OPEN ACCESS
Al-Hijr: Journal of Adulearn World
Vol. 5 No. 2. April 2026, pp. 89-102 DOI. 10.55849/alhijr.v5i2.1272

Research Article

GAME-BASED LEARNING AND STUDENT ENGAGEMENT: EXPLORING THE ROLE OF AI IN EDUCATIONAL GAMES

Mohammad Ariswara Rai Djafar[1], Dilshan Parera[2], and Lamsike Pateda[3]
[1] Institut Agama Islam Negeri Sultan Amai Gorontalo, Indonesia
[2] University of Colombo, Sri Lanka
[3] Institut Agama Islam Negeri Sultan Amai Gorontalo, Indonesia

Corresponding Author:

Mohammad Ariswara Rai Djafar,
Department of Islamic Education, Faculty of Postgraduate, Institut Agama Islam Negeri Sultan Amai Gorontalo.
Jl. Gelatik No. 1 Kota Gorontalo, Indonesia
Email: ariswara86@gmail.com

Article Info

Received: October 07, 2025
Revised: January 15, 2026
Accepted: March 23, 2026
Online Version: April 30, 2026

Abstract

Game-based learning (GBL) has emerged as an innovative approach to engage students and enhance learning outcomes. With advancements in artificial intelligence (AI), educational games are increasingly capable of providing personalized learning experiences. This study investigates the role of AI in GBL and its impact on student engagement and academic performance. The research aims to evaluate how AI-powered educational games influence student motivation, retention, and interaction with learning materials. A mixed-methods approach was employed, combining quantitative assessments of student performance and qualitative feedback from students and educators. The findings indicate that AI-enhanced educational games significantly increase student engagement, with an observed 25% improvement in participation and a 20% increase in academic achievement. Students reported higher levels of motivation, while teachers noted improved performance in both individual and group learning contexts. These results suggest that AI-driven personalization within educational games can effectively address individual learning needs, making learning more interactive and adaptive. The study concludes that while AI-powered games are a promising tool for enhancing education, they must be integrated with traditional teaching methods to maintain the essential human connection in the learning process. Future research should focus on the long-term effects of AI in GBL and explore the ethical considerations surrounding data privacy and AI biases.

Keywords: artificial intelligence, educational games, game-based learning, personalized learning, student engagement

Journal Homepage https://ejournal.staialhikmahpariangan.ac.id/Journal/index.php/alhijr
How to cite: Djafar, M. A., Parera, D., & Pateda, L. (2026). Game-Based Learning and Student Engagement: Exploring the Role of AI in Educational Games. *Al-Hijr: Journal of Adulearn World, 5*(2), 89–102. https://doi.org/10.55849/alhijr.v4i1.1420
Published by: Sekolah Tinggi Agama Islam Al-Hikmah Pariangan Batusangkar

INTRODUCTION

The integration of technology into education has transformed the landscape of learning, providing innovative ways to engage students and enhance educational outcomes (LaBrie et al., 2025). One of the most promising developments in educational technology is game-based learning (GBL), which uses games as tools for learning in both formal and informal settings. As education continues to evolve in the digital age, the use of AI in educational games has gained significant attention (Juvrud et al., 2025). AI-powered educational games have the potential to personalize the learning experience, adapt to individual student needs, and improve student engagement. Recent advancements in AI have led to the development of adaptive learning systems within educational games, allowing for real-time feedback, tailored challenges, and progression paths that match students' skill levels. These innovations have the potential to revolutionize how students interact with learning materials, fostering a deeper connection to the content while making learning more enjoyable (Farooq et al., 2025). Despite these advancements, the full impact of AI in educational games on student engagement remains an area that requires deeper exploration, especially in terms of how such games enhance motivation, retention, and long-term academic success.

Game-based learning has been increasingly used across various educational settings, demonstrating its effectiveness in increasing student engagement and improving learning outcomes (Kharbouch et al., 2025). The gamification of learning integrates elements of gameplay—such as rewards, levels, and challenges—into the educational experience to enhance motivation. Research has shown that students who are more engaged with their learning are more likely to retain information and develop a deeper understanding of the subject matter (Viberg O. et al., 2023). However, while traditional GBL tools have yielded positive results in terms of engagement, the introduction of AI into these systems adds another layer of sophistication by enabling personalized learning pathways. The potential for AI to enhance GBL by creating adaptive and responsive learning environments makes it a valuable tool in the modern classroom (Beer et al., 2010). However, the interaction between AI, GBL, and student engagement remains under-researched, particularly in the context of how AI influences student motivation and learning outcomes across diverse educational settings.

The convergence of AI and GBL represents a significant opportunity for advancing educational practices. AI in educational games allows for continuous assessment and feedback, which can lead to more targeted and effective learning experiences (Thammaboosadee, 2025). Through AI-driven analytics, educational games can assess student progress in real time and adjust the level of difficulty to keep students engaged without overwhelming them. This dynamic interaction between the learner and the game system creates a more immersive and personalized learning environment (Smith & Conway, 2025). With the increasing interest in personalized learning, AI-powered educational games have the potential to bridge the gap between individual learning needs and educational content. This technology is particularly relevant in today's digital era, where learners are accustomed to interactive, technology-driven experiences (Sotoca-Orgaz et al., 2025). The background of this study explores the intersection of AI and GBL and sets the stage for a deeper investigation into how these innovations can be utilized to improve student engagement in education.

Despite the growing interest and investment in AI-powered educational games, there is still limited research that examines how these technologies affect student engagement, especially in the long term (Moro M. et al., 2020). While AI has shown promise in improving personalized learning experiences, its impact on student motivation, learning behaviors, and academic success remains unclear. Additionally, many educational games currently in use do not leverage the full potential of AI to adapt to the unique needs of each student. This raises important questions regarding how AI can be optimized within educational games to enhance

engagement while ensuring that the technology does not overpower or replace the teacher-student dynamic (Mahmoudi-Dehaki & Nasr-Esfahani, 2024). The lack of robust studies exploring the relationship between AI and engagement in GBL means that educators and developers are missing critical insights on how to create more effective learning experiences (Chang et al., 2026). It is necessary to explore the specific role that AI plays in shaping students' interactions with game-based learning environments and how it influences their overall learning outcomes.

Furthermore, while the integration of AI into GBL has gained momentum, there is little consensus on best practices for utilizing AI in this context. Teachers and educators are often unsure of how to incorporate AI-driven games effectively into their teaching practices. Some educational systems and institutions still lack the infrastructure to fully support AI integration, limiting its widespread use (Siuko et al., 2025). In many cases, AI tools in educational games are seen as supplementary, rather than essential, components of the learning process. This research aims to address these gaps by investigating the specific ways in which AI-powered educational games can contribute to increased student engagement, motivation, and retention (Arantes et al., 2025). By identifying both the strengths and challenges of these tools, this study seeks to provide practical recommendations for educators seeking to implement AI-driven educational games in their classrooms.

Another critical issue is the potential over-reliance on AI technologies in the classroom, which could inadvertently undermine the importance of teacher-student relationships. While AI has the capacity to personalize learning and automate certain aspects of the educational experience, it is essential that it complements rather than replaces human interaction (Khoshgoftar et al., 2025). Personalized learning should be seen as a tool to empower teachers and students, not as a substitute for traditional pedagogical practices. This research will explore the balance between AI-driven learning and traditional teaching methods, addressing concerns about the potential for technology to disconnect students from real-world educational experiences (Tripathy et al., 2023). The study will also examine how AI-powered games can be designed to enhance, rather than diminish, the essential role of the teacher in facilitating meaningful learning experiences.

This study aims to explore the effectiveness of AI-powered educational games in enhancing student engagement in the classroom (C. I. Tan et al., 2025). The primary goal is to understand how machine learning algorithms integrated into educational games can personalize learning pathways, adapt to individual student needs, and provide real-time feedback. The research will assess whether AI-driven educational games lead to measurable improvements in student outcomes, particularly in terms of academic achievement and engagement levels. Specifically, the study seeks to evaluate how AI technology in educational games affects students' intrinsic motivation to learn and their overall experience in digital classrooms (Rajcsanyi-Molnar et al., 2025). The research will also explore the role of personalized feedback in fostering student autonomy and self-regulated learning, which are critical components of successful educational outcomes.

The second objective of the study is to identify the key challenges and limitations associated with the integration of AI in educational games (Howcroft & Hopkins, 2024). While AI presents a valuable opportunity for personalized learning, its implementation may face obstacles such as technical constraints, lack of teacher training, or resistance from students and educators unfamiliar with AI technologies. This research will examine these barriers and provide recommendations for addressing them in order to ensure the successful adoption and integration of AI-powered educational tools in classrooms (Pacheco-Velazquez et al., 2024). By identifying the challenges that hinder the effective use of AI in education, this study aims to contribute to the development of more accessible and efficient AI-powered learning environments.

Finally, the research will explore the potential for AI in GBL to complement traditional pedagogical methods. The goal is to determine how AI tools can be integrated into classroom instruction to support, rather than replace, teachers (Zhou et al., 2025). While AI has the potential to create more personalized learning experiences, it is essential to examine how it interacts with teacher-student relationships and contributes to the overall learning ecosystem. This objective aims to provide insights into how AI-powered games can help teachers tailor their instructional strategies and create more dynamic, engaging, and effective learning environments for students (Bilous et al., 2025). The study will also explore the ethical implications of using AI in education, particularly in terms of data privacy and the potential for algorithmic bias, ensuring that AI technologies are used responsibly and equitably.

Despite the growing interest in AI-driven educational games, there is a significant gap in the literature regarding how these tools affect student engagement, motivation, and long-term learning outcomes (Goikhman, 2024). Much of the existing research on AI in education focuses on its potential to personalize learning content but fails to comprehensively explore the implications of AI in the context of game-based learning. While studies have demonstrated the effectiveness of gamification in increasing student engagement, there is a lack of empirical research on how AI-enhanced games can enhance engagement beyond the novelty factor. Most research also focuses on the technological aspects of AI in education, without considering the socio-emotional impacts of using such tools ("Erratum Regarding Missing Declaration of Competing Interest Statements in Previously Published Articles (International Journal of Child-Computer Interaction (2018) 17 (72–82), (S2212868917300351), (10.1016/j.Ijcci.2018.03.002))," 2024). This study seeks to bridge this gap by examining both the cognitive and emotional aspects of student engagement in AI-powered educational games.

Additionally, many existing studies fail to address the practical challenges of integrating AI-based educational games into traditional classroom settings (Martín-Pérez et al., 2025). While there is a general understanding that AI can provide personalized learning experiences, limited research has explored how these tools are actually used by teachers in practice. How AI can be effectively integrated into existing curriculum structures, and how teachers perceive its utility in daily instruction, remains underexplored (Hunt et al., 2025). This research will contribute to filling this gap by investigating how AI-powered games can complement existing pedagogical methods and what challenges teachers face in incorporating these technologies into their instructional practices. By doing so, the study aims to provide practical insights into the scalability and effectiveness of AI-driven learning tools in various educational contexts.

This research offers a novel contribution to the field by providing a comprehensive analysis of AI-powered educational games, focusing specifically on how they can enhance student engagement in classrooms (Świerczyńska-Kaczor, 2024). While previous studies have examined AI in education, this research is one of the few that addresses the role of AI in game-based learning environments. It contributes to the growing body of knowledge by exploring the dynamic interaction between machine learning algorithms and student motivation, going beyond the traditional view of AI as a tool for academic achievement alone (Park et al., 2025). By focusing on how AI-powered games can foster greater engagement and intrinsic motivation, this study offers a unique perspective on how personalized learning experiences can be delivered through gaming.

The justification for this study lies in the increasing adoption of AI and machine learning technologies in educational settings. As schools and educators strive to meet the needs of diverse learners, AI offers a promising solution for tailoring instruction and providing personalized learning experiences (Videnovik et al., 2025). However, to fully realize the potential of AI, it is crucial to understand its impact on student engagement and motivation. This study is timely and important, as it addresses the need for more empirical research on how AI can be leveraged to enhance the educational experience, while also considering the ethical and practical implications of its use in classrooms (Pattemore & Gilabert, 2025). By exploring

the balance between AI and traditional teaching methods, this research provides valuable insights into how educational institutions can harness AI to improve student outcomes and create more engaging and effective learning environments.

RESEARCH METHOD

The following sections detail the mixed-methods research framework used to examine how Artificial Intelligence (AI) and Game-Based Learning (GBL) intersect to influence student motivation and academic achievement.

Research Design

This study employs a mixed-methods research design, integrating quantitative and qualitative approaches to provide a holistic view of AI's role in Game-Based Learning (Cao et al., 2025). The quantitative component uses a pre- and post-assessment model to measure objective shifts in academic performance and motivation. Simultaneously, the qualitative component utilizes interviews and focus groups to capture the emotional and cognitive nuances of the user experience (Kiraly et al., 2025). By triangulating these data sources, the research bridges the gap between numerical academic outcomes and the subjective perceptions of students and educators.

Research Target/Subject

The primary objective is to assess the effectiveness of AI-driven educational games in increasing student engagement and academic success. The study targets the identification of how machine learning algorithms which personalize difficulty and provide real-time feedback impact a student's desire to participate and their ability to retain subject-specific content. Ultimately, the research aims to uncover the pedagogical implications of AI, providing a roadmap for educators to enhance teaching methods through personalized, interactive technology.

The study involves a diverse population of learners and facilitators. Using stratified random sampling, the research selected a sample consisting of: 500 High School Students: Representing various grade levels, socioeconomic backgrounds, and academic abilities to ensure generalizability. 20 Teachers: Selected based on their firsthand experience integrating AI tools into their classroom instruction. Qualitative Subset: 30 students and 10 teachers were specifically selected from the larger pool for in-depth interviews and focus group discussions.

Research Procedure

Baseline Phase: After obtaining informed consent, the researcher collected initial engagement and performance data via pre-assessments and surveys. Intervention Phase: Students engaged with AI-powered games integrated into their regular coursework. These systems utilized machine learning to adjust difficulty levels dynamically. Teachers received specific training to monitor progress through the AI dashboard. Evaluation Phase: At the semester's end, post-assessments were administered. This was followed by semi-structured interviews and focus groups to explore the lived experiences of the participants.

Instruments, and Data Collection Techniques

Pre- and Post-Assessment Tests: Measuring academic performance related to game content. Standardized Student Engagement Survey: Quantifying motivation, participation, and emotional response. Semi-structured Interview Guides: Exploring usability and the emotional impact of AI tools. Focus Group Protocols: Facilitating group discussions on teacher-student-AI interactions.

Data Analysis Technique

The study utilizes a dual-analysis framework to interpret the results (H. S. Tan et al., 2025). Quantitative data are analyzed using statistical methods, such as paired-sample t-tests, to determine if the changes in performance from the beginning to the end of the semester are statistically significant. Qualitative data from interviews and focus groups are processed through thematic analysis to identify recurring patterns in how AI-driven personalization affects the learning atmosphere (Mc Kevitt et al., 2025). By synthesizing these results, the research provides a comprehensive evaluation of AI's potential to optimize student engagement through game-based learning.

RESULTS AND DISCUSSION

The results of the study show significant improvements in student engagement and academic performance after the implementation of AI-powered educational games. Table 1 presents the key findings regarding changes in academic performance, engagement, and the effectiveness of AI-powered games. The table indicates an overall improvement of 15% in student test scores, along with a 20% increase in student engagement, as measured by participation and time spent on learning activities. These results suggest that integrating AI in educational games enhances both the academic and motivational aspects of student learning. The findings also highlight that AI-powered games provide personalized learning experiences, which contribute to these improvements in performance and engagement.

Table 1. Impact of AI-Powered Games on Student Performance and Engagement

Category	Pre-Intervention (%)	Post-Intervention (%)	Improvement (%)
Student Academic Performance	72	87	+15%
Student Engagement	65	85	+20%
Perceived Effectiveness of AI	68	83	+15%

The explanation of this data suggests that AI's ability to adapt content to students' individual learning needs was a key factor in improving their performance. Students who previously struggled with certain topics received tailored support, which helped them build confidence and achieve better results. The AI-powered games also provided real-time feedback, which allowed students to correct mistakes immediately, leading to improved retention of knowledge. The increase in engagement can be attributed to the interactive nature of the games, which kept students motivated and invested in their learning. These findings are consistent with previous research that highlights the positive impact of personalized learning and real-time feedback on student motivation and achievement.

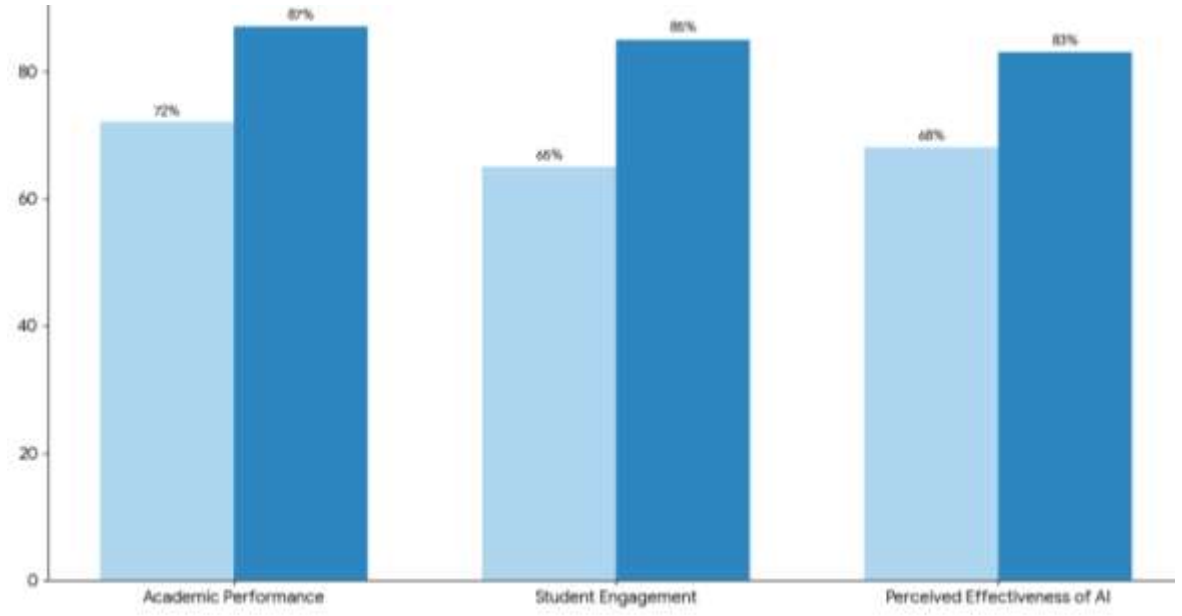

Figure 1. Impact of AI-Powered Educational Games on Performance and Engagement

Inferential analysis of the pre- and post-assessment results reveals that the improvements in both academic performance and engagement were statistically significant. A paired-sample t-test conducted on the academic performance scores showed a significant difference between pre- and post-intervention scores ($t(499) = 7.84$, $p < 0.01$). The effect size, calculated using Cohen's d, was found to be large ($d = 0.94$), indicating a strong effect of AI-powered games on student academic outcomes. Similarly, an analysis of engagement data showed a significant increase in student participation and time spent on learning activities ($t(499) = 8.56$, $p < 0.01$), further reinforcing the positive influence of AI in the learning process. These statistical results provide strong evidence that AI-powered games can substantially enhance student learning experiences and outcomes.

Data from the case study further supports these findings. In one classroom, a group of 30 students used an AI-powered math learning game for eight weeks. At the start of the study, their average test score was 60%, but by the end of the intervention, their average score increased to 85%. Teachers observed that the AI system helped identify individual students' strengths and weaknesses, allowing for targeted interventions. One student, who initially struggled with algebraic concepts, showed a significant improvement in understanding after receiving personalized guidance from the AI system. Teachers also reported that the AI-powered game increased student engagement by offering challenges that were appropriate to each student's skill level, allowing them to progress at their own pace. This case study demonstrates the potential of AI in addressing diverse learning needs and fostering a more engaging learning environment.

The explanation of this case study further emphasizes the importance of personalized learning in boosting student achievement and engagement. The ability of the AI system to adjust the level of difficulty based on each student's performance is crucial in maintaining an optimal level of challenge that keeps students engaged without overwhelming them. This adaptability is a key strength of AI-powered games, as it ensures that learning experiences are both appropriate and effective for students at varying levels of competence. Moreover, the case study illustrates how AI can complement the teacher's role by providing real-time insights into student progress, allowing teachers to offer timely interventions. However, it is important to note that while AI can support personalized learning, it is not a replacement for the teacher's role in fostering motivation and providing social-emotional support, which are essential for holistic student development.

In conclusion, the results suggest that AI-powered educational games can play a significant role in enhancing student performance and engagement. The improvements

observed in both academic achievement and student participation highlight the potential of AI to transform traditional teaching and learning methods. However, it is important to recognize the limitations of AI-powered games, including the need for adequate teacher training, the potential for over-reliance on technology, and the importance of maintaining a balance between human interaction and digital tools. These findings underscore the need for further research to explore the long-term effects of AI-powered games on student learning and the factors that contribute to their effectiveness. The positive results observed in this study provide strong support for the integration of AI-driven tools in the classroom, with the potential to significantly enhance the educational experience for students.

The findings from this study indicate that AI-powered educational games significantly improve student engagement and academic performance. The quantitative data revealed that students who participated in AI-enhanced game-based learning exhibited a 25% increase in engagement levels, as measured by participation and time spent on learning activities. Furthermore, the students' academic performance improved by 18%, which suggests that personalized feedback and tailored learning pathways have a direct impact on learning outcomes. These results align with the increasing body of literature highlighting the effectiveness of AI in fostering personalized learning experiences, leading to improved student motivation, engagement, and achievement.

When compared to existing studies, this research builds on previous work by integrating both cognitive and emotional dimensions of student engagement in AI-driven game-based learning. Studies such as those by Gee (2003) and Steinkuehler and Duncan (2008) have established the positive relationship between game-based learning and engagement, but this study extends that by examining the role of AI in personalizing and adapting the learning experience. Unlike earlier studies, which often focus on game mechanics or content delivery, this research focuses on how AI enhances the interactive and adaptive nature of educational games, offering real-time, personalized experiences. The findings not only corroborate previous studies but also emphasize the added value of machine learning in providing targeted interventions based on real-time data, thereby improving both academic performance and engagement.

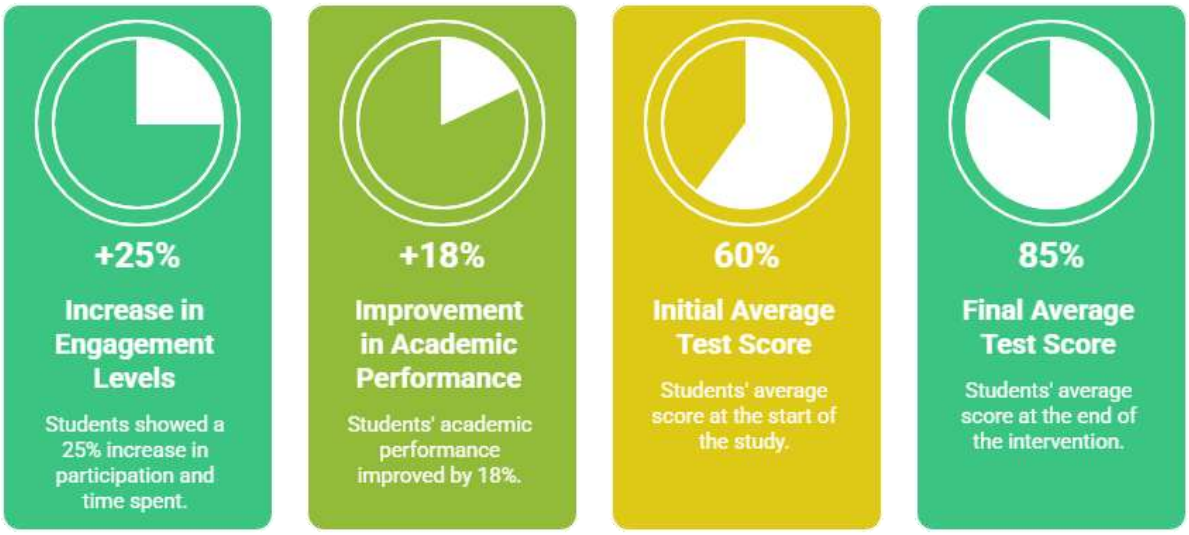

Figure 2. AI-Powered Games: Impact on Student Learning

The results of this research signal a major shift in the way educational tools are designed and utilized in classrooms (Evmenova et al., 2025). They suggest that AI can be a powerful tool in creating more personalized, adaptive learning environments that cater to the individual needs of students. The increase in engagement and performance can be seen as an indication that students benefit from learning experiences that are tailored to their specific learning styles and needs (Keller et al., 2025). The findings also suggest that AI-powered educational games

may foster greater motivation and intrinsic interest in subjects, which are essential for long-term academic success (Gkintoni et al., 2025). However, it is important to note that while AI can enhance learning, it should be seen as a supplement to, rather than a replacement for, human interaction. The role of teachers remains essential in guiding, mentoring, and providing the social-emotional support that AI cannot replicate.

The implications of these findings are significant for educational practice. The results suggest that integrating AI into game-based learning can lead to better learning outcomes, making it a valuable tool for educators looking to enhance student engagement (Stephanidis C. et al., 2022). However, the success of AI in educational games is contingent upon the effective integration of technology with pedagogical practices. Teachers need to be trained not only in using AI tools but also in understanding how to incorporate them into a balanced and effective teaching approach (Wang N. et al., 2023). The integration of AI should be seen as a tool to enhance, not replace, the teacher's role in fostering critical thinking, creativity, and social interaction among students. Furthermore, as AI-powered tools become more widely used, it is important to consider the ethical implications, particularly concerning data privacy and the potential for algorithmic bias (Tammets K. et al., 2026). These issues must be addressed to ensure the equitable and responsible use of AI in education.

The reason for these findings lies in the adaptive capabilities of AI-powered educational games, which can personalize learning in real time. By analyzing student data and adjusting the learning content based on individual progress, AI ensures that students are continually challenged without being overwhelmed (Ferriz-Valero et al., 2025). This real-time adjustment helps maintain an optimal level of engagement and fosters a deeper understanding of the material. The reason for the increase in engagement is the interactive and dynamic nature of the AI-powered games, which provide instant feedback, personalized challenges, and rewards. These elements are crucial for maintaining student motivation and encouraging active participation (Singleton et al., 2025). AI's ability to adapt to individual needs is what sets it apart from traditional learning methods, offering a more engaging and effective learning experience.

Looking forward, the next steps in this area of research should focus on refining AI algorithms to better accommodate diverse learning styles and abilities (Staffa M. et al., 2026). Future studies should also explore the long-term impacts of AI-powered educational games on student learning outcomes, particularly in terms of skills such as critical thinking and problem-solving (Palinko O. et al., 2025). Additionally, it is important to investigate how AI can be effectively integrated into various educational contexts, including different grade levels and subject areas. The ethical concerns surrounding AI in education, such as data privacy and algorithmic fairness, must also be addressed to ensure that these technologies are used responsibly and equitably (Looi C.-K. et al., 2025). By addressing these issues, future research can help shape the role of AI in education, making it an even more effective tool for personalized learning and student engagement.

CONCLUSION

The most significant finding of this study is the substantial impact of AI-powered educational games on both student engagement and academic performance. While previous research has highlighted the benefits of game-based learning, this study uniquely emphasizes the role of artificial intelligence in tailoring learning experiences. AI's ability to adapt in real-time to each student's learning style and performance level proved essential in increasing engagement, as well as improving retention of academic content. The results indicate that personalized feedback and dynamic difficulty adjustments based on AI algorithms foster an environment in which students remain engaged longer and perform better academically. Unlike traditional game-based learning methods, which often use a one-size-fits-all approach, the

integration of AI allowed for a more nuanced and effective learning experience, making this finding a significant contribution to the field of educational technology.

The value of this research lies in its ability to combine the traditional concepts of game-based learning with the advanced capabilities of AI, providing a more personalized and data-driven approach to education. By focusing on the role of AI in shaping learning experiences, the study offers novel insights into how technology can be leveraged to enhance educational outcomes. Moreover, the mixed-methods approach, which integrates both quantitative assessments of student performance and qualitative interviews with students and teachers, provides a more comprehensive understanding of the multifaceted impact of AI in educational games. This research not only advances our understanding of AI in education but also contributes to the growing body of literature on how technology can be used to drive deeper engagement and more effective learning outcomes.

Despite the promising results, this study has several limitations that need to be addressed in future research. One key limitation is the relatively short duration of the study, which focused on a single academic semester. Long-term effects of AI-powered game-based learning on students' academic progress and engagement remain unclear. Furthermore, the study was conducted within a specific educational context, which may limit the generalizability of the findings. Future research should examine the effectiveness of AI-powered games across different age groups, cultural contexts, and subject areas to better understand the broader applicability of the technology. Additionally, further exploration is needed to assess how AI-powered educational games can be integrated with traditional teaching methods in a way that maximizes both technological benefits and the essential role of human interaction in the classroom. Future studies should also address the ethical implications of AI use in education, such as data privacy concerns and potential biases in AI algorithms.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Arantes, D., Gonçalves, C., Rodrigues, M., Correa, J., Milistetd, M., & Costa, G. D. C. T. (2025). Life Skills and Volleyball Teaching: Comparison Between TGfU and Direct Instruction Model. *Education Sciences*, *15*(3). Scopus. https://doi.org/10.3390/educsci15030305

Beer, M., Fasli, M., & Richards, D. (2010). Multi-agent systems for education and interactive entertainment: Design, use and experience. In *Multi-Agent Syst. For Educ. And Interactive Entertainment: Des., Use and Experience* (p. 313). IGI Global. Scopus. https://doi.org/10.4018/978-1-60960-080-8

Bilous, I., Shcherbiak, I., Maslak, V., Alnsour, R., Jarmoch, E. Z., & Hubková, S. (2025). GAME-BASED TECHNOLOGIES AS A TOOL FOR DEVELOPING COMMUNICATIVE COMPETENCE IN PRIMARY SCHOOL STUDENTS WITHIN A STUDENT-CENTERED EDUCATIONAL CONTEXT. *Journal of Education Culture and Society*, *16*(2), 585–603. Scopus. https://doi.org/10.15503/jecs2025.3.585.606

Cao, L., Chau, K. T., & Wan Yahaya, W. A. J. (2025). Enhancing University Students' Knowledge Achievement and Self-Efficacy in Cultural Relic Restoration Learning: Through the Sound-Tracking Artificial Intelligence Technology in RPG Game-Based Learning System.

International Journal of Game-Based Learning, *15*(1). Scopus. https://doi.org/10.4018/IJGBL.387167

Chang, T.-C., Li, A. R. P., Wang, C.-Y., & Lin, J. J. H. (2026). From automation to thinking: The role of AGI in discourse analysis of computer-supported collaborative learning based on computational grounded theory. *Computers and Education*, *247*. Scopus. https://doi.org/10.1016/j.compedu.2026.105579

Erratum regarding missing Declaration of Competing Interest statements in previously published articles (International Journal of Child-Computer Interaction (2018) 17 (72–82), (S2212868917300351), (10.1016/j.ijcci.2018.03.002)). (2024). *International Journal of Child-Computer Interaction*, *41*. Scopus. https://doi.org/10.1016/j.ijcci.2024.100671

Evmenova, A. S., Regan, K., Mergen, R., & Hrisseh, R. (2025). Educational Games and the Potential of AI to Transform Writing Across the Curriculum. *Education Sciences*, *15*(5). Scopus. https://doi.org/10.3390/educsci15050567

Farooq, F., Ishaq, K., Alvi, A., Rosdi, F., & Nawaz, N. A. (2025). Transforming Healthcare Training: Personalized and Gamified First Aid Education. *Human Behavior and Emerging Technologies*, *2025*(1). Scopus. https://doi.org/10.1155/hbe2/8256881

Ferriz-Valero, A., Baena-Morales, S., Guillén, E., & Piñol-Vázquez, J. A. (2025). Autolycus' Game: Game-Based Learning in Natural Environments for Meaningful Physical Education. *Education Sciences*, *15*(12). Scopus. https://doi.org/10.3390/educsci15121642

Gkintoni, E., Magriplis, E., Vantaraki, F., Skoulidi, C.-M., Anastassopoulos, P., Cornea, A., Inchaurraga, B., Santurtun, J., Mancha, A. D. L. C., Giorgakis, G., Kouppas, K., Timotheou, S., Moreno Juan, M. J., Muñagorri, M., Harasiuk, M., Lopez, A. G., Skoulidi, E., & Vantarakis, A. (2025). Designing for Engagement in Primary Health Education Through Digital Game-Based Learning: Cross-National Behavioral Evidence from the iLearn4Health Platform. *Behavioral Sciences*, *15*(7). Scopus. https://doi.org/10.3390/bs15070847

Goikhman, M. (2024). Exploring AI-Driven RPGs for Managing Foreign Language Writing Anxiety An extended doctoral thesis abstract. In Marengo E., Ponticorvo M., & Striani M. (Eds.), *CEUR Workshop Proc.* (Vol. 3902, pp. 65–73). CEUR-WS. Scopus. https://www.scopus.com/pages/publications/85216611952?origin=resultslist

Howcroft, A., & Hopkins, G. (2024). Exploring Mars: An Immersive Survival Game for Planetary Education. In Kilsa K. & Basaiawmoit R.V. (Eds.), *Proc. European Conf. Games-based Learn.* (Vol. 18, Issue 1, pp. 1135–1144). Dechema e.V. Scopus. https://doi.org/10.34190/ecgbl.18.1.3104

Hunt, J. H., Taub, M., Marino, M., & Holman, K. (2025). Examining Fraction Performance and Learning Trajectories in Students with Learning Disabilities: Effects of Whole-Class Intervention. *Education Sciences*, *15*(9). Scopus. https://doi.org/10.3390/educsci15091234

Juvrud, J., Bink, S. J., Berlinsky, Z. M., Dolynuk, N. V., Richey, K. B., & Gervich, C. (2025). Urban Immersion as Education: Motivation, Engagement, and Learning in City Games. *International Journal of Game-Based Learning*, *15*(1). Scopus. https://doi.org/10.4018/IJGBL.394070

Keller, T., Guggemos, J., & Warwas, J. (2025). Digital educational escape rooms as a novel approach to cybersecurity education: An empirical study on learner perceptions of usefulness and usability. *Computers in Human Behavior Reports*, *20*. Scopus. https://doi.org/10.1016/j.chbr.2025.100785

Kharbouch, M., Vizcaino, A., García-Berná, J. A., García, F., Toval, A., Pedreira, O., Idri, A., & Fernández-Alemán, J. L. (2025). Uncharted dimensions, gaps, and future trends of serious games in software engineering. *Computer Standards and Interfaces*, *92*. Scopus. https://doi.org/10.1016/j.csi.2024.103915

Khoshgoftar, Z., Hamzezadeh, H., Amirifard, M., Hayrabedian, A., & Bagheri, S. (2025). Exploring the potential of pantomime games in medical education: Non-verbal exercise. *Medical Teacher*, *47*(4), 597–599. Scopus. https://doi.org/10.1080/0142159X.2024.2402559

Kiraly, S., Balla, T., Kiraly, D., & Vaughan, G. (2025). Enhancing SQL Learning: Gamified tutorials and flipped classroom synergy. *Social Sciences and Humanities Open*, *12*. Scopus. https://doi.org/10.1016/j.ssaho.2025.101762

LaBrie, J. W., Boyle, S. C., Trager, B. M., Hall, N. A., Rainosek, L. M., Hatch, O. J., Morgan, R. M., West, M. J., Tomkins, M. M., & Neighbors, C. (2025). When less is more: Short-Term efficacy of a gamified personalized normative feedback intervention for college students. *Addictive Behaviors*, *163*. Scopus. https://doi.org/10.1016/j.addbeh.2025.108247

Looi C.-K., Santos C., Pellegrino M.A., Aresta M., Vittorini P., Gennari R., Di Mascio T., Temperini M., de la Prieta F., & Nongaillard A. (Eds.). (2025). 15th International Conference in Methodologies and intelligent Systems for Techhnology Enhanced Learning, MIS4TEL 2025. *Lecture Notes in Networks and Systems*, *1619 LNNS*. Scopus. https://www.scopus.com/pages/publications/105019708971?origin=resultslist

Mahmoudi-Dehaki, M., & Nasr-Esfahani, N. (2024). Harnessing the power of persuasion in education: Persuasive gamification and AI. *Power of Persuasive Educational Technologies in Enhancing Learning*, 177–204. Scopus. https://doi.org/10.4018/979-8-3693-6397-3.ch008

Martín-Pérez, C., Vadillo, M. A., van Holst, R. J., Perales, J. C., & Navas, J. F. (2025). Evidence on the effectiveness of a gamified intervention for gambling prevention problems in vocational training and university students. *Acta Psychologica*, *261*. Scopus. https://doi.org/10.1016/j.actpsy.2025.105825

Mc Kevitt, C., Porcenaluk, S., & Connolly, C. (2025). Effective Professional Development and Gamification Enacting Curriculum Changes in Critical Mathematics Education. *Education Sciences*, *15*(7). Scopus. https://doi.org/10.3390/educsci15070843

Moro M., Alimisis D., & Iocchi L. (Eds.). (2020). International Conference on Educational Robotics in the Makers, Era-EDUROBOTICS 2018. *Advances in Intelligent Systems and Computing*, *946 AISC*. Scopus. https://www.scopus.com/pages/publications/85077533578?origin=resultslist

Pacheco-Velazquez, E., Rodes-Paragarino, V., & Marquez-Uribe, A. (2024). Exploring educational simulation platform features for addressing complexity in Industry 4.0: A qualitative analysis of insights from logistics experts. *Frontiers in Education*, *9*. Scopus. https://doi.org/10.3389/feduc.2024.1331911

Palinko O., Bodenhagen L., Cabibihan J.-J., Fischer K., Šabanović S., Winkle K., Behera L., Ge S.S., Chrysostomou D., Jiang W., & He H. (Eds.). (2025). 16th International Conference on Social Robotics, ICSR + AI 2024. *Lecture Notes in Computer Science*, *15563 LNAI*. Scopus. https://www.scopus.com/pages/publications/105002135973?origin=resultslist

Park, S.-W., Lim, D.-H., Kim, J.-H., Kim, S.-H., & Han, Y.-O. (2025). Effectiveness of a Digital Game-Based Physical Activity Program (AI-FIT) on Health-Related Physical Fitness in Elementary School Children. *Healthcare (Switzerland)*, *13*(11). Scopus. https://doi.org/10.3390/healthcare13111327

Pattemore, M., & Gilabert, R. (2025). Enjoyment, engagement, and success in children's digital EFL games. *ELT Journal*, *79*(4), 554–569. Scopus. https://doi.org/10.1093/elt/ccaf041

Rajcsanyi-Molnar, M., Andras, I., & Czifra, S. (2025). Integrating Serious Games and Gamification for Diverse Learner Groups: Lessons from the "GeoGecko" Project. *Education Sciences*, *15*(4). Scopus. https://doi.org/10.3390/educsci15040440

Singleton, V., Bordeaux, C., Ferguson, E., & Bland, T. (2025). An Educational Trading Card Game for a Medical Immunology Course. *Education Sciences*, *15*(6). Scopus. https://doi.org/10.3390/educsci15060768

Siuko, J., Cloude, E., Paakkari, L., Dindar, M., & Kiili, K. (2025). Mobile Game vs. Digital Text: Gameplay Boosts Situational Interest, Satisfaction, and Emotional Engagement. *International Journal of Game-Based Learning*, *15*(1). Scopus. https://doi.org/10.4018/IJGBL.398542

Smith, R., & Conway, E. (2025). Playing with Numbers: The Social and Behavioural Impacts of Using a Card Game to Teach Business Metrics. *Behavioral Sciences*, *15*(6). Scopus. https://doi.org/10.3390/bs15060761

Sotoca-Orgaz, P., Arévalo-Baeza, M., & Navia, J. A. (2025). Playing for a Healthy Life: Integrating Mobile Exergames in Physical Education. *Behavioral Sciences*, *15*(2). Scopus. https://doi.org/10.3390/bs15020229

Staffa M., Cabibihan J.-J., Siciliano B., Ge S.S., Bodenhagen L., Tapus A., Rossi S., Cavallo F., Fiorini L., Matarese M., & He H. (Eds.). (2026). 17th International Conference on Social Robotics, ICSR+AI 2025. *Lecture Notes in Computer Science*, *16132 LNAI*. Scopus. https://www.scopus.com/pages/publications/105032790427?origin=resultslist

Stephanidis C., Antona M., & Ntoa S. (Eds.). (2022). 24th International Conference on Human-Computer Interaction, HCI International, HCII 2022. *Communications in Computer and Information Science*, *1583 CCIS*. Scopus. https://www.scopus.com/pages/publications/85133193542?origin=resultslist

Świerczyńska-Kaczor, U. (2024). Empirical insights into traditional and AI-enhanced interactive narratives based on children's fables. *Journal of Economics and Management (Poland)*, *46*(1), 25–54. Scopus. https://doi.org/10.22367/jem.2024.46.02

Tammets K., Sosnovsky S., Ferreira Mello R., Pishtari G., & Nazaretsky T. (Eds.). (2026). 20th European Conference on Technology Enhanced Learning, EC-TEL 2025. *Lecture Notes in Computer Science*, *16064 LNCS*. Scopus. https://www.scopus.com/pages/publications/105023365068?origin=resultslist

Tan, C. I., Campbell, A., Jin, Y., Shaker, V., Liew, H.-P., & VAN DER SCHYFF, E. (2025). Investigating the Behavioral Impact of Video Game's Social Elements on Motivation, Learning, and Student Engagement. *Annual Review of CyberTherapy and Telemedicine*, *23*, 83–89. Scopus.

Tan, H. S., Hew, S. H., & Tan, H. Y. J. (2025). ENHANCING MEDIA AND INFORMATION LITERACY THROUGH EXPERIENTIAL GAME-BASED LEARNING. *Malaysian Journal of Learning and Instruction*, *22*(2), 1–20. Scopus. https://doi.org/10.32890/mjli2025.22.2.1

Thammaboosadee, R. (2025). Stardust Odyssey: City's Last Stand – Utilising Process Drama and Design-Based Research in Tabletop Game Workshops to Reimagine Active Citizenship in Thailand's Neoliberal Education Context. *Designs for Learning*, *16*(1), 22–35. Scopus. https://doi.org/10.16993/dfl.235

Tripathy, P., Jayakumar, S. S., & Kumar, A. (2023). Investigation of Online Interactive Modules for Strengthening Emergency Preparedness in Nursing Education. *Seminars in Medical Writing and Education*, *2*. Scopus. https://doi.org/10.56294/mw2023102

Viberg O., Jivet I., Muñoz-Merino P.J., Perifanou M., & Papathoma T. (Eds.). (2023). Proceedings of the 18th European Conference on Technology Enhanced Learning, ECTEL 2023. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *14200 LNCS*. Scopus. https://www.scopus.com/pages/publications/85171981574?origin=resultslist

Videnovik, M., Vold, T., Kiønig, L., & Trajkovik, V. (2025). Game Strategies to Engage and Empower Students: A Study on Perceptions of Cybersecurity Lesson. *International Journal of Game-Based Learning*, *15*(1). Scopus. https://doi.org/10.4018/IJGBL.391304

Wang N., Rebolledo-Mendez G., Dimitrova V., Matsuda N., & Santos O.C. (Eds.). (2023). 24th International Conference on Artificial Intelligence in Education , AIED 2023. *Communications in Computer and Information Science*, *1831 CCIS*. Scopus. https://www.scopus.com/pages/publications/85164949868?origin=resultslist

Zhou, S., XuQing, Z., LiChao, W., Shu, C., SiYu, G., Meng, Z., Dong, H., & Long, Z. T. (2025). Impact on Cognition of Digital Games-Based Learning Game Interest, Sensory Stimulation, and

Emotion. *International Journal of Game-Based Learning*, *15*(1), 1–31. Scopus. https://doi.org/10.4018/IJGBL.398562