Creative AI in education: The role of technological dependence, motivation, and student participation

La IA creativa en la educación: El papel de la dependencia tecnológica, la motivación y la participación estudiantil

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Abstract

The rapid advancement of Artificial Intelligence (AI) offers a transformative opportunity for education, yet its full potential in learning environments remains largely unexplored, particularly regarding its impact on student engagement and personalized learning. This study examines the role of AI in education, focusing on its contribution to the learning process and its impact on student motivation. A cross-sectional survey was conducted with 1,294 Indonesian students (51.16% female, 48.84% male) selected through random sampling. Data was gathered using an online questionnaire that assessed AI usage, perceived effectiveness, motivation, and participation before and after AI implementation. The findings indicate that students viewed AI as a valuable tool for academic tasks, particularly for summarizing content and writing essays. Most notably, motivation increased significantly after AI usage, with mean scores rising from 2.9 to 4.1, suggesting a strong correlation between AI use and active participation ($r = .69$). These results suggest that AI technologies effectively enhance student motivation and engagement, fostering a more interactive learning experience. These findings imply that integrating AI into education should be guided by clear pedagogical strategies to enhance motivation and participation while supporting creativity and critical thinking.

Keywords: artificial intelligence; AI; adaptive learning; educational technology; motivation; student engagement.

Resumen

El rápido avance de la Inteligencia Artificial (IA) ofrece una oportunidad transformadora para la educación, aunque su pleno potencial en los entornos de aprendizaje sigue siendo en gran medida inexplorado, particularmente en lo que respecta a su impacto en la participación estudiantil y el aprendizaje personalizado. Este estudio examina el papel de la IA en la educación, centrándose en su contribución al proceso de aprendizaje y su impacto en la motivación del alumnado. Se encuestó a 1294 estudiantes indonesios (51.16 % mujeres) seleccionados mediante muestreo aleatorio. Los datos se recopilaron mediante un cuestionario en línea que evaluaba el uso de la IA, su efectividad percibida, la motivación y la participación antes y después de la implementación de la IA. Los hallazgos indican que los y las estudiantes perciben la IA como una herramienta valiosa para las tareas académicas, especialmente para resumir contenidos y redactar ensayos. De manera más notable, la motivación aumentó significativamente tras el uso de la IA, con un incremento de las puntuaciones medias de 2.9 a 4.1, lo que sugiere una fuerte correlación entre el uso de la IA y la participación activa ($r = .69$). Estos resultados sugieren que las tecnologías de IA mejoran eficazmente la motivación y el compromiso del estudiantado, fomentando una experiencia de aprendizaje más interactiva. Los hallazgos implican que la integración de la IA en la educación debería estar guiada por estrategias pedagógicas claras para potenciar la motivación y la participación, al tiempo que se apoye la creatividad y el pensamiento crítico.

Palabras clave: inteligencia artificial; IA; aprendizaje adaptativo; tecnología educativa; motivación; compromiso estudiantil.

Introduction

One of the most promising technological advancements is artificial intelligence (AI). AI has emerged as a powerful force with the revolutionary potential to transform the learning paradigm (Xu et al., 2021). AI can be used to develop adaptive learning systems that are capable of tailoring educational content to meet the needs and learning styles of each student (Gligorea et al., 2023). AI-supported adaptive learning allows the educational system to adjust the material according to the individual needs of the learner (Schumann et al., 2024). Through the analysis of learning data, AI can identify students' strengths and weaknesses (Alaqlobi et al., 2024), allowing the provision of appropriate learning recommendations and personalised feedback (Afzaal et al., 2024).

Research on AI in education has gained significant attention in the past decade. A meta-analysis by Zhai et al. (2021) highlighted the rapid growth of AI, underscoring the urgent need to understand how educators can effectively leverage AI techniques to support students' academic success. This body of research explores various AI-related topics and methodologies, including the Internet of Things, swarm intelligence, deep learning, and neuroscience, as well as assessing the impact of AI on education. However, it is crucial to consider factors such as the age and readiness of learners when designing AI-driven learning environments or fostering collaboration between students and AI systems (Brusilovsky, 2024). Furthermore, the increasing accessibility of generative AI tools has significantly influenced education, transforming school systems in various ways (Chiu, 2024). AI has the capacity to process large-scale data quickly and perform in-depth analysis, providing the opportunity to make accurate data-driven decisions (Ali et al., 2023). Today, AI can also support teachers' instruction (Dieker et al., 2024), enabling them to focus on creative aspects and develop students' unique characteristics (Fang et al., 2024), while administrative tasks can be automated (Sørensen et al., 2023). This creates an environment where teachers can interact more closely with students, build stronger relationships, and provide more intensive guidance.

Although the implementation of AI in education is progressing rapidly, it still faces significant challenges (Rodway & Schepman, 2023). A lack of in-depth understanding of the full potential of AI (Volkmar et al., 2022), coupled with insufficient participation in it integration into curricula (Allil, 2024), can hinder progress. Furthermore, infrastructure gaps and limited technological resources in some educational institutions can reduce the effectiveness of AI implementation (Owoc et al., 2019).

An often overlooked aspect in developing AI-based educational solutions is the recognition that each individual has a unique learning style (Bajaj & Sharma, 2018).

Therefore, this study focusses on optimising AI to provide personalised responses and support to the individual needs of students. Creating an adaptive and motivating learning environment is the key to improving participation and learning outcomes. The aims of this study was to investigate how students use AI in the learning process and to examine its influence on their motivation and participation. By outlining how this technology can be optimised to improve the effectiveness and efficiency of teaching and learning, this research hopes to offer practical insights to policymakers, educational institutions, and practitioners in the field. Hence, we formulate the research questions.

1. How is AI being used by students in the learning process?
2. To what extent does the use of AI influence students' motivation in learning activities?

Theoretical framework

Personalized learning

The core concept of personalized learning theory is that each individual learns in a unique way (Shemshack et al., 2021). In recent years, personalized learning has gained recognition as an effective instructional approach for accommodating the diverse needs of students (Pane et al., 2015). This educational approach emphasises student individuality, designing learning experiences that align with each learner's needs, interests, and pace (Bernacki et al., 2021; DeMink-Carthew et al., 2020). Central to this theory is the teacher's understanding of students' individual characteristics, including learning styles (Romanelli et al., 2009), comprehension levels (Oakhill et al., 2005), and personal preferences (Fatouros, 1995), in order to tailor appropriate learning experiences. Moreover, personalised learning encourages the provision of choice and flexibility throughout the teaching and learning process, supporting students in engaging with content in ways that best suit their abilities and motivations (Mills, 2003; Wanner & Palmer, 2015).

AI in education

AI is a broad field focused on automated decision making without requiring human intervention (Tapalova & Zhiyenbayeva, 2022). AI has revolutionised the education sector by improving personalised learning, automating administrative tasks, and improving student engagement (Shoaib et al., 2024). AI-powered adaptive learning systems analyse student data to customise educational content based on individual learning styles, strengths, and weaknesses, thus promoting a more effective learning experience (Zawacki-Richter et al., 2019). These systems use machine learning algorithms to identify patterns in student performance and provide real-time feedback, allowing educators to intervene when

necessary. Additionally, AI-driven chatbots and virtual tutors offer on-demand support, helping students reinforce their understanding outside the classroom (Sajja et al., 2024). AI in education can create more inclusive and accessible learning for diverse students.

Despite its advantages, AI in education also presents challenges related to data privacy, ethical considerations, and the digital divide (Eden et al., 2024). Adopting human-machine collaboration theory emphasises the importance of cooperation between teachers and artificial intelligence (Clegg & Sarker, 2024). Human-machine collaboration theory is an approach that considers how humans and machine processors can work together synergistically to achieve more optimal outcomes than they could independently (Ben-Assuli et al., 2023). This theory is relevant in today's era of technological advancement, where artificial processors, automation, and robotics are increasingly influential. Its core principles, educational applications, challenges, and impacts across sectors remain crucial areas of discussion.

Constructivism and motivation in learning

Constructivism is a learning theory that emphasises the active role of learners in building their own understanding and knowledge through experience and interaction with their environment (Bada, 2015). According to this perspective, learning is not a passive process of receiving information, but an active process in which students build their knowledge based on prior experiences and social interactions and encompasses cognitive, social, moral, and other areas of development (Waite-Stupiansky, 2022). Vygotsky's concept Zone of Proximal Development (ZPD) highlights the importance of scaffolding, where learners receive guidance from teachers or peers to bridge the gap between their current knowledge and their potential understanding (Vygotsky, 1978). In a constructivist learning environment, students engage in problem solving, critical thinking, and collaborative activities that foster deeper comprehension and long-term knowledge retention (Jonassen & Rohrer-Murphy, 1999).

Motivation plays a crucial role in constructivist learning, as it drives students to engage in meaningful learning experiences and persist in the face of challenges (Deci & Ryan, 2012). Self-determination theory (SDT) suggests that intrinsic motivation, driven by autonomy, competence, and relatedness, is essential for effective learning (Deci & Ryan, 2012). When learners perceive that they have control over their learning process and can relate new information to their existing knowledge, they are more likely to remain motivated and engaged (Schunk, 2008). Constructivist approaches that incorporate student-centred learning, project-based tasks, and real-world applications enhance motivation by making learning more relevant and personally meaningful (Bruner, 1974). Constructivist learning fosters autonomy and collaboration, boosting intrinsic motivation and lifelong learning.

Method

Participants

The study was approved by the Institutional Review Board of XXX, ensuring compliance with institutional ethical standards. A total of 1,294 students (51.16% female and 48.84% male) were selected in Indonesia using a random sampling technique from March to July 2024. The participants had a mean age of 14.56 years (*SD* = 3.59). This cross-sectional study included only students who provided informed consent prior to participation. Table 1 presents the detailed demographic characteristics of the sample.

Table 1

Demographic characteristic   of the sample

Gender *n* (%)		Level of school *n* (%)			Place *n* (%)	
Male	Female	Primary education	Secondary education	Higher education	City	Suburb
632 (48.84)	662 (51.16)	258 (19.94)	647 (50.00)	389 (30.06)	681 (52.63)	613 (47.37)

Instruments

The instruments comprised two components: AI usage and motivation to use AI. The students completed the online survey. On average, the survey took approximately 10-20 minutes to complete, including time to provide instructions and clarifying questions.

The use of AI in the learning process

This instruments was to measuring students' frequency of AI usage and perceptions of AI's effectiveness in assisting them with academic tasks. These instrument was adapted from C. Chai et al. (2024) and modified by authors. Comprising five items, respondents rate their anxiety using a 4-point Likert scale, varying from 1 (indicating never) to 4 (representing very often). The initial items exhibited strong reliability, boasting a Cronbach's alpha of .91. Open-ended questions are 3 to capture additional insights from respondents develop by authors based on theoretical framework as we mentioned earlier. The survey covered topics such as the types of AI tools they used, the tasks they completed with AI, and their main reasons for using AI.

Motivation use of AI

The motivation to use AI in the learning process questionnaire was adopted from Yurt & Kasarci (2024) and consisted of four items. Examples of these items include: "The ability to effectively use AI is important to me", "Learning and implementing innovations in artificial AI

are a priority for me", "It is important for me to stay updated on developments related to AI", and "I attach great importance to strengthening my skills in using artificial AI." The original items were validated, with a Cronbach's alpha of .92, composite reliability (CR) of .92, and an average variance extracted (AVE) of .75. Motivation was measured using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Meanwhile, participation refers to students' active engagement in classroom activities, measured by the frequency of their contributions.

Data analysis

This study began with an initial data analysis using descriptive statistics, including the mean (*M*) and standard deviation (*SD*), along with correlation assessments between variables, conducted using SPSS version 29. To examine changes in students' motivation before and after using AI, paired-samples t-tests were subsequently performed across educational levels. Effect sizes were also calculated to assess the magnitude of these changes. Additionally, R software was utilized to generate visual representations of the descriptive variables, illustrating students' response patterns and highlighting trends in motivation and participation.

Results

The use of AI in the learning process

As illustrated in Table 2, participants generally used AI technologies during their learning processes, with mean scores ranging from 1.33 to 2.71. In particular, students expressed the greatest confidence in the utility of AI for academic tasks, as indicated by the statement 'In your opinion, how helpful is AI in completing assignments?' which received the highest mean score of 2.71 (*SD* = 1.03). On the contrary, the statement 'Have you ever received a warning or penalty from a teacher / trainer for using AI in your assignments?' secured the lowest mean score of 1.33 (*SD* = .64). This suggests that while students generally appreciate the benefits of AI in enhancing their learning experiences, they may lack awareness regarding the potential risks associated with its use, such as academic dishonesty or overreliance on technology.

Additionally, we also collected students' responses to the open-ended question: 'What type of AI do you use most often?".

Figure 1 presented the types of AI commonly used by participants, along with their corresponding percentages.

Table 2

The use of AI in the learning process

Statement	M	SD
Do you know what AI is?	2.45	.89
How often do you use AI to learn or complete assignments?	2.09	.80
Statement	M	SD
In your opinion, how helpful is AI in completing assignments?	2.71	1.03
Have you ever received a warning or penalty from a teacher/lecturer for using AI in your assignments?	1.33	.64
What proportion of your assignments are completed using AI?	2.23	.95

The highest percentage was for ChatGPT, with 33% of the respondents indicating its use, reflecting students' strong reliance on AI tools that support writing and communication tasks. In contrast, the lowest percentage was for Gemini, with only 1% of participants reporting its use, suggesting limited awareness or low perceived relevance for academic purposes. Canva accounted for 8%, indicating students' preference for visual design tools that enhance presentation quality, while SlideGo, at 6%, pointed to its utility in creating structured academic presentations. Ok Google had 15%, reflecting its role as a quick information-seeking and problem-solving tool, whereas Grammarly, at 7%, highlighted its perceived usefulness for improving language accuracy in academic writing. This distribution reflected the varying functionalities and user familiarity with different AI tools in the learning process.

Figure 1

Types of AI used by participa ts
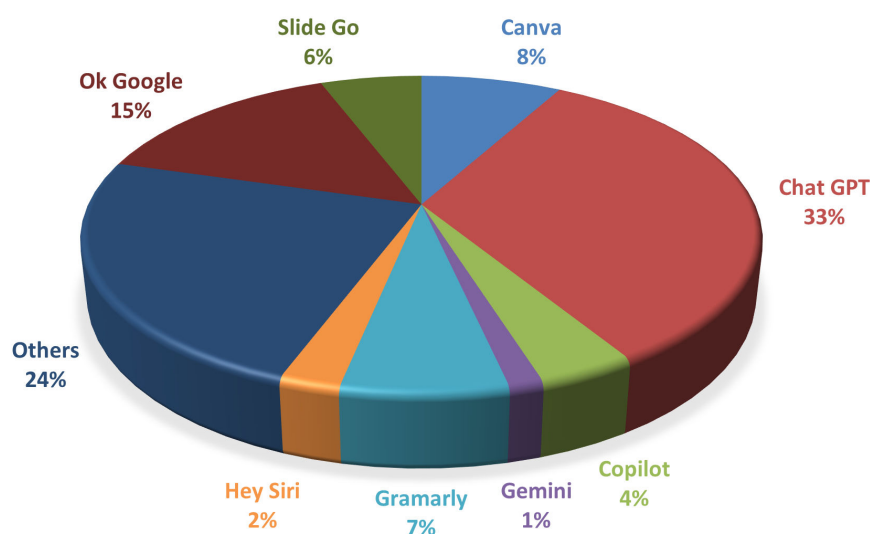
Furthermore, the results for the question *"What types of tasks do you ofte complete using AI?"* indicated the tasks that students most commonly performed, along with the corresponding percentages of respondents. The most frequently reported task was summarizing articles or journal assignments, with 55.10% of participants indicating that they used AI for this purpose. This was closely followed by essay or paper writing at 50.31% and research and information gathering at 49.46%. Text translation and presentation creation were also notable tasks, reported by 30.37% and 30.06% of students, respectively. In contrast, mathematics or statistics assignments were completed less frequently using AI, as indicated by 24.11%, and other tasks accounted for only 3.10% of responses.

Furthermore, the questions 'What is the main reason for using AI to help with school or college assignments?

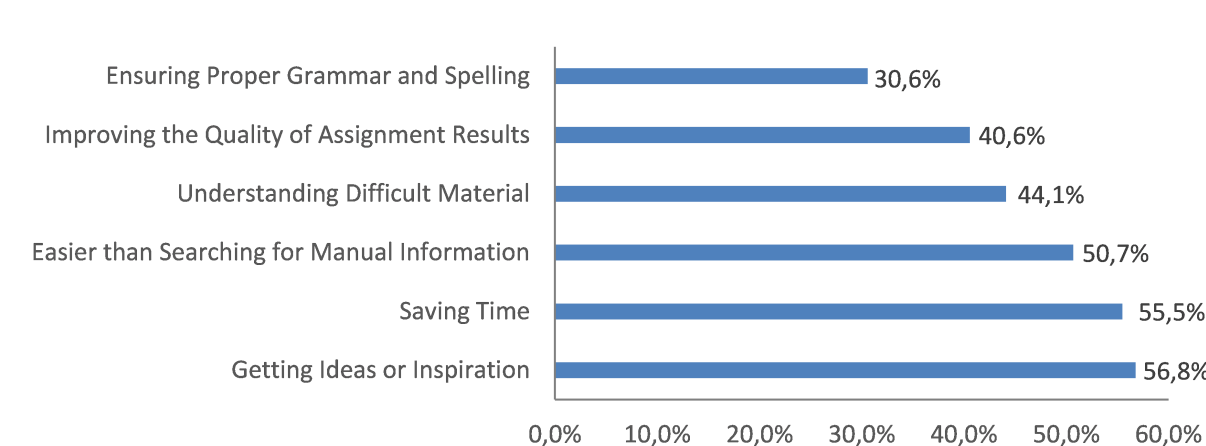**Figure 2**

Main reasons for using AI

Figure 2 shows the main reasons students use AI to help with their school or college assignments, along with the corresponding frequencies and percentages. The most commonly cited reason is "Getting Ideas or Inspiration," with 735 responses (56.80%). In contrast, the least cited reason is "Ensuring Proper Grammar and Spelling," with 396 responses (30.60%). This indicates that while students rely heavily on AI for creative support, they are less concerned with its role in grammar and spelling assistance.

Motivation in the learning process

To determine whether AI influences the learning process and whether its use reflects dependency or optimisation, a quantitative analysis was conducted based on the feedback of the respondents. Dependency was examined by assessing the frequency and types of tasks

students relied on AI for, distinguishing between productive use that supported learning and overreliance that indicated potential dependency.

The mean scores indicate an increase in motivation after using AI (*M* = 4.10, *SD* = .70) compared to before using AI (*M* = 2.90, *SD* = .80). Furthermore, active participation shows a relatively high mean score (*M* = 3.80, *SD* = 0.60). In terms of data normality, Kline (2015) suggested that skewness values should not exceed |3|, and kurtosis should remain below |10|. For this study, the skewness values ranged between -.54 and -.16, while kurtosis was observed between -.33 and .92. Levene's test for homogeneity of variances was not significant for higher education, *F*(2, 386) = .39, *p* = .674, primary school, *F*(2, 255) = 2.29, *p* = .104, and secondary school, *F*(2, 644) = 1.86, *p* = .156, indicating that the assumption of homogeneity of variances was met.

Additionally, the correlation analysis reveals a positive relationship between motivation before and after using AI (*r* = .21) and a stronger correlation between motivation after using AI and active participation (*r* = .69), suggesting that the use of AI may contribute to greater participation in learning activities. To strengthen the conclusions drawn from the descriptive analysis, a difference test was conducted to compare the motivation of the students before and after using AI in learning process. In more detail, the descriptive statistics for motivation and active participation are illustrated in Figure 3.

Figure 3

Pirate plot of students motivati   of using AI
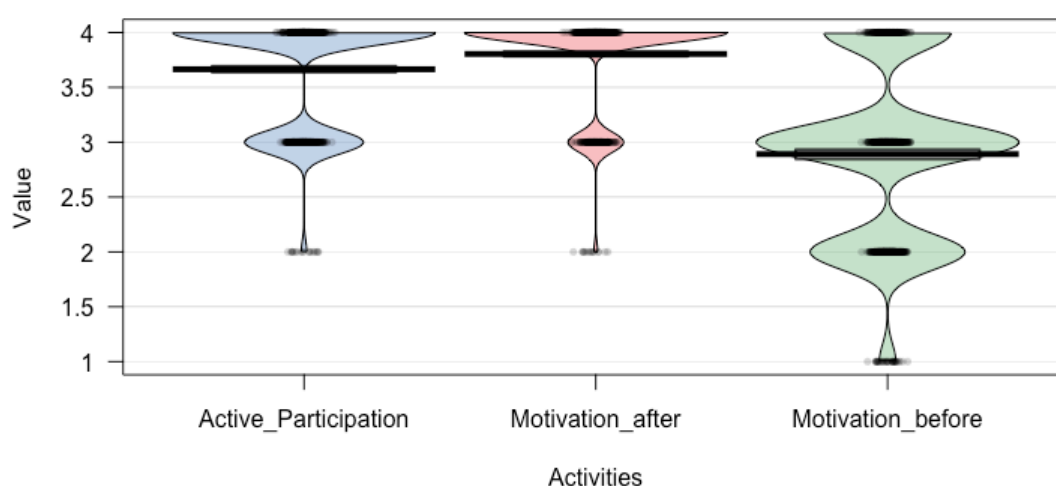
The paired-sample *t*-tests in Table 3 indicated that motivation scores increased significantly following the use of AI across all educational levels. For example, in higher

education, motivation rose from *M* = 2.86 (*SD* = .78) before AI use to *M* = 3.82 (*SD* = .43) after, with a large effect size (Cohen's d = .91). Similar significant increases were observed in secondary and primary education, suggesting a substantial improvement in motivation following AI use.

Table 3

Motivati   Scores Before And Afte Using AI Across Educationa Levels

School	Motivation Before	Motivation After	*t*	*df*	*p*	Cohen's *d*
	M (*SD*)	*M* (*SD*)				
Higher Education	2.86 (.78)	3.82 (.43)	-20.91	388	< .001	.91
Secondary Education	2.93 (.77)	3.79 (.43)	-24.78	646	< .001	.93
Primary Education	2.84 (.79)	3.82 (.41)	-16.91	257	< .001	.88

Discussion

The findings indicate that AI has become an integral part of student academic activities, with a notable emphasis on its perceived usefulness in completing assignments. The relatively high mean score for AI's help suggests that students recognise its potential to enhance efficiency and improve academic performance (Escalante et al., 2023). These findings align with previous research highlighting the growing reliance on AI in education and its perceived advantages in streamlining learning processes (Doğan et al., 2025; Mutambik, 2024; Pedro et al., 2019). Studies have shown that AI tools can improve student engagement and productivity (Bijja Vishwanath, 2025; Kuzminska et al., 2024), yet there remains a need for greater awareness of ethical considerations and responsible usage. This showed the importance of developing clear guidelines and instructional strategies to ensure that AI is used as a complementary tool rather than a substitute for critical thinking and independent learning.

Our results show that among the AI tools surveyed, ChatGPT had the highest usage and recognition among students, while tools such as Gemini were rarely used or known. This pattern supports the claim that students prefer applications offering immediate, practical benefits—such as writing assistance and content creation—aligning with prior research (Khalifa & Albadawy, 2024; Su & Cheng, 2015; Zhou, 2023) and highlighting the growing importance of effective communication tools for academic success. Additionally, the results indicate that Canva was among the most frequently used AI tools by students, alongside ChatGPT. While the study did not specifically measure the reasons for this preference, the high usage suggests that students are more inclined to adopt tools they find accessible or

helpful for completing tasks. This finding highlights the potential value of providing guidance and training on various AI tools to support a more effective learning environment (Chan, 2023; Widiarti, 2024).

The results on the types of tasks that students frequently complete using AI reveal clear trends in their academic preferences and needs. The predominant use of AI for summarizing articles or journal assignments indicates that students are seeking efficient ways to digest complex information, suggesting an emphasis on comprehension and retention in their learning processes (Aluko et al., 2025). This aligns with previous research highlighting the increasing reliance on AI to improve understanding and reduce cognitive load in academic tasks (Gerlich, 2025; Uppal & Hajian, 2024). The high usage rates for essay writing and research further underscore the pivotal role that AI plays in helping students produce well-informed and structured work. Tasks such as text translation and presentation creation are also commonly performed using AI, whereas its reported use for mathematics or statistics assignments is comparatively lower. Although the study did not differentiate between specific fields of study, this pattern may suggest that students perceive certain subjects as requiring more traditional learning methods or additional guidance (Debs et al., 2019), or that they encounter challenges in effectively applying AI tools in quantitative contexts (Zawacki-Richter et al., 2019). Further research is needed to explore how subject-specific differences influence AI adoption and usage in academic tasks.

In addition to the types of tasks, the reasons for using AI reveal deeper insights into student motivations. The overwhelming preference for AI as a source of inspiration suggests a shift toward using technology as a creative aid rather than merely a tool for technical assistance (Anantrasirichai & Bull, 2022). This observation aligns with existing literature emphasizing the importance of creativity in education (Boussioux et al., 2024; Suherman & Vidákovich, 2024; Wingström et al., 2024), as students increasingly turn to AI for idea generation and enhancing their academic expression. These findings indicate that students value AI not only for efficiency but also for supporting creativity in their learning processes. However, this interpretation is based on self-reported data and broad patterns; further research is needed to confirm these trends, particularly across different subjects and contexts, which is addressed in the limitations and directions for future research.

In terms of the main reasons for using AI to support school or college assignments, the most commonly cited reason is "getting ideas or inspiration," which may reflect students' increasing reliance on technology to enhance creativity and generate new perspectives in their work (Habib et al., 2025). In contrast, the least cited reason is "ensuring proper grammar and spelling," suggesting that students perceive technical corrections as less critical or readily manageable through other means (F. Chai et al., 2024). This pattern indicates that while students heavily rely on AI for creative and cognitive support, they are comparatively

less concerned with its role in basic technical assistance. By utilising tools such as creativity interactive AI visualisations, AI further supports the comprehension of complex materials, simplifies difficult concepts, and strengthens students' overall learning processes (Davar et al., 2025). This can foster greater motivation and participation in the learning process (Farida et al., 2023; Supriadi et al., 2024).

This study demonstrates that the integration of AI in education significantly increases student motivation. Before AI implementation, student motivation tended to be low, but improved after AI was incorporated into the learning process. AI facilitates more interactive and personalised learning experiences, incorporating gamification elements that foster intrinsic motivation (Liu, 2025).

This study demonstrates that the integration of AI in education significantly increases student motivation. Before AI implementation, student motivation tended to be low, but improved after AI was incorporated into the learning process. This improvement suggests that AI tools can offer tailored support, enhance engagement, and make learning experiences more interactive and relevant to students' interests. Such findings align with previous research highlighting the potential of AI to foster motivation and active participation in educational settings (Yuan & Liu, 2025). Additionally, AI allows students to engage in self-directed learning, regulate their own learning pace, and develop a sense of responsibility for their educational progress. Students reported increased active participation, indicating that they engaged more in interactive tasks aligned with their interests, promoting full participation in the learning process, and influence of motivation on the process and results activities (Monteiro et al., 2025). Therefore, motivation to learn supports better academic performance and knowledge acquisition (dos Santos et al., 2022).

This research has several limitations that should be acknowledged. The study relied on self-reported data collected through an online questionnaire, which may be influenced by participants' subjective biases and does not necessarily reflect actual behaviors in the learning process. Additionally, the open-ended research instrument was not formally validated within this sample, which may limit the reliability and generalizability of the results. The absence of a control group prevents causal conclusions between AI use, motivation, and participation, so the observed associations should be interpreted with caution. Contextual factors specific to the educational and cultural setting in Indonesia, such as variations in digital literacy, access to AI tools, and institutional support, may have influenced students' responses and the patterns observed. For future research, longitudinal designs are recommended to examine changes in motivation and participation over time, along with validated instruments and control or comparison groups to better assess AI's effects. Studies in diverse educational and cultural contexts, as well as mixed-methods

approaches, could provide deeper insights into how AI interacts with student motivation, engagement, and learning outcomes.

Conclusions

The findings of this study indicate a significant integration of AI technologies into the learning process, reflecting both the utility and potential challenges associated with their use. Participants generally recognised the benefits of AI in improving academic tasks, particularly in summarising articles, writing essays, and conducting research. The results suggest that students are primarily motivated to use AI tools for creative support, such as generating ideas, rather than for technical assistance, such as grammar checks. Variability in the usage of AI tools, with a preference for applications that enhance writing and visual presentations, suggests that students tend to prioritise tools that align with their immediate academic needs. This pattern underscores the potential value of providing guidance and training on the broader range of AI functionalities available for learning, helping students utilise AI more effectively and responsibly in diverse academic contexts.

Furthermore, the analysis of motivation and participation reveals that AI not only boosts student motivation but also positively correlates with their active participation in learning activities. The data show a marked increase in motivation after the use of AI, indicating its effectiveness in promoting a more interactive and engaging educational environment. These results highlight the importance of integrating AI technologies into curricula to enhance student participation and motivation. The implications of the study suggest that educators should focus on developing strategies that use AI tools to promote creativity and active learning while addressing the potential downsides of the use of technology in education. This research also contributes to the growing body of evidence supporting the incorporation of AI in educational settings, advocating for a balanced approach that maximises benefits while mitigating risks.

Limitation and future research

Although this study provides valuable information on the use of AI in the learning process, it also has several limitations that should be acknowledged. First, the study relies on self-reported data, which may be subject to biases such as social desirability and recall bias, potentially affecting the accuracy of the responses. Additionally, the research was conducted within a specific cultural and educational context in Indonesia, which may limit the generalisability of the findings to other regions or educational systems. Furthermore, the cross-sectional design does not allow causal inferences to be drawn about the relationship between AI use and changes in motivation and participation, highlighting the need for

longitudinal studies to better understand these dynamics over time. Future research should aim to address these limitations by employing mixed methods that combine quantitative surveys with qualitative interviews to gain deeper insights into students' experiences with AI. Expanding the participant pool to include various educational institutions and cultural backgrounds would enhance the generalisability of the findings. Additionally, longitudinal studies could explore the long-term effects of AI usage on learning outcomes, motivation, and participation, providing a more complete understanding of how AI tools can be optimally integrated into educational practices. Finally, further investigation into the potential risks associated with AI use, such as academic dishonesty and over-reliance on technology, would be crucial to developing guidelines and best practices for educators and students alike.

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