

## Student Dependence on Generative AI and Its Impact on Classroom Learning: A Mixed-Methods Study in Chemistry Education

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### ABSTRACT

This study examines students' dependence on generative AI and its impact on classroom learning. The research contributes to understanding how AI use, AI literacy, and ethical practices interact to shape learning outcomes in higher education. Using a mixed-methods embedded survey design, data were collected through a questionnaire combining Likert-scale items and open-ended questions from 40 undergraduate students in the Chemistry Education program at Universitas Negeri Makassar during one semester of classroom learning activities. The analysis included descriptive statistics, correlation, regression analysis, and thematic analysis of qualitative responses. The findings show that AI dependence is associated with perceived learning benefits, while AI literacy strongly predicts positive learning outcomes and lower integrity risk. These results highlight the importance of AI literacy and responsible AI use in supporting meaningful classroom learning.

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## **INTRODUCTION**

The rapid development of generative artificial intelligence (AI) technologies has significantly transformed the landscape of education. Tools such as ChatGPT, Gemini, and other AI-based systems enable students to generate written content, summarize materials, and obtain instant explanations for academic tasks. These technologies provide new opportunities for enhancing learning efficiency and accessibility to information (Saúde et al., 2024; El Bahri et al., 2025). In science and chemistry education, generative AI has also been recognized as a tool that can help students clarify complex concepts and support learning processes through interactive explanations and examples (dos Santos, 2023; Jere & Mpetta, 2025). However, the widespread availability of generative AI has also introduced new challenges in educational contexts, particularly regarding how students rely on these tools in completing academic activities.

In recent years, the phenomenon of student reliance on generative AI has become increasingly visible in classrooms. Many students use AI not only as a supplementary learning tool but also as a primary source for completing assignments, generating ideas, and solving academic problems (Wood & Moss, 2024; Irshad et al., 2025). While AI can support learning by providing quick feedback and assistance, excessive dependence may reduce students' engagement in critical thinking, problem-solving, and independent learning processes. Several studies have highlighted the tension between AI reliance and the development of students' critical thinking skills, particularly when learners rely on AI-generated responses without sufficient evaluation (He et al., 2025; Stone, 2024). This situation raises concerns among educators regarding the potential impact of AI usage on classroom participation, academic integrity, and the development of higher-order thinking skills.

Previous studies have largely focused on the benefits and challenges of artificial intelligence in education, particularly in terms of learning support and technological integration. For instance, generative AI has been reported to enhance motivated engagement and support conceptual understanding in science learning environments (Gervacio, 2024; Guo et al., 2025). In chemistry education, AI tools have been shown to assist students in explaining scientific concepts and organizing academic reasoning in writing-based learning activities (Watts et al., 2023; Priyadi et al., 2025). However, limited research has specifically examined the extent to which students become dependent on generative AI and how this dependence influences classroom learning dynamics. Understanding this issue is important because classroom learning involves not only the acquisition of knowledge but also active participation, collaboration, and cognitive engagement among students.

Therefore, this study aims to investigate student dependence on generative AI and its impact on classroom learning by employing a mixed-methods approach. By combining quantitative survey data with qualitative insights from student experiences, this research seeks to provide a more comprehensive understanding of how AI influences students' learning behaviors. The contribution of this study lies in providing empirical evidence on the relationship between generative AI dependence and classroom learning engagement, while

also highlighting the role of responsible and critical AI use in educational contexts (Deng et al., 2023; Blonder & Feldman-Maggor, 2024). These insights may help educators develop strategies for responsible and effective AI use in classroom learning environments.

Despite the growing body of research on generative AI in education, most existing studies have primarily examined its potential benefits, such as enhancing learning efficiency, engagement, and conceptual understanding, or discussed ethical considerations in AI integration within educational environments (Saúde et al., 2024; Gervacio, 2024; Deng et al., 2023). While these studies provide valuable insights into how generative AI can support learning, relatively few studies have specifically investigated the issue of **student dependence on generative AI and its implications for classroom learning dynamics**. In particular, limited empirical research has explored how students' reliance on generative AI interacts with their learning behaviors, participation, and engagement in classroom settings. Addressing this gap is important for understanding whether generative AI functions primarily as a cognitive support tool or whether excessive reliance may influence students' active learning processes.

## LITERATURE REVIEW

### *Generative AI in Education*

Generative Artificial Intelligence (AI) refers to advanced computational systems capable of producing human-like outputs such as text, images, and other forms of content based on user input. In educational contexts, generative AI tools such as ChatGPT, Bard, and other AI-powered writing assistants have increasingly been used to support students in completing academic tasks, including writing assignments, generating ideas, summarizing readings, and obtaining explanations of complex topics. The integration of generative AI in education offers several advantages, particularly in enhancing learning accessibility and supporting students in understanding course materials more efficiently (Saúde et al., 2024; El Bahri et al., 2025). In science and chemistry education, generative AI has also been recognized as a useful tool for helping students clarify complex concepts and explore academic ideas through interactive explanations and examples (dos Santos, 2023; Jere & Mpetta, 2025).

Previous studies have highlighted that generative AI can function as a learning support tool that improves students' productivity and academic performance. For example, research has shown that AI-based systems can help students quickly access relevant information and receive personalized assistance in completing learning tasks (Wood & Moss, 2024; Qadir, 2025). Other studies also report that generative AI can enhance motivated engagement and support students in organizing their learning processes more effectively (Gervacio, 2024; Guo et al., 2025). However, several scholars emphasize potential concerns related to the excessive use of AI tools, particularly regarding students' dependence on automated systems. When students rely heavily on AI-generated responses, they

may engage less actively in cognitive processes such as critical thinking, problem-solving, and independent learning (He et al., 2025; Stone, 2024).

Based on this perspective, generative AI can both support and potentially reshape students' learning behaviors. While AI tools may enhance engagement and efficiency in learning environments, responsible use and critical evaluation of AI-generated information remain essential to ensure meaningful learning outcomes (Deng et al., 2023; Blonder & Feldman-Maggor, 2024). Therefore, it is important to investigate how students' dependence on generative AI influences classroom learning dynamics and how such reliance may affect students' participation and cognitive engagement in classroom learning contexts.

### ***Technology Dependence Theory***

Technology Dependence Theory explains how individuals may develop a strong reliance on technological systems to accomplish tasks that were traditionally performed independently. According to this perspective, increased accessibility and convenience of technology may lead users to depend on these tools to solve problems, process information, and complete daily activities. In educational settings, the growing availability of digital technologies has significantly influenced how students interact with learning materials and complete academic assignments. Recent studies indicate that generative AI tools are increasingly used by students as immediate learning resources for generating explanations, solving academic problems, and assisting with coursework (Irshad et al., 2025; Saúde et al., 2024). As AI systems become more integrated into learning environments, students may rely on these technologies not only as supplementary tools but also as primary sources for completing academic tasks.

Several studies have shown that technology dependence among students may lead to reduced cognitive engagement and limited development of critical thinking skills when learners rely excessively on technological assistance. When students frequently depend on automated tools to generate answers or complete tasks, their ability to analyze information independently may decline. Research on generative AI in higher education suggests that students often experience a tension between relying on AI-generated responses and maintaining independent reasoning processes (He et al., 2025). Similarly, concerns have been raised that excessive reliance on AI tools may reduce opportunities for deeper cognitive engagement and reflective learning if students accept AI outputs without critical evaluation (Stone, 2024; Wood & Moss, 2024).

On the other hand, some research indicates that when used appropriately, technology can complement traditional learning methods and enhance students' understanding of complex subjects. In science and chemistry education, generative AI tools have been shown to support conceptual understanding and facilitate students' exploration of academic ideas when used as cognitive support systems (dos Santos, 2023; Jere & Mpeta, 2025). In the context of generative AI, students may therefore develop varying levels of dependence on AI tools to complete academic work. This dependence may affect how students participate in classroom discussions, interact with instructors, and engage with learning activities. Therefore, understanding the relationship between AI dependence and

classroom learning outcomes becomes essential in evaluating the broader impact of generative AI in education.

### *Classroom Learning Engagement*

Classroom learning engagement refers to the degree to which students actively participate in learning activities, including discussions, collaborative work, and problem-solving tasks. Engagement plays an important role in promoting meaningful learning experiences and improving students' academic outcomes. Active participation encourages students to critically evaluate information, share ideas, and develop deeper understanding of course materials. Recent studies indicate that generative AI can also support student engagement by providing explanations, examples, and learning guidance that help students explore academic content more interactively (Gervacio, 2024; Qadir, 2025). In science and chemistry education, AI-supported learning environments have been shown to enhance students' engagement and conceptual understanding when technology is used as a cognitive support tool (Jere & Mpetta, 2025; dos Santos, 2023).

However, the increasing use of digital technologies in education has also changed how students approach learning activities. While technology can enhance engagement by providing interactive learning tools and immediate access to information, excessive reliance on automated systems may reduce students' motivation to engage directly in classroom discussions and collaborative learning processes. Some studies suggest that students who frequently depend on AI-generated responses may become less inclined to analyze information independently or participate actively in learning activities (He et al., 2025; Stone, 2024). In addition, research on generative AI use in higher education indicates that the educational impact of AI depends largely on how students critically evaluate and integrate AI-generated information into their learning processes (Wood & Moss, 2024; Deng et al., 2023). Therefore, understanding how generative AI influences classroom engagement is essential for educators seeking to balance the benefits of technological innovation with the development of essential cognitive and collaborative skills.

### *Conceptual Framework*

Based on the literature discussed above, this study proposes that student dependence on generative AI influences classroom learning engagement and students' critical thinking abilities. Generative AI tools provide convenience and academic support, but excessive reliance may lead to reduced independent learning and classroom participation. The conceptual framework of this study positions generative AI dependence as the independent variable, while classroom learning engagement and critical thinking represent the dependent variables. This framework aims to explore how students' reliance on AI tools shapes their learning behavior and classroom experience.

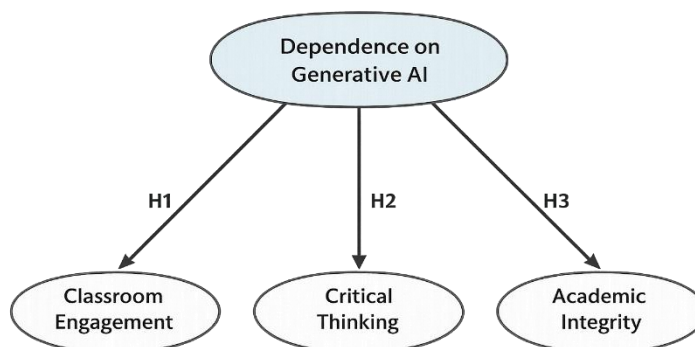


Figure 1. Conceptual Framework

## METHODOLOGY

This study used a mixed-methods approach with an embedded survey design, where the quantitative strand (Likert-scale measures) was the main component and qualitative open-ended responses were included to explain the quantitative patterns in more depth. The research focused on classroom learning contexts and examined how students use generative AI, the extent of their dependence on it, and the perceived positive and negative impacts on learning. Data were collected from 40 undergraduate students in the Chemistry Education program at Universitas Negeri Makassar, selected randomly from different semesters to represent varied academic experience. Participation was voluntary, responses could be submitted anonymously, and participants were informed that their answers would not affect course grades or academic evaluation.

Data collection was conducted through a single online questionnaire that combined structured items and open-ended questions. The instrument covered (1) patterns of generative AI use across pre-class, in-class, and post-class activities as well as course-related tasks, (2) AI dependence in the classroom-learning context, (3) perceived positive impacts (e.g., conceptual clarification, preparedness, and participation), (4) perceived negative impacts (e.g., surface learning, passivity, conceptual errors, and integrity-related risks), and (6) AI literacy and verification/ethical practices. Quantitative items were rated on a five-point scale, while open-ended prompts asked respondents to provide specific examples of when AI helped or hindered their learning, how they verified AI outputs, and what boundaries they considered appropriate in classroom-related work.

Quantitative analysis began with descriptive statistics (frequencies, means, and standard deviations) and the computation of scale scores by averaging items within each construct; internal consistency for each scale was assessed using Cronbach's alpha. Relationships among key variables were examined using Pearson correlations and multiple regression analyses to test how AI dependence and AI literacy (along with AI use intensity indicators such as frequency/duration) related to perceived positive and negative impacts on classroom learning, and differences across semester groups were explored using ANOVA when appropriate. Qualitative responses were analyzed using thematic analysis (coding and grouping into themes such as scaffolding of understanding,

time pressure and efficiency, reduced reasoning effort, misinformation/mismatch with course content, and verification practices), and the results were integrated with quantitative findings at the interpretation stage using a joint display logic to explain why certain statistical patterns occurred.

## RESEARCH RESULT

### *Patterns of Generative AI Use in Classroom Learning*

This section presents descriptive findings on how students use generative AI across different stages of classroom-related learning activities. Understanding these usage patterns provides an initial context for interpreting the extent to which AI is integrated into students' learning processes. The analysis focuses on AI use before class, during class, after class, and in course-related assignments.

Table 1 shows the mean levels of AI usage across the four learning phases. Students reported the highest use of generative AI during classroom activities and when completing course-related assignments, indicating that AI is frequently used as an immediate learning support tool. Usage before and after class was slightly lower but still present, suggesting that AI is also used for preparation and review.

**Table 1. Mean Use of Generative AI Across Learning Phases**

Learning Phase	Mean	SD
Pre-class preparation	3.07	1.05
In-class support	3.95	0.89
Post-class review	3.34	0.97
Course-related assignments	3.82	0.91

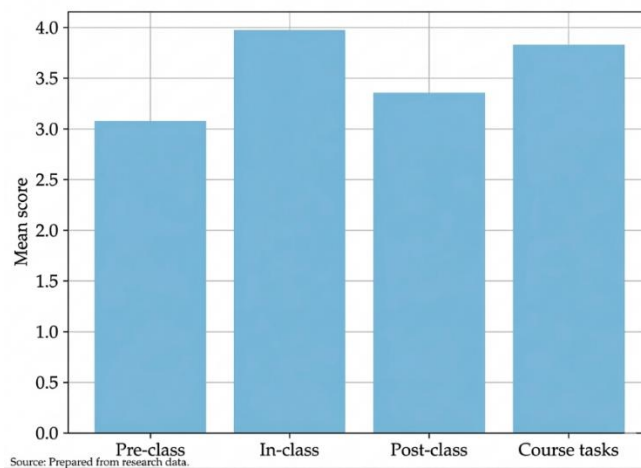


Figure 1. Mean AI use across learning phases

These results suggest that generative AI is not only used outside the classroom but also integrated directly into the learning process during class sessions. This pattern highlights the importance of examining how such use may influence students' learning experiences and outcomes, which are explored

further through the analysis of dependence and perceived impacts in the following section.

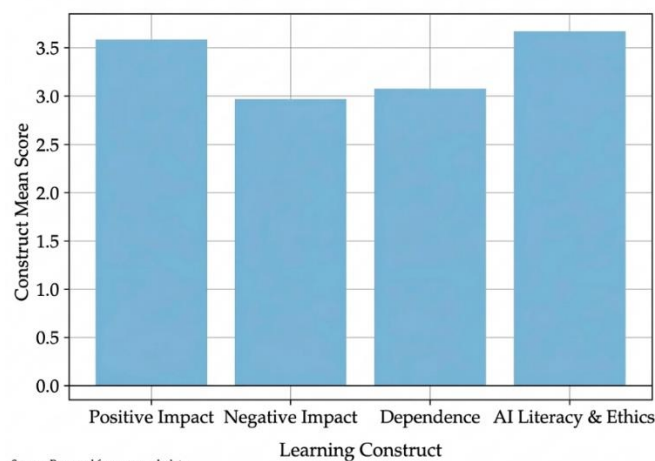
**Descriptive Statistics of Key Constructs**

After examining usage patterns, the next step was to analyze the main constructs measured in the survey: AI dependence, perceived positive impacts, perceived negative impacts, AI literacy and ethical practices, and perceived integrity risks. These constructs were calculated by averaging the Likert-scale items corresponding to each concept.

Table 2 presents the descriptive statistics for each construct. Overall, students reported a moderate level of dependence on generative AI. Perceived positive impacts were relatively high, suggesting that many students viewed AI as helpful for clarifying concepts, preparing for class, and organizing academic work. At the same time, moderate levels of negative impacts were reported, indicating that some students perceived risks such as surface learning or reduced reasoning effort.

**Table 2. Descriptive Statistics of Main Constructs**

Construct	Mean	SD	Min	Max
AI Dependence	3.07	0.70	1.71	5.00
Positive Learning Impact	3.58	0.72	1.86	5.00
Negative Learning Impact	2.97	0.75	1.33	4.83
AI Literacy & Ethical Practice	3.66	0.66	2.00	5.00
Integrity Risk	2.46	0.69	1.25	4.25



**Figure 2. Mean scores of key constructs**

These descriptive findings indicate that while students perceive substantial benefits from generative AI, concerns related to learning depth and academic integrity also exist. To better understand how these constructs relate to each other, the next section examines the statistical relationships among them.

**Relationships Between AI Dependence, Literacy, and Learning Impacts**

To investigate the relationships among the main variables, Pearson correlations and multiple regression analyses were conducted. The regression models examined how AI dependence, AI literacy and ethical practices, and AI

use intensity predicted perceived positive and negative impacts on classroom learning, as well as integrity risk.

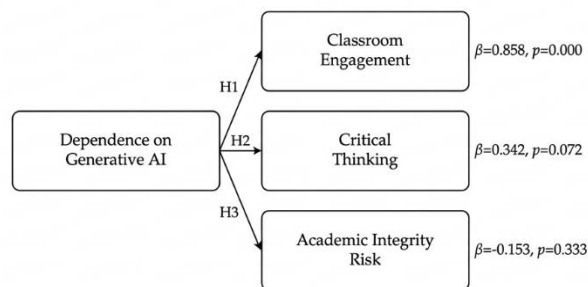
The results show that AI dependence and AI literacy significantly predicted perceived positive learning impacts. AI literacy had the strongest effect, indicating that students who reported stronger verification habits and ethical awareness were more likely to experience beneficial learning outcomes when using AI. The regression model explained approximately 73% of the variance in positive learning impact.

In contrast, the predictors did not significantly explain negative learning impacts. This suggests that negative experiences such as surface learning or conceptual errors may occur in specific contexts rather than being consistently associated with higher dependence or use intensity.

A different pattern emerged for academic integrity risk. AI literacy and ethical practices showed a strong negative relationship with integrity risk, indicating that students who were more aware of responsible AI use reported lower likelihood of misusing AI in academic tasks.

**Table 3. Multiple Regression Results Predicting Learning Impacts**

Dependent Variable	Predictor	B	p
Positive Impact	AI Dependence	0.35	0.020
	AI Literacy/Ethics	0.52	<0.001
	Use Intensity	0.32	0.074
Negative Impact	AI Dependence	0.33	0.155
	AI Literacy/Ethics	0.17	0.229
	Use Intensity	0.25	0.368
Integrity Risk	AI Dependence	0.11	0.491
	AI Literacy/Ethics	-0.72	<0.001
	Use Intensity	0.17	0.380



**Figure 3. Regression relationships between AI dependence, literacy, and learning impacts**

These findings indicate that the benefits of generative AI are closely associated with students' ability to use AI critically and ethically rather than

with the mere frequency of use. To further understand the mechanisms behind these statistical patterns, the next section presents the qualitative findings derived from students' open-ended responses.

**Qualitative Themes Explaining Quantitative Patterns**

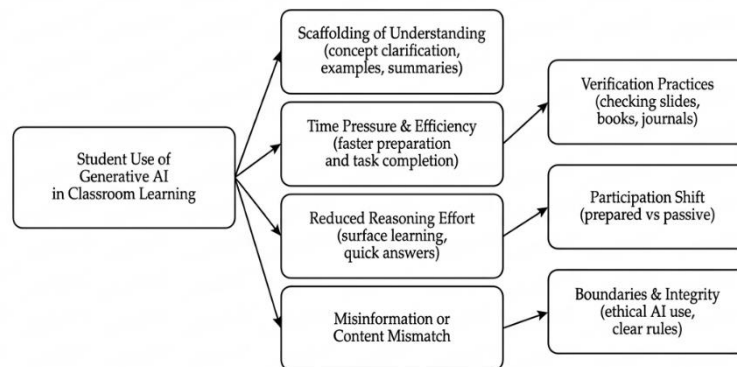
The qualitative strand of the study aimed to provide deeper explanations for the statistical relationships identified in the quantitative analysis. Thematic analysis of open-ended responses revealed several recurring themes related to how students experience generative AI in classroom learning.

The most prominent theme was scaffolding of understanding, where students described using AI to clarify complex concepts, generate examples, or summarize explanations given by lecturers. Another frequent theme was time pressure and efficiency, in which students reported using AI to cope with limited time when completing assignments or preparing for class discussions.

However, some responses highlighted potential drawbacks, including reduced reasoning effort and surface-level understanding, where students relied on quick AI-generated answers rather than engaging in deeper analytical thinking. In addition, several students reported encountering incorrect or mismatched AI outputs, particularly when AI responses did not fully align with course content. At the same time, many respondents described verification practices, such as cross-checking AI outputs with lecture slides or academic sources. Students also emphasized the importance of clear boundaries and ethical guidelines regarding acceptable AI use in coursework.

**Table 4. Main Qualitative Themes Identified in Open-Ended Responses**

Theme	Description
Scaffolding understanding	AI helps clarify concepts and provide examples
Time pressure and efficiency	AI helps manage limited time during tasks
Reduced reasoning effort	Risk of relying on quick answers instead of deeper learning
Misinformation or mismatch	AI outputs sometimes inconsistent with course material
Verification practices	Students cross-check AI outputs with other sources
Boundaries and integrity	Importance of clear rules for responsible AI use



**Figure 4. Thematic map of qualitative findings**

These qualitative insights help explain why AI dependence was associated with positive learning outcomes in the quantitative results : many students used AI as a cognitive support tool rather than a complete substitute for learning. At the same time, the themes also highlight potential risks that may emerge when AI is used without verification or clear academic guidelines.

## DISCUSSION

The present study aimed to understand how students' dependence on generative AI influences classroom learning by integrating quantitative survey findings with qualitative insights from students' experiences. The results show that generative AI has become embedded in students' learning routines, particularly during classroom activities and when completing course-related tasks. As shown in Table 1 and Figure 1, AI was most frequently used during class and for coursework, suggesting that AI tools are increasingly integrated into real-time learning processes rather than being used only outside class. This pattern reflects a broader shift in how students access explanations and process academic information, where AI functions as an immediate cognitive support system within the learning environment. Similar patterns have been observed in recent studies on AI-enhanced classrooms, which report that students increasingly use generative AI tools as on-demand learning assistants that support problem solving, idea generation, and knowledge exploration (Saúde et al., 2024; Qadir, 2025).

The descriptive results further indicate that students reported moderate levels of AI dependence alongside relatively high perceived positive learning impacts (Table 2). These findings suggest that students generally perceive generative AI as beneficial for improving their understanding of lecture material and organizing academic work. In many cases, students reported using AI to clarify concepts explained by lecturers or to obtain additional examples and explanations. One respondent described this experience by stating that *"AI helps explain concepts in simpler language when the lecture explanation feels too complex."* Such responses illustrate how generative AI can function as a learning scaffold that supports students in processing complex information during classroom learning. This interpretation aligns with previous studies indicating that generative AI can act as a cognitive support tool that helps students break down complex academic concepts and engage more effectively with learning materials (dos Santos, 2023; Jere & Mpeteta, 2025).

The regression analysis provides further insight into these patterns. As shown in Table 3 and Figure 3, AI dependence was positively associated with perceived positive learning impacts. Students who relied more frequently on AI were also more likely to report benefits such as improved preparation for class discussions and better organization of assignments. However, the most influential factor was AI literacy and ethical practice, which emerged as the strongest predictor of positive learning outcomes. This finding suggests that the benefits of AI use are not merely determined by how often students use AI but

rather by how critically they engage with AI-generated information. Previous research similarly emphasizes that AI technologies are most beneficial when learners actively interpret and evaluate AI outputs rather than passively accepting them (Wood & Moss, 2024; Noblecilla Olaya & Chéquer Bajaña, 2025).

Qualitative responses further reinforce this interpretation. Many students reported actively verifying AI outputs by comparing them with lecture slides or other academic sources. For example, one participant explained that *"I usually check the answer from AI with lecture slides or textbooks to make sure it matches the course material."* These responses correspond with the theme of verification practices illustrated in Figure 5, highlighting that students who treat AI as a tool for exploration rather than a final source of answers are more likely to experience meaningful learning benefits. This finding supports emerging perspectives in AI-in-education research that emphasize the importance of critical engagement with AI-generated content and the development of AI literacy as an essential academic skill (Deng et al., 2023; Blonder & Feldman-Maggor, 2024).

Interestingly, the statistical models did not show a strong relationship between AI dependence and perceived negative learning impacts (Table 3). This suggests that negative experiences associated with AI use, such as surface learning or reduced reasoning effort, may not occur consistently across all students. Instead, the qualitative findings indicate that such risks often appear in specific contexts, particularly when students face time pressure or rely on AI-generated responses without further reflection. One respondent noted that *"sometimes when the deadline is close, I just take the AI answer quickly without thinking too much about the reasoning."* Similar concerns have been reported in previous studies, which highlight the potential tension between AI reliance and the development of independent critical thinking skills (He et al., 2025; Stone, 2024).

Another important finding relates to academic integrity and ethical awareness. The results show that AI literacy and ethical practices were strongly associated with lower integrity risk, indicating that students who understand appropriate boundaries for AI use are less likely to misuse AI in academic tasks. This relationship is also reflected in the qualitative responses, where several participants emphasized the importance of clear guidelines for AI use in coursework. For example, one student suggested that *"lecturers should clearly explain when AI can be used and when it should not be used in assignments."* Such responses indicate that students themselves recognize the importance of ethical frameworks for AI-assisted learning. These findings are consistent with research emphasizing the need for responsible AI integration and clear institutional policies regarding AI use in higher education (Hamerman et al., 2024; Deng et al., 2023).

Taken together, these findings suggest that generative AI in classroom learning should not simply be framed as either beneficial or harmful. Instead, the educational impact of AI appears to depend on the interaction between students' learning strategies, AI literacy, and classroom expectations. As illustrated in Figure 5, generative AI may support learning through mechanisms such as scaffolding understanding and improving efficiency, while also presenting potential risks such as reduced reasoning effort or conceptual mismatches. However, verification practices and ethical awareness can mitigate these risks

and transform AI into a productive learning tool. Similar conclusions have been drawn in studies exploring AI-enhanced learning environments, which emphasize that effective AI integration requires pedagogical guidance and critical digital literacy (Erümit & Sarıalioğlu, 2025; El Bahri et al., 2025).

Overall, this study contributes to the growing body of research on generative AI in education by highlighting that AI literacy and verification practices play a central role in determining whether AI dependence leads to meaningful learning outcomes or superficial engagement. The integration of quantitative and qualitative findings demonstrates that students are not simply passive users of AI technologies but actively negotiate how these tools fit within their learning processes. These insights extend previous research on AI-supported learning by emphasizing the importance of responsible AI practices and reflective learning strategies in AI-enhanced classrooms (Guo et al., 2025; Irshad et al., 2025).

## **CONCLUSIONS AND RECOMMENDATIONS**

This study examined students' dependence on generative AI and its impact on classroom learning using a mixed-methods embedded survey design. The findings indicate that generative AI has become integrated into students' learning practices, particularly during classroom activities and when completing course-related tasks. While students reported moderate levels of dependence on AI, they also perceived meaningful learning benefits, especially in terms of conceptual clarification, preparation for class discussions, and organizing academic work. The results further demonstrate that AI literacy and ethical practices play a critical role in shaping these outcomes. Students who actively verify AI-generated information and understand appropriate boundaries for AI use tend to experience greater learning benefits and lower integrity risks. These findings suggest that the educational impact of generative AI depends less on the frequency of its use and more on how critically and responsibly students engage with the technology.

Based on these findings, higher education institutions should focus on developing students' AI literacy and responsible AI practices as part of contemporary academic competencies. Educators are encouraged to provide clear guidelines regarding acceptable AI use in coursework and to design learning activities that require students to critically evaluate and verify AI-generated information. By integrating AI literacy training, transparent academic policies, and reflective learning tasks, universities can better harness the potential of generative AI to support meaningful classroom learning while minimizing risks related to superficial learning and academic integrity.

## **ADVANCED RESEARCH**

This study has several limitations that should be considered when interpreting its findings. First, the research involved a relatively small sample of 40 undergraduate students from a single study program (Chemistry Education) at Universitas Negeri Makassar, which may limit the generalizability of the

results to other disciplines or institutional contexts. Second, the study relied primarily on self-reported perceptions of AI use and its learning impacts, which may not fully reflect students' actual learning behaviors or objective academic performance. In addition, the study focused mainly on students' perspectives, while the broader integration of generative AI in education also depends on instructional design, assessment practices, and institutional policies implemented by educators and universities. Future research could therefore involve larger and more diverse samples across different academic fields, combine survey data with classroom observations or experimental designs to examine the direct effects of AI use on learning outcomes, and explore instructors' perspectives on how generative AI can be integrated into teaching strategies. Longitudinal studies would also be valuable for understanding how students' AI literacy, dependence, and learning strategies evolve as generative AI technologies continue to develop and become more embedded in higher education environments.

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