

Teachers' Roles in AI-Integrated Gamified Learning Environments to Enhance Creativity and Students' Critical Thinking

Hendarman ¹, Dian Sudiantini ², Mayadi ³, Mira Mirnawati ⁴, Lisa Chandrasari Desianti ⁵

¹ Pakuan University, Bogor, Indonesia; hendarmananwar@gmail.com

² Bhayangkara University, Jakarta Raya, Indonesia; dian.sudiantini@dsn.ubharajay.ac.id

³ Bhayangkara University, Jakarta Raya, Indonesia; miramirnawati@unpak.ac.id

⁴ Pakuan University, Bogor, Indonesia; mayadi@dsn.ubharajaya.ac.id

⁵ Pakuan University, Bogor, Indonesia; lisachandrasari@unpak.ac.id

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Abstract

This study examines the role of teachers in designing and implementing AI-integrated gamified learning environments to enhance teacher creativity and students' critical thinking skills at the senior high school level. Grounded in the demands of 21st-century education, this research responds to persistent challenges in classroom practice, including low student motivation, limited literacy skills, and passive learning engagement. Employing a qualitative case study approach, data were collected through in-depth interviews with 30 teachers, supported by analysis of student learning instruments. Thematic analysis was used to identify patterns related to teachers' pedagogical creativity, instructional decision-making, and classroom interactions. The findings suggest that teachers play a crucial role in transforming gamification from a technical tool into a meaningful pedagogical strategy by creatively integrating AI-supported features, such as personalized feedback, adaptive learning pathways, and smart tutoring assistance. Teachers reported that this approach increased students' learning motivation, engagement, and ability to critically analyze and understand concepts. However, the study also reveals challenges faced by teachers, including variations in student readiness, low literacy levels, and students' overreliance on technological support without deep reflection. The study concludes that the effectiveness of gamified learning environments depends largely on teachers' creative and reflective pedagogical practices, particularly when supported by AI-driven personalization. These findings underscore the strategic role of teachers as key agents of innovation and contribute to the development of teacher-centered, technology-enhanced learning models that aim to strengthen creativity and critical thinking skills in Indonesian secondary education.

Keywords

AI in Learning; Critical Thinking; Gamification; Teacher Creativity

Corresponding Author

Hendarman

Pakuan University, Bogor, Indonesia; hendarmananwar@gmail.com

1. INTRODUCTION

In the context of 21st-century education, many classrooms continue to struggle with low student engagement, limited critical thinking development, and passive learning behaviors. Despite curriculum reforms emphasizing higher-order thinking skills, instructional practices in secondary education often



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remain teacher-centred and content-driven, limiting opportunities for students to construct knowledge and develop analytical abilities actively. At the same time, teachers are increasingly required to integrate digital technologies into their teaching practices without sufficient pedagogical support or clear instructional frameworks. This gap between educational demands and classroom realities highlights an urgent need for innovative teaching approaches that can simultaneously enhance student engagement and support teachers' instructional creativity (Lubbe et al., 2025). Although contemporary assessments increasingly prioritize critical thinking and creativity, many students continue to struggle with applying these skills meaningfully in classroom learning contexts (Xia et al., 2024).

In response to these challenges, gamification has been widely adopted in schools as a practical strategy to increase student motivation and participation. Digital platforms such as Quizizz and Kahoot have been shown to stimulate classroom interaction and reduce learner disengagement. However, empirical evidence indicates that the use of gamification often remains superficial, focusing primarily on competition, rewards, and short-term engagement rather than fostering deeper cognitive processes such as analysis, reflection, and critical reasoning (Dichev & Dicheva, 2017). Moreover, teachers often face challenges in aligning gamified activities with learning objectives, assessment requirements, and the diverse needs of students. While the integration of Artificial Intelligence has been proposed as a potential solution to enhance personalization and adaptive feedback, its application in classrooms raises concerns regarding overreliance on technology and the risk of diminishing students' autonomous thinking if not pedagogically guided (Bedrossian, 2021); (Szmyd & Mitera, 2024). Although AI-driven tools, including chatbots and augmented reality, show promise in increasing student engagement, their instructional effectiveness remains highly dependent on how teachers design and facilitate learning activities (Nadeem et al., 2023); (Bognár et al., 2024).

Artificial Intelligence, particularly machine learning and adaptive learning technologies, offers significant opportunities to address these instructional challenges by enabling personalized gamified learning pathways. AI can support teachers by dynamically adjusting task difficulty, providing real-time feedback, and generating learning analytics to inform instructional decision-making. Nevertheless, the successful integration of AI within gamified learning environments is not merely a technical issue but a pedagogical one that requires teachers' creative and reflective involvement. When effectively implemented, AI-integrated gamification has the potential to reposition teachers from content transmitters to designers and facilitators of meaningful learning experiences, thereby supporting the development of both teacher creativity and students' higher-order thinking skills. This pedagogical transformation is particularly critical in remote and technology-mediated learning contexts, where limited face-to-face interaction may intensify student disengagement and cognitive isolation (Peng et al., 2023).

This research aims to investigate the integration of gamification and AI from the perspectives of educators and students in Indonesian secondary schools. Specifically, the study aims to understand how gamified media influence teacher creativity and student critical thinking, what challenges and benefits emerge, and what design features are most desired by practitioners. This study contributes to the growing body of literature on AI-enhanced educational innovation and the role of human-centered technology in achieving curriculum transformation. By examining these dynamics, this research provides practical insights for educators and policymakers looking to harness AI's capabilities to foster more engaging and effective learning environments (Lan & Zhou, 2025). The effective use of generative AI technology for autonomous learning is becoming increasingly critical for students to acquire skills and adapt to the rapidly changing educational landscape (L. Wang & Li, 2024).

Gamification and AI can converge to cultivate essential skills like creativity, collaboration, and critical thinking in education (Niño et al., 2024). AI can be an effective learning tool that lightens the load for both teachers and students and provides pupils with engaging learning opportunities (Zhai et al., 2021). Coupled with current educational reforms, such as the digitalization of educational resources and personalized learning experiences, there are numerous opportunities for developing AI

applications in education (Zhai et al., 2021). For example, AI techniques have been exploited to develop individualized learning environments. AI-driven tools can offer personalized learning experiences and provide immediate feedback, which helps educators manage administrative tasks and improves overall educational effectiveness and efficiency (Phua et al., 2025). These advancements can reshape the educational landscape and offer innovative opportunities (Zhao et al., 2025).

Previous studies have consistently highlighted the role of Artificial Intelligence in supporting personalized learning through data-driven student profiling. AI systems are capable of collecting and analyzing learning data to create adaptive learning environments that accommodate individual learning pace and needs (Hashim et al., 2022); (Peng et al., 2023); (Rad, 2025). Through customized feedback and tailored learning resources, AI-driven adaptive systems enable students to master concepts more effectively and progress autonomously (Zaman, 2023); (Jose et al., 2025). Several studies also emphasize that AI functions as a supplementary tool to enhance instructional efficiency and learner engagement rather than replacing teachers (Lampou, 2023); (Ayala-Pazmiño, 2023). Furthermore, AI-powered platforms have been shown to identify learning gaps, provide timely feedback, and support intelligent tutoring systems (Zou et al., 2025); (Tanjga, 2023); (Saputra et al., 2023). However, while these studies demonstrate the technical potential of AI for personalization, they largely overlook how teachers strategically design and integrate AI-supported systems within pedagogical frameworks, particularly in gamified learning environments.

Research on gamification has similarly demonstrated its effectiveness in increasing student motivation, engagement, and participation across educational contexts (Li & Pan, 2023). When combined with AI, gamified platforms are reported to offer faster feedback, adaptive content delivery, and decision-support mechanisms for teachers (Shi et al., 2024); (Saputra et al., 2023); (Ward et al., 2024). AI-powered gamified systems dynamically adjust instructional content based on students' real-time performance, fostering a responsive and interactive learning environment (Merino-Campos, 2025). Despite these promising outcomes, existing studies predominantly focus on student engagement and system performance, paying limited attention to the pedagogical role of teachers in creatively integrating gamification and AI to promote higher-order cognitive skills, particularly critical thinking.

Other studies emphasize AI's capacity to analyze learning data, identify patterns, and forecast learning outcomes to support differentiated instruction (Harry & Sayudin, 2023); (Jose et al., 2025). AI-facilitated personalization enables instruction to be tailored according to students' learning styles, preferences, and strengths, thereby enhancing instructional efficiency and scalability. Nonetheless, these studies tend to frame AI as an autonomous instructional agent, with insufficient discussion of teachers' creative decision-making processes in leveraging AI-generated insights to design meaningful learning experiences.

Beyond cognitive outcomes, several scholars highlight AI's contribution to learner-centered education by supporting emotional intelligence, creativity, inclusivity, and mental well-being (Kamalov & Gurrib, 2023); (Lampou, 2023). AI systems have been shown to provide inclusive learning opportunities for students with special needs and language barriers, as well as to automate administrative tasks that allow teachers to focus more on instructional activities (Rizvi et al., 2023). Adaptive learning platforms further demonstrate potential in addressing long-standing challenges in differentiated instruction (Sposato, 2025). However, these studies rarely examine how teachers creatively mediate AI-supported systems to strike a balance between technological efficiency and reflective and critical learning practices.

Additional research underscores AI's expanding role in language learning, academic writing assistance, and teacher professional development (Tilfarlioğlu & Yalçın, 2005); (Gudonien.e et al., 2023); (Adewale et al., 2024). AI chatbots and personalized learning systems have been found to enhance instructional support and optimize learning outcomes by responding to individual learner needs (Peng et al., 2023). Nevertheless, the integration of AI in these studies remains largely technology-driven, with

limited exploration of how AI-integrated teachers can intentionally design gamified learning environments to foster teacher creativity and students' critical thinking skills simultaneously. Based on these gaps, this study aims to examine the role of teachers in designing and implementing AI-integrated gamified learning environments to enhance teacher creativity and students' critical thinking skills in secondary education.

2. METHODS

This study employed a qualitative descriptive approach (Ratnaningtyas et al., 2023). To explore teachers' experiences and perceptions regarding the implementation of gamified learning environments and the integration of Artificial Intelligence (AI) in classroom practice. The research was conducted in two private senior high schools in Bogor, Indonesia, involving 30 tenth-grade teachers selected through purposive sampling. Data were collected through semi-structured interviews that focused on teachers' instructional practices, classroom constraints, student engagement, creative teaching strategies, and expectations regarding AI-supported features in digital learning applications. The qualitative design enabled an in-depth examination of how AI-assisted gamification was operationalized in real classroom settings to support teacher creativity and foster students' critical thinking development.

The collected data were analyzed using thematic analysis to identify recurring patterns and meaningful categories that emerged from the teachers' responses. The coding process generated key themes related to creativity stimulation, problem-solving engagement, learning motivation, digital media responsiveness, and challenges in AI-supported instructional implementation. To enhance the trustworthiness of the findings, data triangulation was conducted by comparing teacher interview data with student learning instruments. At the same time, member checking was carried out with selected teacher participants to validate the accuracy of the interpretations. This analytical procedure provided empirical insights into the pedagogical opportunities and challenges of integrating AI-powered gamification in classroom practice, while also acknowledging broader concerns related to technological deployment in education, including data privacy, algorithmic bias, and equitable access.

3. FINDINGS AND DISCUSSIONS

Findings

The analysis of interviews with 30 teachers revealed several recurring patterns related to students' learning conditions, engagement levels, and the implementation of interactive and gamified learning strategies in tenth-grade classrooms. Teachers consistently reported that conventional teaching approaches often failed to sustain students' attention, resulting in low participation, limited critical thinking, and passive learning behaviors. In response, many teachers began experimenting with interactive and gamified digital platforms such as Quizizz and Kahoot to address declining motivation and engagement. According to teachers' accounts, students generally demonstrated increased enthusiasm, improved focus, and a greater willingness to participate when learning activities incorporated competitive elements, such as points, rankings, and audiovisual features. However, teachers also highlighted practical challenges, including technical disruptions, differences in students' learning pace, and the risk of excessive dependence on digital tools if not carefully managed. Overall, teachers emphasized the need to balance digital gamification with structured instructional guidance to ensure meaningful learning outcomes.

Students' Difficulties in Solving HOTS Problems

Based on interview data, teachers reported that many tenth-grade students continue to experience substantial difficulties when solving Higher Order Thinking Skills (HOTS) problems. These difficulties were observed across cognitive, literacy, and affective domains. A frequently mentioned issue was

students' weak understanding of basic concepts, which hindered their ability to analyze complex problems or connect information across topics. Teachers noted that students often struggled to identify relevant data, select appropriate solution strategies, and visualize abstract concepts, particularly in subjects such as Physics, Chemistry, and Mathematics. This condition was further compounded by low reading literacy, as students frequently encountered difficulties in interpreting problem statements, identifying key information, and constructing logical arguments.

Teachers also reported that students lacked confidence in responding to open-ended questions and were less accustomed to expressing their reasoning either orally or in written form. In addition, limited exposure to contextual and analytical questions contributed to students' unpreparedness for problem-solving tasks. Several teachers observed that students tended to seek instant answers from digital sources rather than engaging in reflective thinking processes. Affective factors such as low motivation, fear of making mistakes, and passive learning habits were also identified as barriers to effective problem-solving. Teachers further noted that students' cultural backgrounds and language proficiency influenced their ability to interpret questions, particularly in language-based and religious subjects. These findings indicate that students' difficulties in HOTS problem-solving stem from a combination of conceptual gaps, limited literacy skills, and underdeveloped thinking habits.

The percentages presented in Figure 1 represent estimated proportions derived from the frequency of themes emerging from teacher interviews. Each category reflects the frequency with which specific difficulties were mentioned across the interviews, rather than the results of a structured quantitative survey. As teachers could identify multiple challenges, the percentages are intended to illustrate the relative prominence of each factor from the teachers' perspectives.

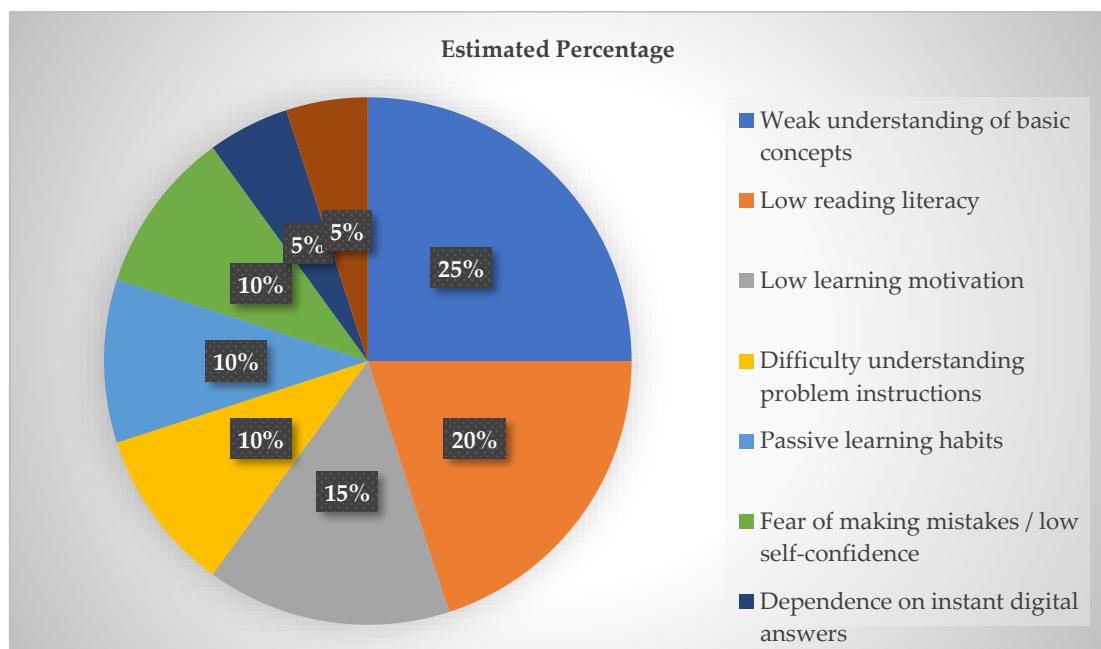


Figure 1. Percentage of Students' Difficulties in Solving HOTS Questions from the Teacher's Perspective

The data illustrated in Figure 1 reflect teachers' assessments of the main factors contributing to students' difficulties in solving HOTS-based questions. A lack of understanding of basic concepts was identified as the most dominant challenge, accounting for the largest proportion of responses. Literacy-related difficulties, including limited critical reading skills, were also reported as a significant obstacle. Other contributing factors included low motivation, difficulty understanding problem instructions, and passive learning habits. Although some challenges were reported less frequently, teachers emphasized that even minor obstacles could accumulate and negatively affect students' readiness to engage in higher-order thinking tasks.

Obstacles in Students' Learning

Teachers identified multiple obstacles affecting students' learning processes in tenth grade. One of the most commonly reported challenges was students' lack of focus and concentration during lessons. Teachers observed that students were easily distracted, particularly when using digital devices, and often shifted attention away from learning tasks. Psychological factors such as fatigue, mood fluctuations, and personal issues were also reported to influence students' classroom behavior and engagement. These conditions resulted in reduced participation and limited interaction during learning activities.

Differences in students' basic abilities were another significant challenge, especially in science-related subjects. Teachers noted that many students struggled to understand abstract material due to a lack of foundational knowledge and weak visualization skills. This issue was often accompanied by low motivation and varying levels of interest among students, particularly during the transition from junior high school to senior high school. Teachers explained that this transition required not only academic adjustment but also emotional and social adaptation, which affected students' readiness for independent learning. Additionally, teachers reported that lessons perceived as disconnected from students' real-life experiences tended to reduce engagement. While some teachers observed positive learning outcomes when instructional approaches were tailored to student needs, others found it challenging to design engaging and meaningful learning experiences in technology-rich environments.

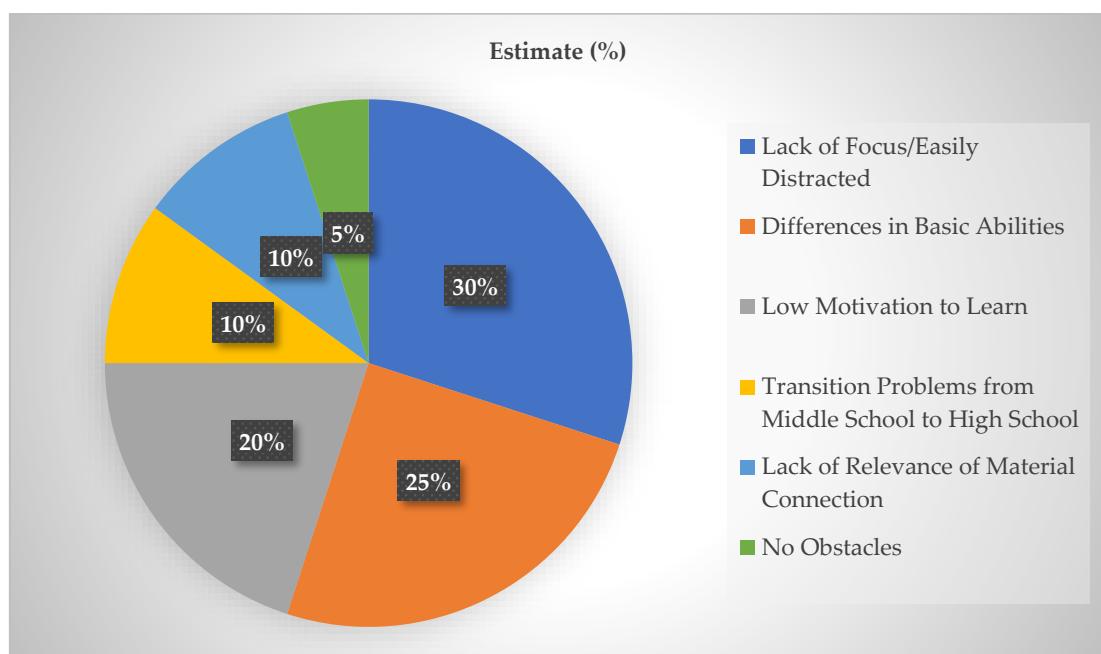


Figure 2. Student Engagement Distribution Analysis from the Teacher's Perspective

Figure 2 presents teachers' perceptions of student engagement levels in classroom learning. The data indicate that a substantial proportion of students demonstrated low to moderate enthusiasm toward learning activities, while only a small percentage were consistently active and highly engaged. Teachers highlighted that these patterns reflected the need for more adaptive, interactive, and student-centered learning strategies to address engagement disparities and encourage broader participation among students.

Benefits of Interactive and Gamified Learning Approaches

Teachers reported several benefits associated with the use of interactive and gamified learning approaches. One of the most prominent advantages was the noticeable increase in student motivation and engagement. Teachers observed that learning activities incorporating quizzes, points, levels, and

simulations made students more enthusiastic and attentive during lessons. Gamified activities reduced classroom boredom and encouraged students to participate actively, even among those who were typically passive. Teachers also noted that students appeared more focused and enjoyed the learning process when lessons were designed as interactive experiences.

In terms of learning outcomes, teachers stated that gamified approaches helped students understand concepts more effectively. Visual elements and simulations enabled students to grasp abstract material more easily and apply concepts to real-life contexts. These strategies were reported to be effective across both science-based and literacy-oriented subjects. Teachers further observed improvements in students' collaborative skills, problem-solving abilities, and willingness to express ideas during discussions. Interactive learning environments also allowed teachers to differentiate instruction by adjusting tasks to accommodate varying levels of student ability and concentration.

Teachers additionally reported positive effects on their own instructional practices. Many teachers experienced increased motivation and creativity in lesson planning, as gamification provided greater flexibility in designing learning activities. However, teachers also acknowledged challenges related to technological infrastructure, preparation time, and concerns about students becoming overly reliant on digital stimuli. Despite these challenges, teachers expressed a strong interest in instructional tools that could support personalization, feedback, and classroom management.

The percentages presented in Figure 3 represent teachers' estimated perceptions based on qualitative interview data and thematic frequency analysis, rather than direct quantitative measurement of individual students.

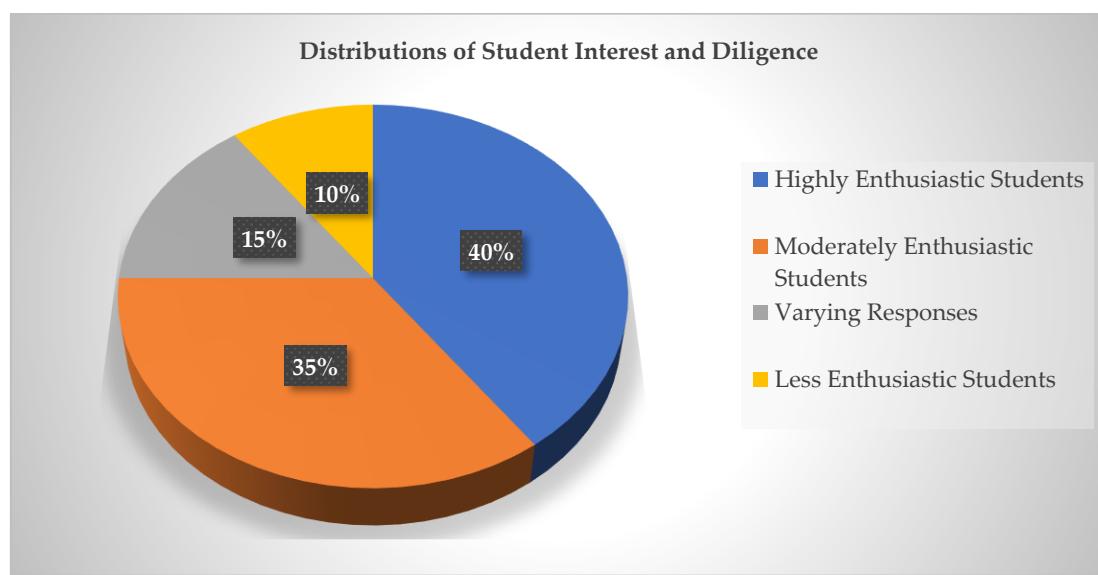


Figure 3. Distributions of Student Interest and Diligence in Learning

Figure 3 illustrates variations in students' interest and diligence as observed by teachers. While a substantial group of students demonstrated high enthusiasm and active participation, a notable proportion showed inconsistent or low engagement. Teachers emphasized that these patterns underscored the importance of adaptive and engaging learning strategies to support all learners. Overall, the findings highlight that interactive and gamified learning approaches contribute positively to classroom dynamics, student motivation, and teacher creativity when implemented with careful instructional planning and reflective practice.

Discussion

The findings of this study can be understood within the broader shift toward AI-supported pedagogical ecosystems, where Intelligent Tutoring Systems (ITS) play a central role in mediating

personalized and adaptive learning experiences (Zou et al., 2025). Rather than merely enhancing efficiency, the integration of AI within gamified environments appears to address a fundamental pedagogical challenge: balancing student engagement with the cultivation of higher-order thinking skills. This explains why teachers in this study emphasized AI-driven personalization, automated feedback, and adaptive difficulty levels. Reinforcement learning-based personalization mechanisms enable instructional systems to dynamically calibrate cognitive challenge, thereby sustaining motivation while preventing cognitive overload (Liu et al., 2025). This aligns with recent evidence that adaptive learning technologies improve engagement and conceptual understanding when instructional scaffolding is responsive to learner performance (Yaseen et al., 2025).

From a theoretical standpoint, the combination of gamification and AI extends classical gamification theory, which has often been criticized for emphasizing extrinsic motivation over deep learning outcomes (Dichev & Dicheva, 2017). By embedding AI-powered personalization and feedback mechanisms, gamified learning environments can transition from surface-level engagement to support metacognitive regulation and critical thinking. This supports prior studies demonstrating that personalized feedback and adaptive content significantly enhance learning gains compared to static instructional designs (H. Wang et al., 2023); (Zhai et al., 2021). Moreover, Natural Language Processing (NLP)-enabled dialogue systems allow ITS to prompt reflection, challenge assumptions, and guide problem-solving processes, which are essential components of critical thinking development (Martínez-Caro et al., 2020); (Zhao et al., 2025).

The study's findings also align with recent literature that emphasizes the evolving role of teachers in AI-enhanced classrooms. Rather than being replaced, teachers become creative learning designers and facilitators who orchestrate interactions between students, content, and intelligent systems. This helps explain why AI integration was perceived as a catalyst for teacher creativity in this study. By automating routine tasks such as feedback delivery and progress tracking, AI systems free teachers' cognitive resources, allowing them to focus on higher-level pedagogical decisions, collaborative learning, and socio-emotional support (Phua et al., 2025); (Silva et al., 2024). These findings support earlier work indicating that AI-enhanced environments foster innovative teaching practices when educators possess sufficient AI literacy and pedagogical autonomy (Shi et al., 2024); (Zhao et al., 2025).

At the same time, this study reinforces critical perspectives that caution against the uncritical adoption of AI in education. Ethical considerations, such as data privacy, algorithmic transparency, and equitable access, remain central to the responsible deployment of AI. Recent scholarship warns that overreliance on AI systems may lead to cognitive offloading and reduced learner autonomy if not carefully designed (Jose et al., 2025). Therefore, the effectiveness of AI-powered gamification depends not only on technological sophistication but also on intentional pedagogical alignment and ethical governance (Han et al., 2024).

In terms of contribution, this study adds to the growing body of research on AI and gamification by providing empirical insights from the Indonesian secondary education context, which remains underrepresented in global discussions on these topics. Theoretically, it contributes to a more nuanced understanding of how gamification and AI jointly support teacher creativity and student critical thinking, rather than functioning as isolated innovations. Practically, the findings suggest that educators should prioritize adaptive feedback, scaffolded challenges, and teacher-AI collaboration when designing gamified learning environments.

Nevertheless, this study has limitations. The sample size was relatively small and limited to private high schools in Bogor, Indonesia, which restricts the generalizability of the findings. Additionally, the qualitative design captures perceptions rather than measurable learning outcomes. Future research should incorporate mixed-methods approaches, larger samples, and experimental designs to examine the long-term impact of AI-powered gamification on critical thinking and creativity across diverse educational contexts.

4. CONCLUSION

This study concludes that integrating gamified learning environments with artificial intelligence (AI) has significant potential to enhance student critical thinking and teacher creativity. The findings suggest that gamification enhances engagement and motivation, while AI-driven personalization, including adaptive feedback, performance analytics, and scaffolded challenges, facilitates deeper cognitive processing and more responsive instructional design. Importantly, AI functions most effectively as a pedagogical complement rather than a replacement for conventional teaching, reinforcing the teacher's role as a creative facilitator of learning. From a theoretical perspective, this study contributes to the growing literature on educational innovation by demonstrating how the synergy between gamification and AI can facilitate learning that transcends surface-level engagement and fosters higher-order thinking skills. The findings extend prior research by situating AI-enhanced gamification within the context of secondary education in Indonesia, highlighting its relevance for fostering critical thinking and instructional creativity in the development of educational systems. Practically, the results suggest that educators should prioritize adaptive learning features, meaningful feedback, and human–AI collaboration when designing gamified instructional strategies to maximize learning effectiveness.

In terms of implications, this study highlights the need for systemic support to ensure the successful implementation of this approach. Teacher training, adequate digital infrastructure, and ethical governance are essential prerequisites for effectively leveraging AI-powered gamification. In this regard, the Indonesian government, particularly through the Ministry of Primary and Secondary Education and regional education offices, should strengthen policies related to AI integration in schools, while simultaneously investing in professional development programs that enhance teachers' digital and pedagogical competencies. Future research is recommended to expand the scope of investigation by involving larger and more diverse samples, employing mixed-methods or experimental designs, and examining long-term learning outcomes. Further studies may also explore student learning autonomy, ethical considerations, and the differential impact of AI-driven gamification across subjects and educational levels. Such research will be critical for refining evidence-based strategies and ensuring the sustainable and equitable integration of AI in education.

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