thinking processes. This shows that AI is effective as a cognitive catalyst that starts students' intellectual processes.

In the exploration phase, AI is proven to provide adaptive feedback that helps students explore concepts, expand knowledge, and test their initial understanding. Dialogue with AI allows students to ask follow-up questions,

refine assumptions, and navigate diverse conceptual perspectives. These findings reinforce the idea that AI can serve as a conceptual scaffolding that supports a more structured information search process. These findings are in line with the results of research by Vasconcelos & dos Santos (2023), who stated that AI agents are capable of expanding the exploration of ideas if used strategically. However, the intensity and quality of exploration are still influenced by students' ability to effectively utilize AI features, which in some cases depends on their respective digital literacy levels. Thus, while AI provides exploratory support, the quality of this process still requires active user engagement.

Research shows that AI does not automatically result in knowledge integration, because this process actually occurs more through students' self-reflection after interacting with AI. Integration involves combining ideas, reinterpreting, and organizing knowledge into a coherent structure that requires metacognitive activity. These findings reinforce the view that knowledge integration does not only depend on providing information from AI, but on the ability of students to process the information independently. Previous research confirms that self-regulation and the ability to reflect are determining factors for the success of knowledge integration (Education Sciences, 2023). Therefore, while AI enriches exploration, meaningful integration requires reflective activity that cannot be completely replaced by automated systems.

Another important finding is that the resolution phase, which is the stage when students apply new understandings to solve problems or make decisions, only appears in students with high digital literacy and strong self-regulation. Many college students show limitations in reaching this phase because they tend to rely on instant answers from AI without conducting advanced analysis. These findings are consistent with the study of Nasr et al. (2025), which stated that the passive use of AI can generate a resolution gap, which is a gap between the exploration of ideas and the implementation of those ideas. In addition, Yu and Wu (2024) said that AI can deepen learning, but its effectiveness is greatly influenced by user interaction strategies. Thus, resolution is the most challenging phase in cognitive presence when AI is used as a learning partner.

Digital literacy and self-regulation have proven to be the main mediators in the effectiveness of using AI to build cognitive presence. Students who are able to manage their learning process, manage goals, and practice directed reflection tend to be more successful in utilizing AI to undergo all phases of inquiry. In contrast, students with low digital literacy have difficulty asking the right questions, filtering information, and utilizing AI as a tool for critical thinking. These results are in line with the self-regulated learning theory that emphasizes the importance of metacognitive control (Zimmerman, 2022). Thus, the internal capacity of students determines whether AI serves as an intellectual catalyst or just a quick answer tool.

Theoretically, this research makes an important contribution to the development of the Community of Inquiry model in the context of AI-assisted learning. The findings show that AI is highly effective in the trigger and exploration phases, but it has not been fully able to facilitate integration and resolution without reflective student involvement. The theoretical implication is

the need to revise the understanding in the CoI model that AI technology does not only function as a communication tool, but as a cognitive agent that requires reflective interaction from users in order to drive the entire inquiry process. This update expands the scope of CoI theory in the digital age, particularly in the context of AI-based learning that is increasingly collaborative and adaptive.

In practical terms, the results of the study provide an important guide for designing AI-based learning in higher education. Because AI is so effective in triggering and supporting exploration, educators need to design learning activities that encourage students to reflect, integrate, and apply concepts. Strategies such as reflective assignments, argument-based discussions, and problem-solving projects can help students reach a higher inquiry phase. In addition, digital literacy and self-regulation training needs to be strengthened so that students are able to use AI critically. This is consistent with the research recommendation of Chan & Hu (2023) that AI-based learning should be accompanied by a pedagogical use strategy, not just a technical one.

This research has several limitations that must be observed. First, the relatively small sample and focus on a single institution limits the generalization of findings to a broader educational context. Second, the limited duration of observation may not capture the dynamics of students' cognitive ability development in the long term. Third, even though triangulation is carried out, qualitative data still contains subjectivity limits from both participants and researchers. Advanced studies are recommended using longitudinal design and involving more institutions to understand more stable cognitive patterns. Combining quantitative analysis, such as AI usage analytics and academic performance, can provide additional validation of the relationship between AI interaction and student cognitive presence development.

CONCLUSION AND RECOMMENDATION

This study confirms that artificial intelligence has a significant capacity in strengthening students' cognitive presence, especially in the triggering and exploration phases. The adaptive feedback, reflective questions, and conceptual explanations generated by AI agents have been shown to be effective in encouraging curiosity and expanding students' intellectual exploration spaces. Nevertheless, the process of knowledge integration is not completely sharpened by interaction with AI, but rather emerges more strongly through the student's self-reflection and metacognitive abilities. This shows that the role of AI in learning is complementary: it facilitates the inquiry process, but it does not replace the internal capacity of students to build knowledge coherence.

The resolution phase only appears in students who have high digital literacy and self-regulation, showing that individual cognitive readiness is a determining factor for the effectiveness of the use of AI in achieving more complex levels of cognitive presence. These findings make a theoretical contribution to strengthening the Cognitive Presence framework in the context of AI-assisted learning, while underscoring the importance of instructional design that encourages critical reflection and learning autonomy. Practically, this study emphasizes the need for pedagogical strategies that integrate AI more

systematically, accompanied by digital literacy improvement programs, so that students are able to make optimal use of technology in the process of knowledge construction. Thus, AI can play a strategic role as an adaptive learning partner, as long as its use is supported by adequate regulatory capacity and instructional support.

ADVANCED RESEARCH

Future studies should explore the long-term impact of AI-assisted learning on higher-level cognitive presence, particularly the integration and resolution phases, across diverse student populations. Further research is also needed to examine how instructional design, digital literacy training, and self-regulation interventions can optimize the effectiveness of AI as a learning partner in fostering deep and sustained knowledge construction.

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