

The Effectiveness of Generative AI as a Learning Support Tool: Evidence from Higher Education in Indonesia

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INFO ARTIKEL	ABSTRAK
Accepted : 6 July 2026 Revised : 13 August 2026 Approved : 15 September 2026 Keywords: <i>generative artificial intelligence; higher education; personalized learning; AI literacy; student engagement; learning support</i>	Generative Artificial Intelligence (GenAI) has become an increasingly relevant learning support technology in higher education. This study examines its effectiveness in supporting learning among higher education students in Indonesia by synthesizing recent empirical and methodological evidence. A descriptive literature review was conducted using five relevant journal articles published between 2025 and 2026. The reviewed studies addressed perceived AI effectiveness in online learning, personalized learning, student engagement, digital and AI literacy, and machine learning-based analysis of learning effectiveness. The synthesis indicates that GenAI can support material comprehension, flexible individual learning, and personalized learning recommendations. One reviewed study reported an overall perceived effectiveness score of 3.44, with material comprehension reaching 3.55. Another reported a 15.03% increase in average academic performance among students using an AI-based learning analytics tool, compared with 4.63% among non-users. However, the evidence also shows that frequent AI use alone does not guarantee stronger engagement or learning outcomes. Digital and AI literacy, active student participation, lecturer guidance, institutional support, and responsible use influence the value of GenAI. Key risks include inaccurate information, cognitive dependency, reduced critical thinking, privacy and security concerns, infrastructure limitations, and academic integrity. Therefore, GenAI is best positioned as an augmentative learning support tool rather than a replacement for lecturers or independent learning. Future research should use longitudinal or experimental designs and objective learning indicators to establish stronger evidence of its effects.

INTRODUCTION

The development of digital technology has changed higher education and the ways students access and process learning resources. Generative Artificial Intelligence (GenAI) is among the technologies that has received growing attention because it can produce explanations, examples, summaries, and responses to academic questions. These

capabilities allow students to obtain immediate assistance when they encounter difficulties and make GenAI a potential supplementary learning resource (Wahidah, Pixyoriza, & Iskandar, 2026).

Beyond immediate assistance, AI-based learning tools can support more individualized learning. Learning analytics can identify patterns in students' interactions and provide recommendations related to learning materials, learning styles, and study activities. Alifah and Hidayat (2025) reported evidence that AI-based learning analytics can contribute to personalized learning and academic performance. This suggests that the value of AI may extend beyond answering questions toward supporting learning decisions that correspond to students' needs.

However, the effectiveness of GenAI cannot be separated from students' digital and AI literacy. Sudrajat et al. (2026) found that digital and AI literacy were strongly associated with student engagement, whereas the intensity of GenAI use alone did not necessarily produce higher engagement. Students therefore need more than technical access. They need the ability to formulate appropriate prompts, evaluate generated information, identify inaccuracies, and integrate useful information with reliable academic sources.

GenAI also introduces educational and ethical risks. Students may encounter inaccurate or biased information, become overly dependent on automated assistance, or reduce their critical engagement with learning materials. Privacy, data security, infrastructure, and academic integrity are additional concerns (Alifah & Hidayat, 2025; Wahidah et al., 2026; Sudrajat et al., 2026). These issues indicate that GenAI should support, rather than replace, independent learning and lecturer-guided instruction.

Recent studies have used different approaches to examine AI-supported learning. Faqih and Dzikrillah (2026) applied Random Forest to analyze factors associated with GenAI use, self-directed learning, learning styles, and academic achievement. Sallu and Hendriadi (2025) also applied machine learning to examine factors related to learning effectiveness. Although these approaches provide useful analytical perspectives, evidence derived from simulated data requires careful interpretation when drawing conclusions about actual students.

Based on this context, this article examines the effectiveness of GenAI as a learning support tool in higher education, with emphasis on evidence from Indonesia. The review focuses on four questions: (1) how GenAI supports learning and comprehension, (2) how AI contributes to personalized learning, (3) how AI literacy and student engagement influence effectiveness, and (4) what challenges should be considered in responsible implementation.

METHODOLOGY

This study employed a descriptive literature review to synthesize recent evidence concerning Generative Artificial Intelligence as a learning support tool in higher education. The review focused on studies relevant to Indonesian higher education and on themes directly related to learning effectiveness, personalized learning, student engagement, digital and AI literacy, and challenges of AI adoption.

Five journal articles published between 2025 and 2026 were selected as the primary literature. The studies used different research approaches, including quantitative survey research, qualitative or descriptive analysis, and machine learning-based analysis. The selection was based on topical relevance to the research question rather than on a

single methodological design. This approach allowed the research team to compare findings across different forms of evidence while retaining the context of each study.

The analysis followed three stages. First, the research team identified the main objective, method, and reported findings of each study. Second, the findings were grouped into four analytical themes: learning support and comprehension, personalized learning, student engagement and AI literacy, and implementation challenges. Third, the evidence was compared and synthesized to identify common findings, differences in the strength of evidence, and implications for higher education practice. Particular attention was given to the distinction between perceived effectiveness, observed associations, and evidence of actual academic outcomes.

Table 1. Profile of the reviewed studies

Study	Main focus	Approach	Key evidence
Alifah & Hidayat (2025)	AI learning analytics and personalized learning	AI-based learning analytics	Academic performance increased 15.03% among users vs. 4.63% among non-users.
Sallu & Hendriadi (2025)	GenAI and learning effectiveness	Machine learning	Identified factors associated with GenAI-related learning effectiveness; simulated data.
Faqih & Dzikrillah (2026)	GenAI use and academic achievement	Random Forest	Examined GenAI use, self-directed learning, learning styles, and achievement.
Sudrajat et al. (2026)	GenAI adoption and engagement	Empirical higher-education study	Digital and AI literacy were associated with engagement; use intensity alone was insufficient.
Wahidah et al. (2026)	Perceived AI effectiveness in online learning	Quantitative survey	Overall perceived effectiveness 3.44; material comprehension 3.55.

RESULTS AND DISCUSSION

1. Effectiveness in Supporting Learning

The reviewed studies consistently indicate that GenAI has substantial potential to support learning activities in higher education. Wahidah et al. (2026) reported an overall perceived effectiveness score of 3.44, above the scale midpoint of 3.00. Material comprehension recorded the highest mean score at 3.55, while online learning participation was lower at 3.38. The difference is important because it suggests that students may experience stronger benefits from GenAI when using it for individual cognitive tasks than when using it to increase participation in broader learning activities. GenAI can provide immediate explanations, alternative examples, summaries, and clarification when students face difficulties. This function can reduce delays in obtaining basic academic assistance and can complement existing learning resources. Nevertheless, the evidence concerns perceived effectiveness in the study by Wahidah et al. (2026). A positive perception does not by itself establish a causal relationship between GenAI use and improved academic achievement. The research team therefore interprets this result as evidence of perceived usefulness rather than definitive proof of learning gains.

Additional evidence comes from Alifah and Hidayat (2025), who reported a 15.03% increase in average academic performance among students using an AI-based learning analytics tool, compared with a 4.63% increase among students who did not use the tool. This finding provides a stronger indication of an association between AI-supported learning and academic performance. However, the result should still be interpreted within the design and conditions of the original study.

2. Personalized Learning

Personalization is one of the clearest advantages identified across the reviewed literature. AI-based learning analytics can process students' interaction patterns and generate recommendations concerning learning materials, delivery styles, and study schedules (Alifah & Hidayat, 2025). In principle, such support can help students address different learning difficulties without requiring identical learning paths for all students. The effectiveness of personalization depends on active student interaction. Students need to use recommendations, review supplementary materials, and connect AI-generated assistance with learning objectives. Passive use may produce limited benefits because the technology cannot substitute for students' cognitive effort. Lecturer involvement also remains relevant because educators can determine whether AI-supported activities are aligned with course outcomes and disciplinary requirements.

The reviewed evidence therefore supports a conditional interpretation of personalized learning. GenAI can make learning support more responsive, but personalization is not an automatic consequence of AI availability. It emerges from the interaction among technology, student behavior, instructional design, and academic guidance

3. Student Engagement and AI Literacy

GenAI may facilitate individual learning without necessarily increasing student engagement in every dimension. Sudrajat et al. (2026) found that digital and AI literacy were strongly related to engagement, while the intensity of GenAI use alone did not necessarily result in higher engagement. This finding challenges the assumption that more frequent AI use automatically produces better learning involvement.

The result is consistent with Wahidah et al. (2026), where material comprehension obtained a higher score than online learning participation. GenAI appears particularly useful for individual cognitive support, while its contribution to social interaction and active participation depends more strongly on how learning activities are designed. In a higher education setting, AI should therefore be integrated into tasks that require students to explain, evaluate, discuss, and apply information rather than simply generate answers. AI literacy is consequently a central condition for effective use. Students should understand the limitations of generated outputs and verify important claims against reliable academic sources. They also need to recognize that fluent language does not guarantee factual accuracy. Critical evaluation can reduce cognitive dependency and maintain students' active role in the learning process.

4. Challenges and Risks

The benefits of GenAI are accompanied by practical, cognitive, ethical, and institutional challenges. Alifah and Hidayat (2025) identified low digital competency as 50% of the reported challenges, followed by data privacy and security concerns at 30% and infrastructure availability at 20%. These proportions show that implementation barriers are not limited to the technology itself. Human capability and institutional readiness also determine whether AI can be used effectively.

Wahidah et al. (2026) further identified risks involving cognitive dependency,

reduced critical thinking, bias, privacy, and academic integrity. These risks are particularly relevant when students treat generated responses as authoritative and submit AI-generated content without verification or meaningful engagement. Responsible use therefore requires explicit academic guidance concerning acceptable AI assistance, verification of information, and authorship of submitted work.

Institutions should respond through AI literacy programs, ethical guidelines, and lecturer involvement. Students should be encouraged to compare AI-generated information with peer-reviewed literature, inspect supporting evidence, and revise outputs using their own reasoning. Such practices position GenAI within an accountable learning process rather than as an independent source of academic judgment.

5. GenAI as an Augmentative Learning Tool

Taken together, the five reviewed studies indicate that GenAI can function effectively as a learning support tool, particularly for individualized assistance, comprehension, and personalized learning. However, effectiveness depends on conditions surrounding the technology. Digital and AI literacy, active participation, lecturer guidance, institutional support, and responsible use all influence the educational value of GenAI.

The distinction between augmentation and substitution is important. GenAI can extend students' access to explanations and learning resources, but it cannot replace the pedagogical functions of lecturers or the cognitive work required from students. Wahidah et al. (2026) indicates stronger support for individual cognitive understanding than for active social participation. Similarly, the machine learning studies by Faqih and Dzikrillah (2026) and Sallu and Hendriadi (2025) provide analytical perspectives on factors related to effectiveness, but they should not be interpreted as direct proof that GenAI causes improved learning outcomes. In particular, the simulated dataset used by Sallu and Hendriadi (2025) limits its interpretation as evidence about actual students.

The research team therefore concludes that the most defensible position is not whether GenAI is simply effective or ineffective. Its effectiveness is conditional. GenAI provides meaningful support when it is aligned with learning objectives, used critically by students, guided by lecturers, and supported by institutional policies. This interpretation also points to a research gap: future studies need stronger designs that can distinguish perceived usefulness from measurable educational impact.

CONCLUSION

This review shows that Generative Artificial Intelligence has considerable potential to support higher education learning in Indonesia. Across the five reviewed studies, GenAI and related AI-based tools were associated with improved material comprehension, flexible individual assistance, personalized learning support, and measurable differences in academic performance in some settings. The strongest reported indicators include a perceived effectiveness score of 3.44, a material comprehension score of 3.55, and a 15.03% increase in average academic performance among users of an AI-based learning analytics tool compared with 4.63% among non-users.

At the same time, GenAI use alone does not guarantee stronger engagement or better learning. Digital and AI literacy, active student participation, lecturer guidance, institutional readiness, and responsible use shape the effectiveness of AI-supported learning. The main challenges include limited digital competency, privacy and security

concerns, infrastructure, inaccurate or biased information, cognitive dependency, reduced critical thinking, and academic integrity.

Accordingly, higher education institutions should position GenAI as a supplementary and augmentative technology rather than a replacement for lecturers or independent learning. Future research should employ longitudinal or experimental designs, larger and clearly documented samples, and objective learning indicators. Such approaches would provide stronger evidence about whether the benefits identified in current literature translate into sustained improvements in academic achievement and student engagement.

LITERATURE

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