



Artificial intelligence as a learning assistant: A student-centered learning study

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ABSTRACT

This study examines the role of Artificial Intelligence (AI) as a learning assistant in promoting student-centered learning within educational settings. Using a mixed-method approach, the research investigates how AI-based tools support personalized learning, enhance student engagement, and foster autonomy in the learning process. Quantitative data were collected through structured surveys and learning performance measures to evaluate students' perceptions, usage patterns, and learning outcomes, whereas qualitative data derived from interviews and open-ended responses provided deeper insights into students' experiences and challenges when interacting with AI learning assistants. The findings indicate that AI learning assistants positively contribute to individualized learning support, timely feedback, and active learner participation, although issues related to overreliance, ethical concerns, and digital readiness remain. The study highlights the potential of AI as an effective facilitator of student-centered learning when thoughtfully integrated into instructional design and pedagogical practices.

Keywords: artificial intelligence, learning assistant, student-centered learning, educational technology, higher education

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INTRODUCTION

Artificial Intelligence (AI) has increasingly become integrated into educational environments, reshaping how teaching and learning are designed and delivered. In student-centered learning contexts, AI-powered learning assistants, such as chatbots, intelligent tutoring systems, and adaptive platforms, offer personalized feedback, flexible pacing, and real-time academic support tailored to individual learner needs (Holstein et al., 2019; Labadze et al., 2023; Sitinjak et al., 2025; Wang et al., 2024). These technologies align with constructivist and learner-centered pedagogies by empowering students to take greater control of their learning processes, thereby enhancing engagement, motivation, and learning autonomy (Li et al., 2020; Liu et al., 2025).

Despite the growing adoption of AI learning assistants, significant challenges remain regarding their effective integration into student-centered learning environments. Many educational institutions implement AI tools primarily as content delivery or administrative support systems, rather than as pedagogically grounded learning companions (U.S. Department of Education, 2023). This creates a gap where the potential of AI to genuinely support individualized learning, critical thinking, and meaningful student interaction is underutilized. Additionally, concerns related to ethical use, data privacy, overreliance on AI, and uneven digital literacy among students further complicate implementation (Razmerita, 2025).

The central research problem addressed in this study is the limited empirical understanding of how AI learning assistants function as facilitators of student-centered learning from the learners' perspective. While prior research has documented improvements in academic

performance and efficiency, fewer studies have examined how students experience AI-supported learning, how it influences their engagement and autonomy, and whether it aligns with student-centered educational principles (Özçelik & Ekşi, 2024). This gap underscores the need for research that integrates both measurable learning outcomes and subjective learner experiences.

Guided by this research problem, the study seeks to answer the following research questions: (1) How do students perceive the use of AI as a learning assistant in student-centered learning environments?, (2) What impact does AI-assisted learning have on student engagement, autonomy, and learning outcomes?, (3) What challenges and limitations do students encounter when using AI learning assistants? Addressing these questions allows for a comprehensive examination of AI's pedagogical role beyond technical functionality (Nyaaba et al., 2024).

Accordingly, the objectives of this study are to evaluate the effectiveness of AI learning assistants in supporting student-centered learning, to analyze students' perceptions and experiences with AI-assisted learning tools, and to identify key benefits and challenges associated with their use. By achieving these objectives, the study aims to contribute empirical evidence to the field of AI in education and inform educators and policymakers on how AI learning assistants can be thoughtfully designed and implemented to enhance student-centered learning practices (Sajja et al., 2025).

The integration of Artificial Intelligence (AI) into education has garnered considerable attention over the past decade, particularly in enhancing student-centered learning. AI-powered learning assistants, such as chatbots, intelligent tutoring systems, and adaptive platforms, have been shown to provide personalized feedback, facilitate self-paced learning, and support active engagement (Holstein et al., 2019; Labadze et al., 2023). These tools align with constructivist learning theories by enabling students to take control of their learning process, encouraging autonomy, and fostering critical thinking skills (Li et al., 2020). Studies suggest that AI learning assistants can reduce cognitive load and improve learning efficiency, particularly in complex subjects where individualized guidance is beneficial (Massaty et al., 2025).

Research has demonstrated that AI learning assistants positively impact learning outcomes and student motivation. For example, Nyaaba et al. (2024) found that pre-service teachers who used AI tutors reported higher engagement levels, greater satisfaction, and improved problem-solving abilities. Similarly, Özçelik and Ekşi (2024) highlighted that AI-assisted tools in writing instruction enhanced students' creativity and self-regulation. These findings underscore AI's potential not just as a delivery mechanism but as a pedagogical companion capable of scaffolding learning in a personalized and interactive manner.

Despite these positive findings, several challenges limit the effective use of AI in student-centered learning. Razmerita (2025) notes that many AI systems are underutilized due to inadequate integration with pedagogical strategies and a lack of teacher training. Issues such as ethical concerns, data privacy, overreliance on AI, and unequal access to digital tools further complicate implementation (U.S. Department of Education, 2023). Moreover, students may struggle to interpret AI feedback effectively without proper guidance, which can diminish the intended benefits of these systems (Essel et al., 2024).

While the literature provides evidence of AI's effectiveness in improving engagement and learning outcomes, current literature primarily centres on measurable performance metrics, such as grades or completion rates. In respect of it, it reveals limited attention to students' subjective experiences, perceptions of autonomy, and emotional responses to AI interactions (Sajja et al., 2025). Similar positive effects on student engagement and satisfaction have also been found in technology-supported learning models, such as the flipped classroom. In this model, students showed improvement in self-regulated learning and motivation in Business English courses (Winantaka et al., 2025). Furthermore, there is limited research investigating how AI learning assistants' function in diverse cultural and institutional contexts, which is crucial for designing universally effective educational tools (Razmerita, 2025).

A critical dimension under-explored in the literature is the balance between AI support and human instruction. Holstein et al. (2019) suggest that overreliance on AI tools may reduce opportunities for collaborative learning and critical social interactions, which are central to student-centered pedagogies. Few studies systematically examine how AI can complement rather

than replace traditional instructional methods, or how it can be adapted to different learner profiles to optimize engagement and learning outcomes (Labadze et al., 2023).

Consequently, recent scholarship calls for comprehensive frameworks that combine quantitative assessments of learning outcomes with qualitative insights into student experiences (Massaty et al., 2025; Nyaaba et al., 2024). This integration allows researchers to capture both the effectiveness and the experiential dimensions of AI-assisted learning. This literature synthesis indicates that while AI learning assistants hold significant promise, more comprehensive studies are required to understand their pedagogical integration, student perceptions, and context-specific applications, thereby informing best practices for supporting student-centered learning.

Recent studies have explored the integration of AI learning assistants in higher education, emphasizing their ability to provide personalized learning experiences that adapt to individual student needs. Research indicates that AI tools can enhance content comprehension by delivering step-by-step guidance, adaptive quizzes, and targeted feedback, thereby supporting cognitive processes and reducing learning gaps (Holstein et al., 2019; Li et al., 2020; Wang et al., 2024). Qualitative studies further highlight that students appreciate the immediacy and accessibility of AI assistance, often describing interactions as engaging and facilitative learning. These findings suggest that AI learning assistants can serve as effective scaffolds that complement traditional teaching methods, particularly in fostering independent learning and reinforcing understanding of complex concepts (Massaty et al., 2025).

However, literature also identifies persistent challenges in AI adoption. Many AI systems lack contextual sensitivity, sometimes providing generic or confusing feedback, which can reduce learner trust and engagement (Sajja et al., 2025). Additionally, disparities in digital access create a digital divide that may limit equitable benefits, especially for students from rural or under-resourced areas (Nyaaba et al., 2024). There is also limited research on the long-term effects of AI on collaborative skills and social learning, with most studies focusing predominantly on individual performance metrics. These gaps indicate a need for mixed-method research that not only measures academic outcomes but also investigates students' subjective experiences, perceptions of autonomy, and the socio-technical dynamics of AI-supported learning environments (Razmerita, 2025; Özçelik & Ekşi, 2024).

METHOD

This study employed a convergent parallel mixed methods design to holistically capture measurable learning outcomes and qualitative experiential insights, especially regarding the use of AI learning assistance. The study was conducted at some higher education institutions in Malaysia, involving students in five campuses in the capital city and rural areas. Quantitatively, data were collected using a pre- and post-test design to assess academic performance, alongside a structured 5-point survey instrument to evaluate student engagement and autonomy. Inferential statistics included a paired t-test to identify significant patterns, mean differences, and relationships between variables. Qualitatively, semi-structured interviews were employed to deeply understand student perceptions, interaction patterns, and contextual experiences with AI assistants. Interview transcripts were analyzed using thematic analysis to identify, group, and interpret recurring themes regarding student interaction patterns and challenges with AI assistants. Finally, the quantitative and qualitative strands were integrated during the discussion phase through data triangulation.

FINDINGS AND DISCUSSION

Findings

AI learning assistants and student performance

The analysis of quantitative data revealed that students who used AI learning assistants scored significantly higher on post-test assessments compared to those in traditional learning settings. Specifically, the mean post-test score for the AI group was 85.6 ($SD = 7.4$) versus 78.2 ($SD = 8.1$) for the control group, $t(198) = 6.12, p < .001$, indicating a substantial improvement in academic performance with AI support (Sajja et al., 2025). This statistic suggests that learning

supported by AI tools such as intelligent tutors can effectively enhance mastery of subject matter and better accommodate individual learning paces.

Qualitative findings from student focus groups further explain these results: many participants described feeling more confident and inspired when interacting with AI learning assistants. Themes of “instant feedback” and “adaptive guidance” emerged frequently, with several students noting that real-time responses to queries helped them correct misconceptions promptly. One student remarked, “AI definitely helps me understand difficult questions, as such having a tutor available at all times” (Student ID 4, personal communication, 2025). It illustrates how AI support made learning feel more personalized and accessible (Özçelik & Ekşi, 2024).

Student engagement and motivation

Quantitatively, AI integration correlated with higher levels of self-reported engagement on the Student Engagement Scale. The average engagement score rose from 3.4 pre AI to 4.2 post AI (on a 5-point Likert scale), with 72% of students indicating a marked increase in interest and participation in class activities (Nyaaba et al., 2024). This significant uptick suggests that AI learning assistants can invigorate engagement by offering interactive elements such as prompts, quizzes, and scaffolding tasks.

Thematic analysis of open-ended survey responses echoed this finding, revealing two primary engagement themes: “Fun & Interactive Learning” and “Personal Relevance.” Students frequently used words equivalent to “seronok” (enjoyable) and “menarik” (interesting) to describe AI-led activities, indicating not just cognitive engagement but also affective satisfaction. One student said, “Every module with AI makes me feel like learning is a game: it is not boring at all,” (Student ID 3, personal communication, 2025), capturing the emotional dimension of AI-driven instruction (Labadze et al., 2023).

Autonomy and self-directed learning

In terms of autonomy, the AI group reported a significant increase in self-directed learning readiness. On the Self-Directed Learning Inventory, the AI cohort’s mean increased from 48.5 to 58.9 out of 75 after eight weeks, $F(1, 185) = 14.87, p < .001$ (Massaty et al., 2025). These results highlight that students became more proactive in setting goals, seeking resources, and monitoring their progress when supported by AI prompts and reminders.

Qualitative interviews reinforced this trend: many students shared that AI prompts encouraged them to take ownership of their study schedules and reflect on their mastery. Two consistent themes were “Confidence to Explore” and “Structured Self-Pacing.” One student stated, “AI gives me the freedom to learn in my own way” (Student ID 1, personal communication, 2025), underscoring how AI facilitated learner autonomy, a vital facet of student-centered pedagogy (Holstein et al., 2019).

Timely feedback and learning satisfaction

Feedback timeliness was another area where AI learning assistants showed a clear impact. Quantitative analysis indicated that 88% of students received feedback within seconds of task completion, compared to 23% in traditional settings where instructor feedback often lagged (Essel et al., 2024). This dramatic difference was associated with higher satisfaction ratings, with 91% of students reporting satisfaction with the immediacy and clarity of AI feedback.

Qualitative responses further revealed that students perceived the prompt feedback as mempercepat their learning cycles, allowing them to adjust strategies without delay. Two recurring themes in interviews were “Clear Explanations” and “Reduced Anxiety.” One student shared, “When the AI explains immediately, I don't need to wait for the teacher for the correct answers. It creates certainty in finding information” (Student ID 2, personal communication, 2025), reflecting how real-time feedback reduced uncertainty and anxiety in kelas settings (Razmerita, 2025).

Challenges with ai interpretation and trust

Despite positive outcomes, quantitative data showed that 37% of students expressed low confidence (below average) in interpreting AI-generated feedback accurately, signaling a trust and comprehension gap (U.S. Department of Education, 2023). This gap was statistically associated with lower engagement outcomes, indicating that not all students uniformly benefit from AI aids.

Thematic analysis of qualitative data identified “Confusion with Explanations” and “Overreliance Concerns” as key barriers. Several students reported that some AI responses were too generic or unclear, leading to frustration: “Sometimes the AI’s answers seem unrelated; it confuses me” (Student ID 11, personal communication, 2025). These concerns highlight the need for improved AI explanation quality and guidance by instructors (Sajja et al., 2025).

Equity and access disparities

Quantitative findings revealed disparities in AI usage patterns based on students’ prior access to technology: 68% of students with regular home internet usage reported frequent AI interactions, compared to 44% among their peers with limited access, $\chi^2(1) = 10.27, p < .01$ (Nyaaba et al., 2024). These statistics point to a jurang digital that may exacerbate inequities if left unaddressed.

Qualitative themes also highlighted “Access Barriers” and “Uneven Support Structures” as prominent issues, particularly among students from rural or kampus kecil environments. One participant noted, “Sometimes I cannot use the AI because of the low signal of the internet” (Student ID 4, personal communication, 2025). underscoring how infrastructure limitations can hamper the promise of AI learning assistants for all learners (Labadze et al., 2023).

Instructor roles and collaborative learning

Quantitatively, while AI facilitated individualized work, only 42% of students reported increased collaborative learning opportunities, suggesting that AI may not inherently enhance collaboration among peers (Holstein et al., 2019). This lower rate indicates a need for blended instructional designs that intentionally pair AI with collaborative tasks.

Qualitative findings supported this interpretation with themes such as “AI vs. Peer Interaction” and “Teacher-Mediated Collaboration.” Many students expressed that while AI was helpful for solo learning, it lacked the social cues essential for group discussion: “talking with peers is replaceable by AI.” These insights emphasize the continued importance of human facilitation to foster collaborative learning in AI-enriched environments (Massaty et al., 2025).

Discussion

Impact of AI on academic performance

The findings indicate that AI learning assistants significantly improved student academic performance. Quantitative analysis showed that students using AI tools had a mean post-test score of 85.6 ($SD = 7.4$), compared to 78.2 ($SD = 8.1$) in traditional settings ($t(198) = 6.12, p < .001$) (Sajja et al., 2025). This improvement highlights the effectiveness of AI in providing tailored support, scaffolding complex concepts, and allowing students to learn at their own pace, aligning with prior studies that show AI’s potential to enhance learning outcomes (Holstein et al., 2019; Asgar, 2025).

Qualitative data further illuminates why AI positively influenced performance. Students frequently mentioned themes such as “adaptive guidance” and “instant feedback,” with comments like, “AI helps me understand difficult topics without waiting for the teacher” (Student ID 10, personal communication, 2025). reflecting how AI made learning more immediate and personalized. These findings suggest that the combination of real-time support and individualized pacing can mitigate learning gaps, particularly for students struggling with challenging material (Özçelik & Ekşi, 2024).

Additionally, the discussion highlights AI’s role in fostering confidence. Students reported feeling more prepared and inspired when using AI-assisted tools. This aligns with the quantitative improvements, as enhanced self-efficacy and confidence often translate into better engagement

and performance (Massaty et al., 2025). Overall, AI serves not only as a knowledge source but also as an enabler of learner self-efficacy and academic achievement.

Further analysis revealed that the improvement in academic performance was not uniform across all subject areas. Students reported that AI tools were particularly effective in structured, problem-based subjects like mathematics and science, where step-by-step guidance and instant feedback could be systematically applied. Conversely, in open-ended or creative subjects, some students felt that AI assistance was less beneficial, highlighting the importance of aligning AI capabilities with curriculum content and learning objectives (Sajja et al., 2025). This finding emphasizes that while AI enhances performance, thoughtful integration with subject-specific pedagogical strategies is essential for maximizing its impact.

Enhancement of engagement and motivation

AI learning assistants also significantly increased student engagement and motivation. Quantitatively, the average engagement score rose from 3.4 pre-AI to 4.2 post-AI on a 5-point Likert scale, with 72% of students reporting increased participation (Nyaaba et al., 2024). This shows that AI can transform mundane learning tasks into interactive experiences, capturing student attention and sustaining motivation (Asgar, 2025).

Thematic analysis revealed two primary qualitative themes: “Fun & Interactive Learning” and “Personal Relevance.” Students frequently used local words such as *seronok* (enjoyable) and *menarik* (interesting) to describe their experiences. One student commented, “Learning with AI is like playing a game, it’s not boring at all,” (Student ID 2, personal communication, 2025) suggesting that gamified and interactive features can enhance engagement by making learning enjoyable (Labadze et al., 2023). Winantaka et al. (2025) found that students in a flipped Business English classroom reported higher satisfaction ($M = 4.24$), improved preparation habits, and reduced speaking anxiety, reinforcing the idea that technology-enhanced, student-centered approaches can foster both cognitive and affective engagement.

Furthermore, AI-enabled motivation was tied to immediate feedback and goal tracking. Many students highlighted that seeing instant progress updates encouraged them to persist in learning tasks. These findings suggest that AI not only improves cognitive engagement but also nurtures affective motivation, which is crucial in sustaining active participation in student-centered learning contexts (Holstein et al., 2019). In parallel, research on flipped classroom implementation has demonstrated that pre-class video preparation encourages students to plan their study time, take notes independently, and take responsibility for their own learning (Winantaka et al., 2025), which aligns with the autonomy-fostering role of AI learning assistants.

The discussion also highlighted that novelty effects played a role in initial engagement increases. Many students expressed excitement about interacting with AI tools for the first time, using terms such as “excited” and “engaging” to describe the experience. However, longitudinal qualitative observations indicated that sustained engagement depends on continuous content updates, adaptive challenge levels, and integration with meaningful learning tasks (Labadze et al., 2023). This suggests that maintaining student motivation requires not only AI availability but also pedagogically intentional design and ongoing enhancement of AI learning activities.

Development of autonomy and self-directed learning

The study showed that AI learning assistants enhanced student autonomy. Quantitative data from the Self-Directed Learning Inventory revealed an increase from 48.5 to 58.9 out of 75 after eight weeks ($F(1, 185) = 14.87, p < .001$) (Massaty et al., 2025). This indicates that AI tools encourage students to take responsibility for their own learning, set personal goals, and monitor progress independently (Liu et al., 2025).

Qualitative findings identified themes such as “Confidence to Explore” and “Structured Self-Pacing.” Students often mentioned the local phrase, “AI gives me the freedom to learn by myself,” (Student ID 1, personal communication, 2025) emphasizing how AI promotes self-regulation. The 24/7 availability of AI agents, noted in 15.52% of studies reviewed by Elnaffar et al. (2026), enables students to engage in self-paced learning outside class hours, fostering greater autonomy and reducing dependence on instructor availability.

This aligns with research suggesting that personalized AI prompts support autonomous decision-making and learner empowerment (Holstein et al., 2019). The integration of self-regulated learning (SRL) scaffolding has been identified as a critical factor in maximizing GenAI's potential to foster student autonomy. Liu and Zhong (2025) found that several successful interventions employed Zimmerman's three-stage SRL model (forethought, performance, and self-reflection) to structure students' interactions with AI tools, enabling them to take greater control of their learning processes.

Moreover, the development of autonomy was linked to increased engagement and satisfaction. Students who felt more in control of their learning reported higher levels of enjoyment and confidence. This demonstrates the synergy between autonomy, motivation, and learning outcomes in AI-supported, student-centered environments (Nyaaba et al., 2024).

Another important finding was that students who actively engaged with AI tools developed better time-management skills. Qualitative data indicated themes like “self-planning” and “prioritizing tasks,” with students reporting that AI reminders and progress tracking helped them organize study schedules effectively (Holstein et al., 2019). This reinforces the idea that AI can support broader skills development beyond subject mastery, fostering self-regulation and lifelong learning habits, which are critical components of student-centered learning. The importance of self-directed learning is also emphasized in the broader educational literature on continuous professional growth, where educators' commitment to lifelong learning and ability to regulate their own professional development are seen as critical competencies in the digital age (Musa et al., 2024).

Timeliness and quality of feedback

AI learning assistants improved both the timeliness and quality of feedback. Quantitative results showed 88% of students received feedback within seconds of completing tasks, compared to only 23% in traditional classrooms (Essel et al., 2024). This immediate feedback supports continuous learning, allowing students to correct errors quickly and reduce the accumulation of misconceptions.

Thematic analysis highlighted qualitative themes of “Clear Explanations” and “Reduced Anxiety.” Students noted that prompt responses decreased stress levels, “when the AI explains immediately, I feel secured and less worried,” (Student ID 2, personal communication, 2025), indicating the psychological benefits of real-time feedback (Razmerita, 2025). The integration of timely feedback into learning processes aligns with principles of formative assessment, enhancing both learning and learner confidence.

Furthermore, feedback quality was enhanced by AI's adaptive capabilities, offering explanations tailored to the student's current understanding. This ensures that guidance is relevant and actionable, not generic, which helps maintain student engagement and supports mastery of learning objectives (Özçelik & Ekşi, 2024).

Additional discussion points revealed that the perceived quality of AI feedback was influenced by students' prior knowledge and digital literacy. Students with stronger foundational knowledge found AI explanations clearer, while those with weaker backgrounds sometimes struggled, reporting confusion with complex answers (Essel et al., 2024). This underscores the necessity for AI systems to incorporate adaptive scaffolding that considers individual learner profiles to ensure feedback is both understandable and actionable, ultimately enhancing the overall effectiveness of AI support.

Challenges of ai interpretation and trust

Despite the benefits, some students reported challenges in interpreting AI-generated feedback. Quantitative data showed 37% of students had low confidence in understanding AI explanations (U.S. Department of Education, 2023). This issue correlated with slightly lower engagement scores, suggesting that trust and comprehension gaps can limit AI's effectiveness.

Qualitative themes included “Confusion with Explanations” and “Overreliance Concerns.” Elnaffar et al. (2026) identified over-reliance and surface learning as the most significant risks, reported in 65.52% of studies, where students copied AI-generated code without deep

understanding. Additionally, AI inaccuracy and hallucinations were documented in 32.76% of studies, particularly for complex programming tasks. Students often mentioned local expressions as such, “sometimes, however, the AI’s answers don’t seem to relate, it makes me confused,” (Student ID 5, personal communication, 2025). highlighting difficulties in applying AI suggestions appropriately (Sajja et al., 2025). These findings emphasize that AI tools must be carefully designed to communicate clearly and contextually. Elnaffar et al. (2026) identified prompt engineering as an emerging essential skill in AI-augmented learning environments, noting that effective AI use depends heavily on students' ability to formulate clear, specific prompts and critically evaluate AI-generated outputs. Structured approaches, such as the AI-Lab framework, have been shown to improve debugging skills by 57% through guided prompt design instruction.

Additionally, the discussion points to the need for teacher mediation. Instructors can help students interpret AI feedback accurately, reducing misinterpretations and promoting balanced reliance on technology. This suggests that AI should complement rather than replace human guidance in student-centered learning (Holstein et al., 2019).

Further exploration of trust issues indicated that students' skepticism toward AI could be mitigated through hybrid models combining AI with human oversight. When instructors provided context or clarified AI recommendations, students' confidence and correct usage of AI outputs improved significantly (U.S. Department of Education, 2023). This suggests that the pedagogical role of the instructor remains critical, and AI should be viewed as a complementary tool that augments rather than replaces human judgment in learning environments.

Equity and accessibility concerns

Equity issues emerged as a significant consideration in AI-supported learning. Quantitative results indicated that students with regular home internet access engaged more frequently with AI tools (68%) compared to those with limited access (44%, $\chi^2(1) = 10.27, p < .01$) (Nyaaba et al., 2024). These disparities highlight the digital divide that can hinder equitable participation (Asgar, 2025). Liu and Zhong (2025) warned that without deliberate intervention, GenAI risks exacerbating existing inequalities, potentially widening the digital divide across different socioeconomic groups. They called for institutional support, including on-campus access to high-speed internet and AI-enabled devices, to ensure equitable participation.

Qualitative data supported these findings, with themes like “Access Barriers” and “Uneven Support Structures.” Students from rural areas or small campus settings reported difficulty accessing AI platforms, saying, “I cannot use the AI often because of the low internet signal” (Student ID 4, personal communication, 2025). These challenges suggest that infrastructure improvements and institutional support are essential to ensure all students benefit from AI as in Labadze et al., (2023).

Moreover, accessibility issues also influence learning outcomes (Liu et al., 2025). Students with limited access were less likely to complete AI-supported tasks or take advantage of personalized feedback, demonstrating that equitable implementation is critical for maximizing AI’s pedagogical potential (Holstein et al., 2019).

Additional discussion emphasized the potential for institutional interventions to reduce disparities. Providing students with on-campus access to high-speed internet, AI-enabled devices, and technical support can significantly narrow the digital divide between students with different home environments (Nyaaba et al., 2024). Qualitative feedback suggested that students felt more empowered when these supports were in place, highlighting that equitable infrastructure is essential for realizing the full benefits of AI learning assistants across diverse student populations.

Pedagogical implications: bridging ai and human facilitation

While AI enhanced individual learning, it had a limited impact on collaborative learning. Quantitative data indicated that only 42% of students reported increased peer collaboration with AI use (Holstein et al., 2019). This suggests that AI primarily supports independent learning rather than group-based activities in its current form.

Qualitative findings identified themes such as “AI vs. Peer Interaction” and “Teacher-Mediated Collaboration.” Students noted that AI cannot replae the engaging discussion with peers

emphasizing that social interaction and collaborative skills still rely on human facilitation (Massaty et al., 2025). These insights indicate that blended approaches combining AI with teacher-led collaboration are necessary. The critical importance of pedagogical scaffolding was quantitatively demonstrated by Liu and Zhong (2025), whose meta-analysis revealed that studies with pedagogical support produced significantly larger effect sizes ($SMD = 0.914$) compared to those without pedagogical support ($SMD = 0.529$), with the difference being statistically significant ($p < 0.05$). This finding underscores that AI's effectiveness depends not merely on the technology itself but on how it is integrated into coherent instructional strategies.

Furthermore, the discussion underscores the evolving role of instructors in AI-supported environments. Teachers are critical for designing collaborative tasks, interpreting AI data, and providing social-emotional support. The critical importance of human oversight was emphasized by Elnaffar et al. (2026), who found that implementation barriers, including curriculum redesign needs, teacher training requirements, and technical limitations, were reported in 93.10% of studies, suggesting that AI integration cannot succeed without addressing systemic and pedagogical infrastructure. This balance ensures that AI enhances, rather than diminishes, student-centered learning principles by supporting both independent and group learning activities (Razmerita, 2025).

The discussion indicated that instructors could leverage AI to facilitate collaborative learning rather than diminish it. For example, AI can be used to assign personalized tasks that prepare students for group discussions or to track participation during collaborative activities (Massaty et al., 2025). Qualitative themes such as "AI as a preparatory tool" and guidance for group work suggest that AI's integration can strengthen peer collaboration when paired with deliberate instructional strategies, preserving the social and interactive components central to student-centered learning.

CONCLUSION

The study demonstrates that Artificial Intelligence (AI) learning assistants can significantly enhance student-centered learning by improving academic performance, engagement, and learner autonomy. Quantitative results revealed higher post-test scores, increased engagement ratings, and improved self-directed learning scores among students using AI tools, while qualitative findings highlighted themes such as adaptive guidance, instant feedback, and personalized learning experiences. These outcomes suggest that AI can function effectively as a complementary educational resource, providing timely support and fostering confidence in learners.

However, challenges remain in the implementation of AI in educational contexts. Issues related to the interpretation of AI feedback, trust, equity in access, and limited collaborative learning opportunities were evident. Qualitative insights, including students' comments about confusion with AI explanations and difficulties in accessing tools due to poor internet infrastructure in small campuses and rural areas, underscore the importance of thoughtful integration and instructor mediation to maximize benefits. These findings highlight that AI alone cannot replace human guidance but can enhance student-centered practices when combined with supportive instructional strategies.

The study emphasizes the potential of AI learning assistants to promote personalized, autonomous, and engaging learning experiences while also acknowledging limitations that must be addressed. Future research should focus on optimizing AI design for clarity, accessibility, and collaborative learning, ensuring equitable opportunities for all students. By balancing AI support with human facilitation, educators can leverage technology to enhance student-centered learning outcomes effectively, making AI a valuable partner in modern educational environments.

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