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Integrating Artificial Intelligence in Classroom Learning: Opportunities and Challenges for Student-Centered Pedagogy

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ABSTRACT
This study examines the integration of Artificial Intelligence (AI) in classroom learning and its implications for student-centered pedagogy in contemporary educational environments. The research aims to analyze the opportunities, challenges, and pedagogical transformations associated with AI-supported learning practices. The study employed a qualitative approach using a case study design because this method enabled an in-depth exploration of participants' experiences, instructional practices, and institutional contexts related to AI implementation. The research was conducted at Global Future Senior High School and Digital Learning University located in Jakarta and Tangerang, Indonesia, as both institutions actively implemented AI-based educational technologies in classroom instruction. The study involved fifteen informants consisting of teachers, lecturers, educational administrators, students, curriculum officers, and educational technology specialists selected purposively due to their direct involvement in AI-supported learning activities. The findings revealed that AI integration enhanced personalized learning, student engagement, collaborative participation, and instructional flexibility. However, challenges related to technological readiness, ethical concerns, academic integrity, and pedagogical adaptation remained significant issues. The study recommends strengthening digital pedagogical training, institutional technological support, and ethical AI literacy programs to ensure balanced, inclusive, and student-centered educational transformation in the digital era.

INTRODUCTION

The rapid advancement of digital technology has transformed educational practices across various levels of schooling, particularly through the emergence of Artificial Intelligence (AI) as an innovative instructional tool (Nkansah, 2025). In recent years, AI has increasingly been integrated into classroom learning environments to support adaptive instruction, automate administrative tasks, personalize learning pathways, and enhance student engagement. Educational institutions worldwide have begun adopting AI-driven systems such as intelligent tutoring systems, automated feedback platforms, predictive analytics, virtual assistants, and generative AI applications to improve learning effectiveness and efficiency (Hwang, 2024). This transformation reflects the growing demand for educational models that are responsive to the characteristics of twenty-first century learners who require critical thinking, creativity, collaboration, communication, and digital literacy skills (Ponomarenko et al., 2025). Within this context, student-centered pedagogy has become an essential educational paradigm because it emphasizes active participation, learner autonomy, problem-solving ability, and collaborative knowledge construction (Hudson, 2025). Consequently, the integration of AI in classroom learning presents both substantial opportunities and significant challenges for the implementation of student-centered learning approaches.

Current scholarly discussions indicate that AI possesses considerable potential to strengthen personalized learning experiences by adapting instructional content according to students' learning styles, pace, interests, and academic performance (C. Wang et al., 2024). AI technologies may assist teachers in identifying students' learning difficulties more accurately while enabling learners to access flexible educational resources independently. Furthermore, AI-based systems can facilitate interactive

learning environments that encourage inquiry-based learning, collaborative discussion, and real-time feedback mechanisms. Several studies have demonstrated that AI integration contributes positively to student motivation, engagement, and academic achievement when appropriately implemented within pedagogical frameworks (Lehtimäki et al., 2024). In higher education and school settings alike, AI has also been associated with improved accessibility for students with diverse educational needs, thereby promoting more inclusive learning environments (Menon et al., 2024).

Despite these promising developments, the implementation of AI in classroom learning remains accompanied by complex pedagogical, ethical, technological, and institutional challenges (Huang & Huang, 2024). Many educational institutions continue to experience limited technological infrastructure, insufficient teacher readiness, and unequal access to digital resources. Teachers frequently encounter difficulties in integrating AI tools into pedagogical practices that genuinely promote student-centered learning rather than reinforcing teacher-dominated instruction. Moreover, concerns regarding data privacy, algorithmic bias, academic integrity, overdependence on technology, and the reduction of human interaction in educational processes have generated critical debates among educators and researchers (Rekha et al., 2025). The rapid expansion of generative AI technologies has further intensified concerns related to plagiarism, critical thinking decline, and students' overreliance on automated content generation (Reethika & Priya, 2024). Consequently, although AI offers transformative opportunities for educational innovation, its integration into classroom learning requires comprehensive pedagogical strategies that preserve the humanistic dimensions of education.

The state of the art of contemporary research demonstrates that previous studies have primarily focused on the technical effectiveness of AI applications, the acceptance of educational technologies, or the impact of AI on learning outcomes (Fazira & Hadi, 2025). Several investigations have explored teachers' perceptions toward AI adoption, while others have analyzed AI-assisted learning systems from technological or psychological perspectives. Nevertheless, limited research has comprehensively examined how AI integration influences the practical realization of student-centered pedagogy within classroom learning contexts. Existing studies often discuss AI implementation in general educational settings without specifically analyzing the balance between technological innovation and pedagogical transformation. In addition, many prior investigations remain concentrated in technologically advanced countries, resulting in insufficient contextual understanding of AI integration challenges in developing educational environments where disparities in digital infrastructure, teacher competence, and educational policy remain substantial (Trujillo et al., 2025).

This condition reveals a significant research gap. There is still inadequate empirical and conceptual exploration concerning how AI can be integrated into classroom learning while maintaining the principles of student-centered pedagogy. Previous studies have not sufficiently addressed the interconnected dimensions of pedagogical adaptation, teacher readiness, ethical considerations, student autonomy, and institutional support within a unified analytical framework. Furthermore, limited attention has been directed toward understanding the opportunities and challenges of AI integration simultaneously rather than examining them separately. As a result, educational stakeholders continue to lack comprehensive guidance regarding effective pedagogical strategies for utilizing AI in ways that enhance meaningful student participation and collaborative learning experiences (Kim, 2024).

The novelty of this research lies in its integrative examination of AI implementation within classroom learning through the lens of student-centered pedagogy. Unlike earlier studies that primarily emphasize technological effectiveness or user acceptance, this research seeks to analyze the dynamic relationship between AI-based instructional innovation and learner-centered educational practices. The study also contributes a contextualized perspective by identifying pedagogical opportunities, institutional constraints, ethical implications, and instructional adaptation strategies within contemporary classroom environments. In addition, this research proposes a conceptual understanding of how AI can function not merely as a technological supplement but as a transformative educational instrument that supports active learning, critical inquiry, creativity, and collaborative engagement among students.

Based on these considerations, this study formulates several research questions. The first question concerns how Artificial Intelligence can be effectively integrated into classroom learning

environments that promote student-centered pedagogy. The second question examines the opportunities generated by AI integration for improving learning engagement, personalization, collaboration, and learner autonomy. The third question investigates the pedagogical, ethical, technological, and institutional challenges encountered during the implementation process. The fourth question explores strategies that educators and institutions may adopt to optimize AI utilization while preserving meaningful human interaction and educational values in classroom learning.

The primary objective of this research is to analyze the integration of Artificial Intelligence in classroom learning and its implications for student-centered pedagogy. More specifically, the study aims to identify the educational opportunities provided by AI technologies, examine the major challenges affecting implementation, and formulate pedagogical strategies that support effective and ethical AI-assisted learning practices. The research also intends to contribute to the development of a balanced educational framework that integrates technological innovation with learner-centered instructional principles.

Theoretically, this research contributes to the broader discourse on educational technology and pedagogical transformation by expanding the conceptual understanding of AI integration within student-centered learning frameworks. The findings are expected to enrich academic discussions concerning digital pedagogy, adaptive learning systems, and the evolving role of teachers in AI-supported educational environments. Academically, this study provides relevant references for researchers, scholars, and educational practitioners interested in investigating AI implementation in teaching and learning processes. The study may also serve as a foundation for future interdisciplinary research involving education, technology, psychology, and ethics. Practically, the findings are expected to assist teachers, school administrators, curriculum developers, and policymakers in designing effective AI-based instructional strategies that support active learning, collaborative participation, and ethical technology use in classrooms.

Nevertheless, this research acknowledges several limitations. The study may be constrained by differences in technological infrastructure, institutional readiness, and educational policy contexts across schools or regions. In addition, the rapidly evolving nature of AI technologies may influence the long-term relevance of specific findings and recommendations. The research may also encounter limitations related to participants' technological literacy and varying levels of familiarity with AI applications in educational settings. Consequently, the interpretation of findings should consider contextual educational conditions and technological developments.

Future research is recommended to conduct longitudinal investigations examining the long-term effects of AI integration on students' cognitive development, critical thinking skills, creativity, and social interaction. Further studies may also explore comparative analyses between different educational levels, cultural contexts, or AI platforms to generate broader pedagogical insights. Additionally, future researchers should examine ethical governance models, teacher professional development programs, and policy frameworks that can support responsible and equitable AI implementation in education. Such investigations are essential for ensuring that the integration of Artificial Intelligence contributes positively to sustainable, inclusive, and human-centered educational transformation in the digital era.

LITERATURE REVIEW

The integration of Artificial Intelligence (AI) into classroom learning has become one of the most influential transformations in contemporary education (Xiao & Ruonan, 2025). Educational institutions across the world increasingly utilize AI-based technologies to improve instructional quality, personalize learning experiences, and support more adaptive teaching practices. This development is closely associated with the growing emphasis on student-centered pedagogy, which positions learners as active participants in the educational process rather than passive recipients of information (Khatoon et al., 2025). The implementation of AI in education has therefore generated extensive academic discussion regarding its pedagogical implications, technological opportunities, and ethical challenges (McLaren & Nguyen, 2023). In this context, the present study employs three major theoretical perspectives to analyze the integration of AI in classroom learning, namely Constructivist Learning Theory, Technological Pedagogical Content Knowledge (TPACK) Theory, and Diffusion of Innovation

Theory. These theories provide an interdisciplinary framework for understanding how AI technologies influence teaching practices, student engagement, instructional adaptation, and educational transformation in student-centered learning environments.

The first theoretical foundation used in this research is Constructivist Learning Theory, which was widely popularized by Jean Piaget in 1952 through his work at the University of Geneva, Switzerland (Mathur, 2025). Piaget argued that learning is an active cognitive process in which learners construct knowledge through interaction with their environment, experiences, and social contexts. According to Piaget, students do not merely receive information passively; instead, they actively interpret, organize, and reconstruct knowledge based on prior understanding and cognitive development. Constructivism emphasizes inquiry, exploration, collaboration, reflection, and problem-solving as central elements of meaningful learning (Winnberg et al., 2025). In the context of AI integration, constructivist theory becomes highly relevant because AI technologies can support personalized learning pathways, interactive simulations, and adaptive learning environments that encourage students' active participation in the learning process (Asirvatham & Jamil, 2024).

Another influential scholar connected to constructivist perspectives is Lev Vygotsky from Moscow State University, Russia, whose sociocultural learning theory was introduced in 1978 (Shen et al., 2023). Vygotsky emphasized that learning occurs through social interaction and collaborative engagement within the Zone of Proximal Development (ZPD). He argued that teachers, peers, and technological tools function as mediators that assist learners in achieving higher cognitive development. In AI-supported classroom learning, intelligent tutoring systems, collaborative platforms, and virtual assistants may serve as scaffolding instruments that facilitate students' independent and cooperative learning experiences (Mirecki, 2025). Furthermore, Jerome Bruner from Harvard University, United States, expanded constructivist theory in 1966 by introducing discovery learning and learner-centered instruction (Ivanova, 2023). Bruner argued that students learn more effectively when they actively discover concepts and construct understanding independently. The conceptual framework developed by these three scholars demonstrates that student-centered pedagogy requires learning environments that encourage autonomy, exploration, collaboration, and reflective thinking, all of which may be facilitated through AI integration.

The second theoretical foundation applied in this study is the Technological Pedagogical Content Knowledge (TPACK) Theory introduced by Punya Mishra and Matthew J. Koehler in 2006 at Michigan State University, United States (Larsari & Abouabdelkader, 2024). TPACK theory explains that effective technology integration in education requires the interaction of three major forms of knowledge: technological knowledge, pedagogical knowledge, and content knowledge. According to Mishra and Koehler, educators must possess the ability to combine these dimensions strategically in order to implement meaningful instructional innovation. In the context of AI integration, TPACK theory provides an essential framework for understanding how teachers adapt instructional methods while utilizing AI technologies to support student-centered learning practices.

The development of TPACK theory is also influenced by earlier pedagogical concepts proposed by Lee Shulman from Stanford University, United States, in 1986 (Reguragui et al., 2024). Shulman introduced the concept of Pedagogical Content Knowledge (PCK), emphasizing that effective teaching requires teachers to integrate subject knowledge with appropriate pedagogical strategies. Building upon this perspective, Mishra and Koehler incorporated technological dimensions to address the growing impact of digital transformation in education. Another scholar contributing to the development of technology integration theory is Judi Harris from the College of William and Mary, United States, who emphasized activity-based technology integration and instructional planning (Taherdoost, 2025). Harris argued that educational technology should support pedagogical objectives rather than dominate instructional processes. The conceptual framework of these scholars suggests that successful AI integration depends not only on technological availability but also on teachers' pedagogical competence, instructional creativity, and contextual understanding of classroom learning needs.

The third theoretical perspective utilized in this research is Diffusion of Innovation Theory, developed by Everett M. Rogers in 1962 at Michigan State University, United States (Z. Liu, 2025). Rogers explained that innovation adoption occurs through communication processes within social

systems over time. According to Rogers, individuals adopt innovations based on factors such as perceived usefulness, compatibility, complexity, observability, and trialability. This theory is highly relevant to AI integration in classroom learning because educational institutions and teachers often demonstrate varying levels of readiness, acceptance, and resistance toward technological innovation. AI adoption in education therefore depends on institutional culture, professional development, infrastructure availability, and perceived educational benefits.

The development of innovation diffusion perspectives has been expanded by Geoffrey A. Moore from Stanford University, United States, through his work on technological adoption gaps in 1991 (Lin & Lu, 2025). Moore emphasized that technological innovation frequently faces challenges in transitioning from early adopters to mainstream educational implementation. Similarly, Fred D. Davis from the Massachusetts Institute of Technology (MIT), United States, introduced the Technology Acceptance Model (TAM) in 1989, explaining that users' perceptions of usefulness and ease of use significantly influence technology adoption behavior (Orak & Turan, 2024). The conceptual relationship among Rogers, Moore, and Davis demonstrates that the integration of AI into classroom learning requires institutional support, teacher confidence, user-friendly technology systems, and clear pedagogical relevance to encourage widespread educational acceptance.

The development of these three theories has evolved significantly in response to contemporary digital transformation. Constructivist learning theory has expanded into digital constructivism, emphasizing virtual collaboration, interactive simulations, and technology-assisted inquiry learning. TPACK theory has increasingly incorporated AI literacy, digital pedagogy, and data-driven instructional design as central components of teacher competence in the twenty-first century (Guo et al., 2025). Meanwhile, Diffusion of Innovation Theory has evolved through discussions regarding digital transformation, educational resilience, and organizational adaptation in technologically mediated learning environments. Contemporary educational researchers argue that AI integration requires not only technological infrastructure but also ethical awareness, pedagogical flexibility, and institutional sustainability (Murtarelli & Romenti, 2025).

These theories are directly connected to the main problem of the present research, namely the challenge of integrating AI into classroom learning while preserving student-centered pedagogical principles. Constructivist theory explains the importance of maintaining active and collaborative learning processes despite technological automation. TPACK theory highlights the necessity of teacher competence in balancing pedagogy, content, and AI technology integration. Diffusion of Innovation Theory clarifies why many educational institutions experience difficulties in adopting AI technologies effectively due to structural, cultural, and technological barriers (Eriani, 2024).

The theoretical framework also addresses the research gap identified in previous studies. Earlier investigations often emphasized technological efficiency without sufficiently examining pedagogical transformation, teacher readiness, and innovation adoption simultaneously (Chen, 2025). Constructivist perspectives help analyze how AI supports learner autonomy and meaningful interaction, while TPACK theory provides insight into pedagogical adaptation processes. Diffusion of Innovation Theory contributes an understanding of institutional and social dynamics influencing AI implementation. Consequently, the integration of these theories offers a more comprehensive analytical framework for investigating opportunities and challenges associated with AI-supported student-centered learning.

Furthermore, the three theories are closely related to the research questions concerning how AI can support personalized learning, what challenges emerge during implementation, and how educators may optimize AI integration ethically and pedagogically. The theories also support the objectives of the study by providing conceptual foundations for analyzing instructional adaptation, institutional readiness, and learner engagement. Theoretically, these perspectives enrich academic discourse regarding educational technology and digital pedagogy. Academically, the theories contribute to interdisciplinary research concerning AI integration in education. Practically, the theoretical framework assists educators and policymakers in designing balanced AI-supported learning strategies that maintain meaningful human interaction and collaborative learning values.

In conclusion, the literature review demonstrates that Constructivist Learning Theory, TPACK Theory, and Diffusion of Innovation Theory collectively provide a strong conceptual framework for analyzing AI integration in classroom learning. The perspectives of Jean Piaget, Lev Vygotsky, Jerome Bruner, Punya Mishra, Matthew J. Koehler, Lee Shulman, Judi Harris, Everett M. Rogers, Geoffrey A. Moore, and Fred D. Davis explain the pedagogical, technological, and institutional dimensions influencing student-centered AI-supported education. These theories are closely connected to the main research problem, the identified research gap, and the novelty of this study, which lies in examining AI integration through an interdisciplinary pedagogical framework. The theoretical perspectives also support the formulation of research questions, objectives, and benefits by emphasizing the importance of balancing technological innovation with human-centered educational values. Consequently, this literature review establishes a comprehensive theoretical foundation for understanding the opportunities and challenges of integrating Artificial Intelligence into classroom learning environments oriented toward student-centered pedagogy.

RESEARCH METHODS

This study employs a qualitative research method to investigate the integration of Artificial Intelligence (AI) in classroom learning and its implications for student-centered pedagogy (Tripathi et al., 2025). The qualitative approach is considered the most appropriate methodological framework because the study seeks to explore deeply the perceptions, experiences, pedagogical practices, institutional challenges, and contextual realities associated with AI implementation in educational settings. Unlike quantitative approaches that primarily focus on statistical measurement and numerical generalization, qualitative research emphasizes interpretative understanding, social meaning, and contextual analysis (Otieno, 2024). The integration of AI into classroom learning represents a multidimensional educational phenomenon involving human interaction, technological adaptation, pedagogical transformation, and ethical considerations. Therefore, qualitative inquiry enables the researcher to capture complex educational experiences comprehensively and to understand how teachers, students, and educational stakeholders interpret the opportunities and challenges of AI-supported learning environments.

The research design applied in this study is a qualitative case study design (Zhai et al., 2024). The case study approach is selected because it allows the researcher to conduct an in-depth exploration of a particular educational phenomenon within its real-life context. The implementation of AI in classroom learning cannot be separated from institutional culture, teacher readiness, technological infrastructure, and classroom interaction dynamics. Consequently, the case study design provides flexibility for investigating these interconnected dimensions holistically. Furthermore, this design supports detailed examination of how AI technologies are integrated into teaching practices and how such integration influences student-centered pedagogy in actual classroom situations. The case study approach also enables the researcher to analyze contextual variations, instructional adaptation processes, and institutional responses toward educational innovation. Through this design, the research can generate rich descriptive findings that contribute to theoretical understanding and practical educational improvement.

The research was conducted at a private secondary educational institution and a higher education institution located in Jakarta and Tangerang, Indonesia, both of which have actively incorporated digital learning technologies into classroom instruction. The selected institutions are referred to using pseudonyms to maintain confidentiality and research ethics (Sinha, 2025). The first institution is identified as “Global Future Senior High School,” while the second institution is referred to as “Digital Learning University.” These institutions were selected purposively because they demonstrate active utilization of AI-supported educational technologies such as adaptive learning platforms, intelligent tutoring systems, automated assessment tools, virtual learning assistants, and generative AI applications in teaching and learning activities. In addition, both institutions emphasize student-centered learning approaches and encourage innovation in digital pedagogy, making them highly relevant to the objectives of the present study.

The selection of Jakarta and Tangerang as research locations was based on several considerations. First, these urban educational environments possess relatively advanced technological

infrastructure compared to many other educational regions in Indonesia, thereby enabling more extensive implementation of AI-supported learning systems. Second, educational institutions in these areas have increasingly adopted digital transformation initiatives following the acceleration of online and hybrid learning practices in the post-pandemic educational era (khan, 2025). Third, teachers and students in these institutions generally demonstrate higher levels of digital literacy and technological familiarity, which supports deeper exploration of AI integration practices. Finally, the diversity of educational backgrounds, institutional cultures, and technological experiences in these settings provides a comprehensive contextual understanding of both opportunities and challenges associated with AI implementation in student-centered classroom learning.

The participants in this study consisted of teachers, school administrators, university lecturers, students, and educational technology coordinators who were directly involved in AI-supported classroom learning activities. Because this study applies a qualitative approach, participant selection was conducted through purposive sampling techniques (Howe, 2023). Purposive sampling allows the researcher to select participants based on specific criteria relevant to the research objectives. The selected participants were individuals who possessed direct experience and sufficient understanding regarding AI integration in educational practices. This approach ensures that the collected data are rich, relevant, and capable of addressing the central research questions effectively.

The study involved twelve primary participants. Among them were four secondary school teachers identified using the pseudonyms Mr. Adrian, Ms. Clara, Mr. Daniel, and Ms. Sofia. Mr. Adrian serves as a mathematics teacher who integrates AI-based adaptive learning platforms to personalize instructional activities. Ms. Clara is an English language teacher who utilizes generative AI applications to support collaborative writing and student feedback processes. Mr. Daniel teaches science subjects and implements AI-supported simulations for inquiry-based learning activities, while Ms. Sofia integrates virtual AI assistants into social studies instruction to enhance student engagement and discussion. These teachers were selected because they possess practical experience in integrating AI technologies into classroom learning and demonstrate active involvement in student-centered pedagogical innovation.

The research also involved two university lecturers referred to as Dr. Michael and Dr. Helena. Dr. Michael specializes in educational technology and applies AI-supported learning analytics in higher education instruction. Dr. Helena focuses on digital pedagogy and utilizes AI-based collaborative learning systems in blended learning environments. Both lecturers were selected because they represent higher education perspectives regarding AI integration and possess extensive experience in digital instructional design. Their participation contributes broader insight into pedagogical adaptation and institutional transformation associated with AI-supported learning practices.

Additionally, two educational administrators participated in the study. They are identified as Mr. Jonathan, the academic vice principal of Global Future Senior High School, and Ms. Amelia, the director of digital learning at Digital Learning University. These administrators were selected because they play significant roles in educational policy implementation, technological infrastructure development, and institutional decision-making processes concerning AI adoption in classroom learning. Their perspectives provide important contextual understanding regarding organizational readiness, policy challenges, and strategic planning related to AI integration.

Four student participants also contributed to the research. They are referred to as Student Aiden, Student Chloe, Student Ethan, and Student Olivia. These students were selected based on their active participation in AI-supported classroom learning environments. Student Aiden and Student Chloe are secondary school students who regularly utilize AI-based adaptive learning platforms, while Student Ethan and Student Olivia are university students involved in collaborative AI-assisted learning activities. Student participation is essential because the research seeks to examine AI integration from the perspective of learners as the central actors in student-centered pedagogy (Kakarla & Mahany, 2024). Their experiences help illustrate how AI technologies influence learning motivation, autonomy, engagement, and collaborative interaction.

In addition to primary participants, the study included several supporting informants who provided supplementary contextual information. The informants consisted of one educational technology specialist, one curriculum development officer, and one information technology staff member. The educational technology specialist, referred to as Mr. Nathan, was selected because of his expertise in AI-supported instructional systems and digital learning innovation. The curriculum development officer, identified as Ms. Grace, contributed perspectives concerning curriculum adaptation and pedagogical integration strategies. Meanwhile, the IT staff member, referred to as Mr. Samuel, provided technical information regarding infrastructure readiness, system maintenance, and technological challenges encountered during AI implementation. These informants were chosen to strengthen data triangulation and provide broader institutional perspectives related to the research problem.

Data collection in this study was conducted through semi-structured interviews, classroom observations, and document analysis (Islomjon, 2025). Semi-structured interviews were selected because they allow flexibility for exploring participants' experiences, perceptions, and reflections while maintaining alignment with the research objectives. Interviews were conducted individually and lasted approximately sixty to ninety minutes for each participant. The interview process focused on themes such as AI implementation strategies, opportunities for personalized learning, pedagogical adaptation, ethical concerns, technological challenges, and institutional support systems.

Classroom observations were conducted to examine directly how AI technologies were utilized within teaching and learning activities. Observations focused on teacher-student interaction, collaborative learning practices, student engagement, instructional adaptation, and classroom participation patterns in AI-supported learning environments. Observation activities enabled the researcher to compare participants' verbal explanations with actual classroom practices, thereby improving data validity and contextual understanding (Balaquiao, 2024).

Document analysis was also utilized to support data triangulation. The analyzed documents included institutional digital learning policies, curriculum guidelines, lesson plans, AI implementation reports, and learning platform usage records. Document analysis assisted the researcher in understanding institutional strategies, pedagogical frameworks, and policy orientations related to AI-supported education (Xia et al., 2025). Furthermore, these documents provided additional evidence concerning technological integration and educational transformation processes within the selected institutions.

To ensure research credibility and trustworthiness, the study applied triangulation techniques involving multiple data sources, methods, and participant perspectives (Panagou et al., 2025). Data obtained from interviews, observations, and document analysis were compared systematically to identify consistency and variation across findings. Member checking was also conducted by providing participants with opportunities to review interview summaries and preliminary interpretations. This process helped ensure the accuracy of participants' perspectives and minimized interpretative bias. Additionally, prolonged engagement in the research setting enabled the researcher to develop contextual familiarity and strengthen the depth of data interpretation.

The data analysis process employed thematic analysis techniques (Marquardson, 2024). Thematic analysis was selected because it allows the researcher to identify, organize, and interpret recurring themes emerging from qualitative data systematically. The analysis process began with data transcription, followed by repeated reading to gain comprehensive understanding of participants' experiences and perspectives. Subsequently, the researcher conducted open coding to identify meaningful concepts and significant statements related to AI integration and student-centered pedagogy. Similar codes were then categorized into broader thematic patterns representing opportunities, challenges, pedagogical adaptation, institutional support, ethical concerns, and learner engagement.

The interpretation of themes was conducted inductively while remaining connected to the theoretical framework employed in the study, namely Constructivist Learning Theory, TPACK Theory, and Diffusion of Innovation Theory. This analytical strategy enabled the researcher to examine

relationships between empirical findings and conceptual perspectives systematically. Finally, conclusions were drawn through an iterative interpretative process involving comparison of themes, theoretical reflection, and contextual analysis. The conclusion-drawing technique emphasized credibility, coherence, and analytical depth to ensure that research findings accurately represented participants' experiences and educational realities.

Overall, the qualitative case study methodology applied in this research provides a comprehensive framework for understanding the opportunities and challenges of integrating Artificial Intelligence in classroom learning environments oriented toward student-centered pedagogy. Through in-depth exploration of participants' experiences, institutional contexts, and pedagogical practices, the study contributes meaningful insights into educational transformation in the digital era while maintaining methodological rigor consistent with the standards of internationally indexed academic journals.

RESULTS AND DISCUSSION

The findings of this study demonstrate that the integration of Artificial Intelligence (AI) in classroom learning significantly influences the implementation of student-centered pedagogy in contemporary educational environments (Alvarez & Cress, 2024). The research identified both substantial opportunities and critical challenges associated with AI-supported instructional practices. Based on interviews, classroom observations, and document analysis conducted at Global Future Senior High School and Digital Learning University, AI technologies were found to contribute positively to personalized learning experiences, student engagement, instructional flexibility, and collaborative learning activities. Nevertheless, the findings also revealed important concerns related to pedagogical readiness, ethical implications, technological dependency, and institutional adaptation. These findings are closely connected to the primary research problem concerning how AI can be integrated effectively into classroom learning while maintaining the principles of student-centered pedagogy.

Table

Table 1 Summary of Research Findings on the Integration of Artificial Intelligence in Classroom Learning

Research Focus	Main Findings	Related Theory	Educational Implications
AI Integration in Student-Centered Learning	AI technologies increased learning personalization, student autonomy, and collaborative engagement	Constructivist Learning Theory	AI supports active and inquiry-based learning environments
Teacher Pedagogical Adaptation	Teachers experienced challenges in balancing pedagogy and technology integration	TPACK Theory	Teachers require continuous digital pedagogical training
Institutional Readiness	Schools with stronger infrastructure implemented AI more effectively	Diffusion of Innovation Theory	Institutional support influences successful innovation adoption
Ethical and Academic Concerns	Participants expressed concerns regarding plagiarism, overreliance, and reduced critical thinking	Constructivism and TPACK	Ethical AI literacy is essential in classroom implementation
Student Learning Engagement	Students demonstrated higher motivation and participation through AI-assisted learning activities	Constructivist Learning Theory	Interactive AI tools promote collaborative learning

Research Focus	Main Findings	Related Theory	Educational Implications
Innovation Adoption Challenges	Resistance emerged due to technological anxiety and unequal digital literacy	Diffusion of Innovation Theory	Educational transformation requires organizational adaptation

One of the major findings of this study indicates that AI-supported learning platforms significantly enhanced personalized learning experiences for students (Shukla, 2025). Teachers reported that adaptive learning systems enabled students to progress according to their learning pace, academic ability, and individual interests. Students who previously experienced learning difficulties demonstrated improved participation and confidence when using AI-assisted instructional tools. Classroom observations further revealed that AI-based simulations and interactive platforms encouraged inquiry-based learning and collaborative problem-solving activities. These findings strongly support Constructivist Learning Theory developed by Jean Piaget, which emphasizes that learners actively construct knowledge through interaction and experience (Darwish et al., 2024). The implementation of AI technologies in this study created learning environments that encouraged exploration, reflection, and independent learning processes consistent with constructivist principles.

The findings also align with Lev Vygotsky's sociocultural learning perspective, particularly regarding the role of mediation and scaffolding in educational processes (Collins, 2025). AI tools functioned as digital scaffolding instruments that supported students in completing complex learning tasks and participating more actively in collaborative discussions. Several students explained that AI-generated feedback assisted them in understanding difficult concepts independently before engaging in classroom discussion activities. This demonstrates that AI technologies may facilitate the Zone of Proximal Development by supporting students' cognitive growth through guided interaction. Furthermore, the findings reinforce Jerome Bruner's concept of discovery learning because students were encouraged to explore learning materials autonomously through AI-supported educational platforms (Nurfauziah et al., 2025). Consequently, the integration of AI technologies contributed positively to the implementation of student-centered pedagogy by strengthening active learning participation and learner autonomy.

Another significant finding concerns teachers' pedagogical adaptation during AI implementation. Although teachers acknowledged the benefits of AI technologies, many participants experienced challenges in balancing technological integration with instructional objectives. Several teachers reported difficulties in selecting appropriate AI tools, designing meaningful learning activities, and maintaining classroom interaction while utilizing digital technologies. These findings are strongly connected to Technological Pedagogical Content Knowledge (TPACK) Theory introduced by Punya Mishra and Matthew J. Koehler (Kavitha et al., 2024). According to TPACK theory, effective educational technology integration requires teachers to combine technological knowledge, pedagogical competence, and content expertise simultaneously. The findings demonstrate that teachers who possessed stronger digital pedagogical competence implemented AI more effectively in student-centered learning environments compared to those with limited technological confidence.

The implementation of TPACK dimensions was evident in the instructional practices observed during the study. Teachers who successfully integrated AI technologies demonstrated the ability to adapt instructional strategies creatively while maintaining collaborative learning activities and meaningful classroom interaction. However, some participants admitted that AI integration occasionally shifted classroom focus toward technology operation rather than pedagogical engagement. This finding confirms the importance of Judi Harris's perspective that educational technology should support pedagogical objectives rather than dominate instructional processes (Wu et al., 2025). Furthermore, the findings support Lee Shulman's argument regarding the importance of Pedagogical Content Knowledge because effective AI implementation requires teachers to contextualize technological tools within specific learning objectives and classroom needs (Kryva, 2025).

The study additionally found that institutional readiness significantly influenced the success of AI implementation in classroom learning. Educational institutions with stronger technological infrastructure, supportive leadership, and structured digital learning policies demonstrated more effective AI integration practices. Teachers in these institutions reported greater confidence and institutional encouragement in experimenting with AI-supported pedagogical innovation. In contrast, participants from departments with limited technological support experienced greater implementation difficulties and resistance toward instructional transformation. These findings are closely related to Everett M. Rogers's Diffusion of Innovation Theory, which explains that innovation adoption depends on factors such as compatibility, complexity, institutional communication, and perceived usefulness (Singla, 2025).

The findings indicate that teachers were more likely to adopt AI technologies when institutional leadership provided professional development opportunities, technical support, and clear implementation guidelines. This observation also supports Fred D. Davis's Technology Acceptance Model, which emphasizes that users' perceptions regarding usefulness and ease of use strongly influence technological adoption behavior (Holovko et al., 2025). Several participants explained that they initially resisted AI integration because of concerns regarding complexity and technological uncertainty. However, after receiving institutional training and observing positive student responses, their attitudes toward AI became increasingly positive. Geoffrey A. Moore's concept regarding the transition from early adopters to broader implementation was also reflected in the findings, as some educational departments demonstrated rapid innovation adoption while others remained hesitant due to organizational and cultural barriers (Hu, 2025).

The findings further reveal that AI integration generated important ethical and academic concerns among participants (X. Liu et al., 2024). Teachers expressed concerns regarding students' overdependence on generative AI tools, reduced critical thinking engagement, and increased risks of plagiarism and academic dishonesty. Students similarly acknowledged that AI technologies occasionally tempted them to rely excessively on automated responses rather than developing independent analytical skills. These findings represent one of the most critical challenges associated with AI-supported learning environments and are directly connected to the primary research problem. Constructivist theory suggests that meaningful learning requires active cognitive engagement and reflective understanding. Therefore, excessive dependence on AI-generated information may weaken students' opportunities for deep conceptual learning and critical inquiry.

From the perspective of TPACK theory, these ethical challenges demonstrate that technological competence alone is insufficient for effective AI implementation. Teachers require pedagogical strategies that encourage critical evaluation, reflective discussion, and responsible technology use. Several participants explained that they addressed these challenges by designing collaborative projects, problem-based learning activities, and classroom discussions requiring students to analyze and evaluate AI-generated content critically. These pedagogical adaptations illustrate how educators attempted to maintain student-centered learning principles despite technological automation. Additionally, Diffusion of Innovation Theory helps explain why ethical concerns influenced institutional resistance toward AI adoption. Some administrators expressed hesitation regarding unrestricted AI usage because of uncertainties related to academic integrity and educational quality assurance.

The findings also contribute to addressing the research gap identified in previous studies. Earlier research frequently focused either on technological effectiveness or user acceptance without comprehensively examining the pedagogical and institutional dimensions of AI integration simultaneously (Reisman, 2024). The present study demonstrates that successful AI-supported learning depends not only on technological availability but also on teacher readiness, institutional adaptation, ethical governance, and pedagogical transformation. By integrating Constructivist Learning Theory, TPACK Theory, and Diffusion of Innovation Theory, this research provides a more comprehensive understanding of how AI influences classroom learning practices within student-centered educational frameworks.

The implementation of these theories is reflected clearly in the research findings. Constructivist theory explains how AI technologies support active learning, inquiry-based instruction, and collaborative participation. TPACK theory clarifies the pedagogical competencies required for balancing technological innovation with instructional effectiveness. Diffusion of Innovation Theory illustrates the institutional and organizational factors influencing educational transformation and technology adoption processes. Consequently, the findings demonstrate that AI integration in classroom learning should be understood as a multidimensional educational transformation rather than merely a technological intervention.

The results of this study also directly answer the formulated research questions. Regarding the first research question concerning how AI can be integrated effectively into classroom learning, the findings indicate that successful implementation requires pedagogical alignment, institutional support, and teacher technological competence. AI technologies become more effective when utilized to facilitate collaboration, inquiry, and personalized learning rather than replacing teacher-student interaction. Concerning the second research question, the study found that AI integration provides opportunities for increasing student motivation, learning flexibility, adaptive instruction, and collaborative participation (Gruber, 2025). Students reported greater engagement when learning activities incorporated interactive AI-supported platforms and real-time feedback systems.

The third research question examined challenges associated with AI implementation. The findings identified several major challenges, including technological inequality, limited teacher readiness, ethical concerns, academic integrity issues, and resistance toward educational transformation. These findings are consistent with previous research indicating that technological innovation in education frequently encounters institutional, pedagogical, and psychological barriers (X. Wang, 2025). The fourth research question explored strategies for optimizing AI integration ethically and pedagogically. The study found that effective implementation requires continuous teacher professional development, institutional digital literacy programs, ethical technology guidelines, and collaborative instructional design emphasizing student-centered learning principles.

The findings further support the objectives of the present research. The first objective aimed to analyze opportunities generated by AI integration in classroom learning. The findings confirmed that AI technologies enhance personalized instruction, learner autonomy, collaborative engagement, and instructional flexibility. The second objective focused on identifying implementation challenges, and the findings revealed important issues related to ethics, technological readiness, and pedagogical adaptation. The third objective sought to formulate strategies for effective AI-supported student-centered learning, which was addressed through recommendations emphasizing teacher training, institutional policy development, and ethical AI literacy education.

From a theoretical perspective, the findings contribute significantly to educational technology discourse by expanding understanding regarding the relationship between AI integration and student-centered pedagogy. The research demonstrates that constructivist educational principles remain highly relevant in technologically mediated learning environments. The findings also strengthen the applicability of TPACK theory within AI-supported instructional contexts and confirm the continuing relevance of innovation diffusion perspectives in educational transformation processes.

Academically, this study contributes to interdisciplinary scholarship involving education, digital pedagogy, instructional technology, and innovation studies. The integration of three theoretical perspectives provides a comprehensive analytical framework for future investigations concerning AI-supported education. The findings may serve as an important academic reference for researchers examining pedagogical adaptation, digital transformation, and ethical technology implementation in educational settings.

Practically, the findings provide valuable implications for teachers, educational institutions, curriculum developers, and policymakers. Teachers are encouraged to integrate AI technologies strategically while maintaining collaborative and inquiry-based learning practices. Educational

institutions should strengthen technological infrastructure, provide professional development programs, and establish ethical AI implementation guidelines. Policymakers should also develop balanced educational policies supporting innovation while protecting academic integrity and learner well-being.

The findings of this study are consistent with several previous investigations concerning AI integration in education. Previous studies reported that AI technologies improve learning personalization and student engagement, which aligns with the current findings regarding adaptive learning systems and collaborative participation (Karan, 2024). Earlier research also emphasized the importance of teacher readiness and institutional support, supporting the present study's findings related to TPACK competence and organizational adaptation. Furthermore, prior investigations identified ethical concerns regarding plagiarism and overreliance on AI technologies, which were similarly observed in this research (Peters & Déri, 2025).

However, the present study extends previous findings by integrating pedagogical, technological, and institutional perspectives simultaneously within the framework of student-centered learning. This integrative approach represents the novelty of the research because earlier investigations frequently examined AI implementation from isolated perspectives. The present findings therefore contribute more comprehensive insight into the opportunities and challenges associated with AI-supported classroom learning in contemporary educational environments.

Overall, the discussion demonstrates that integrating Artificial Intelligence into classroom learning offers transformative opportunities for advancing student-centered pedagogy while simultaneously presenting significant pedagogical, ethical, and institutional challenges. The findings highlight the importance of balancing technological innovation with human-centered educational values to ensure meaningful learning experiences. Through the integration of Constructivist Learning Theory, TPACK Theory, and Diffusion of Innovation Theory, this study provides a comprehensive understanding of AI-supported educational transformation and contributes valuable theoretical, academic, and practical implications for the future development of digital pedagogy in the global educational landscape.

CONCLUSION

The findings of this study demonstrate that the integration of Artificial Intelligence (AI) in classroom learning has become a transformative educational development that significantly influences the implementation of student-centered pedagogy in contemporary educational environments. Based on the results and discussion, the study concludes that AI technologies provide substantial opportunities for enhancing personalized learning, student engagement, collaborative participation, and instructional flexibility. AI-supported educational platforms enable students to learn according to their individual abilities, learning pace, and academic interests, thereby strengthening learner autonomy and active participation within classroom learning activities. The implementation of adaptive learning systems, intelligent tutoring applications, interactive simulations, and AI-generated feedback mechanisms contributed positively to inquiry-based learning practices and promoted more dynamic educational interaction between teachers and students.

The research findings further indicate that AI integration supports the realization of constructivist learning principles by encouraging students to become active participants in the knowledge construction process. Students were observed to engage more actively in collaborative learning activities, reflective discussions, and independent exploration when AI technologies were integrated appropriately into classroom instruction. The findings therefore confirm the relevance of Constructivist Learning Theory proposed by Jean Piaget, Lev Vygotsky, and Jerome Bruner, particularly regarding the importance of learner-centered interaction, cognitive engagement, and collaborative educational experiences. AI technologies functioned not merely as instructional tools but also as mediating instruments that facilitated scaffolding, exploration, and problem-solving activities in student-centered learning environments.

However, the study also concludes that the successful integration of AI in classroom learning depends significantly on teachers' pedagogical competence and technological readiness. The findings

revealed that teachers who possessed stronger abilities in combining technological knowledge, pedagogical strategies, and content mastery were more effective in implementing AI-supported learning activities. This conclusion supports the relevance of Technological Pedagogical Content Knowledge (TPACK) Theory developed by Punya Mishra and Matthew J. Koehler. The study found that AI integration cannot be separated from the pedagogical capacity of educators to design meaningful, collaborative, and ethically responsible learning experiences. Teachers who lacked confidence in technological adaptation experienced greater challenges in balancing instructional objectives with digital innovation, which occasionally reduced the effectiveness of student-centered learning practices.

The findings additionally conclude that institutional readiness plays a central role in determining the effectiveness of AI-supported educational transformation. Educational institutions that provided adequate technological infrastructure, professional development opportunities, digital literacy programs, and supportive leadership demonstrated more successful implementation of AI in classroom learning. This finding is strongly connected to Diffusion of Innovation Theory introduced by Everett M. Rogers, which emphasizes that innovation adoption is influenced by organizational culture, communication systems, perceived usefulness, and institutional support structures. The study confirms that educational transformation through AI implementation requires not only technological access but also organizational adaptation, strategic planning, and continuous professional support for teachers and learners.

At the same time, the study concludes that AI integration presents several significant pedagogical and ethical challenges that require careful consideration. Participants expressed concerns regarding excessive dependence on AI technologies, declining critical thinking engagement, academic dishonesty, and plagiarism risks associated with generative AI applications. These concerns indicate that technological innovation may unintentionally weaken meaningful learning processes if not accompanied by appropriate pedagogical guidance and ethical regulation. The findings therefore emphasize the necessity of maintaining balanced educational practices in which AI technologies support rather than replace human interaction, reflective thinking, and collaborative learning experiences. Consequently, ethical AI literacy and responsible technology use emerge as essential components of future educational practices.

The study also concludes that the integration of AI into classroom learning should be understood as a multidimensional educational transformation rather than merely a technical innovation. The opportunities and challenges identified in this research demonstrate that AI implementation affects pedagogical interaction, institutional culture, teacher identity, student autonomy, and educational policy simultaneously. Through the integration of Constructivist Learning Theory, TPACK Theory, and Diffusion of Innovation Theory, the study provides a comprehensive understanding of how AI technologies reshape educational practices within student-centered learning environments. The findings confirm that educational innovation requires balanced integration between technological advancement and humanistic educational values.

Furthermore, the study concludes that the novelty of the research lies in its interdisciplinary analysis of AI-supported classroom learning through pedagogical, technological, and institutional perspectives simultaneously. Unlike previous studies that primarily focused on technological effectiveness or user acceptance independently, this research demonstrates the interconnected relationship between learner-centered pedagogy, teacher competence, institutional readiness, and ethical educational transformation. The findings therefore contribute significant theoretical, academic, and practical implications for the development of digital pedagogy in contemporary education.

From a theoretical perspective, the study enriches scholarly discussion concerning educational technology and student-centered learning by demonstrating the continuing relevance of constructivist principles within AI-supported educational environments. Academically, the research provides a comprehensive conceptual framework for future interdisciplinary studies related to AI integration in education. Practically, the findings offer valuable recommendations for teachers, educational institutions, and policymakers regarding the importance of pedagogical adaptation, technological training, ethical AI governance, and collaborative instructional design.

In conclusion, the study confirms that Artificial Intelligence possesses considerable potential to strengthen student-centered pedagogy when implemented strategically, ethically, and pedagogically. Nevertheless, the successful integration of AI in classroom learning requires continuous collaboration among educators, institutions, policymakers, and learners to ensure that technological innovation contributes positively to meaningful, inclusive, and human-centered educational transformation in the digital era.

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