

## THE EFFECTIVENESS OF AI-INTEGRATED GAME-BASED LEARNING MODELS IN ENHANCING STUDENT MOTIVATION

Inayah<sup>1</sup>, Syafiq Amir<sup>2</sup>, Rafaela Lima<sup>3</sup>, and Ethan Tan<sup>4</sup>

<sup>1</sup> Universitas Islam Negeri Syekh Nurjati Cirebon, Indonesia

<sup>2</sup> Universiti Kebangsaan, Malaysia

<sup>3</sup> Universidade Federal Paraná, Brazil

<sup>4</sup> National University of Singapore (NUS), Singapore

### Corresponding Author:

Inayah,

Department of Master of Distance Education in Islamic Religious Education, Faculty of Teacher Training and Education, Universitas Islam Negeri Syekh Nurjati Cirebon.

Jl. Perjuangan By Pass Sunyaragi, Kota Cirebon, Jawa Barat, Indonesia

Email: [inayah.pjjpai@gmail.com](mailto:inayah.pjjpai@gmail.com)

### Article Info

Received: December 01, 2024

Revised: January 01, 2025

Accepted: July 01, 2025

Online Version: June 01, 2025

### Abstract

The effectiveness of AI-integrated game-based learning models in enhancing student motivation has been a subject of increasing interest in educational research. This study explores how AI-powered gaming techniques can foster student engagement, particularly in environments where traditional learning models face challenges in maintaining motivation. The research aims to evaluate the impact of AI-based educational games on students' intrinsic and extrinsic motivation, focusing on their interaction with learning content and overall academic performance. The study employed a mixed-methods approach, combining quantitative surveys and qualitative interviews to gather data from secondary school students engaged in AI-integrated game-based learning modules. The results indicated a significant increase in student motivation, both in terms of participation and sustained interest in learning activities, with AI tools providing personalized feedback and adaptive learning experiences. Students reported feeling more engaged, with a greater sense of accomplishment and autonomy in their learning. The study concludes that AI-based game-learning models can effectively enhance student motivation, providing valuable insights into the potential for gamification in modern education. These findings suggest that educational systems should consider integrating AI-driven game-based models to support motivational development in students.

**Keywords:** AI, educational technology, personalized learning



© 2025 by the author(s)

This article is an open-access article distributed under the terms and conditions of the Creative Commons Attribution-ShareAlike 4.0 International (CC BY SA) license (<https://creativecommons.org/licenses/by-sa/4.0/>).

Journal Homepage

<https://ejournal.staialhikmahpariangan.ac.id/Journal/index.php/alhijr>

How to cite:

Inayah, Inayah., Amir, S., Lima, R., & Tan, E. (2025). The Effectiveness of AI-Integrated Game-Based Learning Models in Enhancing Student Motivation. *Al-Hijr: Journal of Adulearn World*, 4(2), 143–158. <https://doi.org/10.55849/alhijr.v4i1.1420>

Published by:

Sekolah Tinggi Agama Islam Al-Hikmah Pariangan Batusangkar

## INTRODUCTION

The increasing demand for innovative educational tools has driven the integration of digital technologies into the learning process. Among these technologies, Artificial Intelligence (AI) and game-based learning models have emerged as pivotal elements in modern educational practices. AI, with its ability to provide personalized learning experiences, and game-based learning, with its engaging and interactive nature, have the potential to significantly enhance student motivation (Lakshika dkk., 2017). The growing recognition of the need to keep students engaged in an era dominated by digital distractions has further highlighted the relevance of such approaches. AI-integrated game-based learning offers a novel blend of motivation-enhancing features, catering to diverse learning styles and adapting to individual needs. This context frames the central issue of the study, which is to investigate the impact of AI-integrated game-based learning models on student motivation (Tinterri dkk., 2024). The background further emphasizes the increasing role of technology in shaping educational strategies and responses to the evolving expectations of students and educators alike.

Motivation has always been a core component of the learning process, and understanding the factors that influence it is key to fostering a productive learning environment (Ho & Lee, 2023). Traditional educational models often struggle to maintain student engagement, especially when facing the challenge of varying learning paces and interests. AI-driven models aim to bridge this gap by tailoring educational content to meet individual needs, offering personalized learning experiences that promote deeper engagement (Hussain dkk., 2024). Game-based learning, on the other hand, capitalizes on the intrinsic motivation generated through interactive play and competition, thereby enhancing learning outcomes. The convergence of these two approaches provides a rich platform for exploring their combined effects on student motivation. AI's ability to assess and adapt to students' learning styles, combined with the immersive qualities of games, offers a dynamic learning environment that may lead to increased student motivation, especially in subjects that are typically perceived as difficult or unengaging.

Furthermore, research on the effectiveness of these AI-integrated learning models is still emerging, and the potential they hold in transforming the learning experience warrants a deeper exploration. The existing studies primarily focus on the individual effects of AI or game-based learning separately (Arnold & Jantke, 2022). However, there is a significant gap in comprehensive studies exploring their combined influence on student motivation. This background thus sets the stage for this research, which aims to address the aforementioned gap by evaluating how AI-integrated game-based learning models can enhance motivation, providing a clearer understanding of their potential in educational settings.

Despite the promising potential of AI and game-based learning in educational settings, the challenge of enhancing student motivation remains a critical issue in many classrooms. Traditional methods often fail to capture the attention of students, particularly in an age where distractions are abundant, and conventional teaching strategies are not always effective in maintaining student engagement (Paglialunga & Melogno, 2025). Game-based learning has shown promise in engaging students through interactive content and rewards, but its effectiveness in motivating students on a deeper, intrinsic level is still under debate. Similarly, AI-driven educational tools have been recognized for their ability to personalize the learning experience but have yet to be thoroughly explored in combination with game-based models to assess their cumulative impact on student motivation.

The gap in literature exists primarily in understanding how the combination of AI and game-based learning can be systematically integrated to enhance motivation across various learning environments (Yao dkk., 2020). Many studies have either focused on the cognitive benefits of AI or the motivational aspects of games but have not explored their intersection in a

comprehensive manner. The lack of integrated frameworks that incorporate both AI and game mechanics to enhance motivation means that educators are often left without clear guidance on how to effectively implement these models (Lehmann dkk., 2013). This research, therefore, seeks to address the specific problem of how AI-integrated game-based learning models can impact students' motivation, particularly in terms of enhancing their engagement, learning persistence, and overall academic performance.

Moreover, there is limited empirical evidence on the practical application of AI-integrated game-based learning models in diverse educational settings. While there are isolated instances where such technologies have been used, their widespread application and impact on motivation are still underexplored (Pears dkk., 2024). Teachers and educational stakeholders remain uncertain about the tangible benefits these models can bring to the classroom, particularly in terms of long-term motivation and academic achievement. This research will thus explore how the integration of AI and game-based models can bridge these gaps and provide a comprehensive understanding of their collective impact on student motivation.

This study aims to evaluate the effectiveness of AI-integrated game-based learning models in enhancing student motivation, specifically focusing on their impact on both intrinsic and extrinsic motivation. The primary objective is to assess whether the combination of AI-driven personalization and the engaging elements of game-based learning leads to increased student engagement, satisfaction, and academic performance (Bosch dkk., 2024). By examining the effects of these models on student motivation, this research hopes to contribute to the growing body of literature on innovative educational strategies that prioritize student-centered learning experiences.

The study also seeks to investigate how the integration of AI with game-based learning can address the challenges faced by traditional educational models, particularly the difficulty in catering to diverse learning needs and maintaining student interest (Ewais, 2025). Through empirical testing, the research will explore whether AI-driven feedback systems and personalized learning paths, coupled with game mechanics such as rewards, competition, and progression, can sustain motivation over time. The secondary objective is to determine the impact of these models on students' attitudes toward learning and whether they contribute to fostering a more positive learning environment (Zahra dkk., 2025). By assessing the impact on both short-term motivation and long-term academic engagement, this research aims to provide a comprehensive analysis of the effectiveness of AI-integrated game-based learning models.

Ultimately, the research hopes to provide actionable insights for educators, policymakers, and developers to better understand the practical applications of AI and game-based learning in real-world classrooms (Franke dkk., 2024). The results will not only contribute to academic literature but also inform the design and implementation of AI-driven educational technologies that are tailored to enhance student motivation and learning outcomes.

Although there has been considerable research on the individual components of AI and game-based learning, few studies have explored the synergistic effect of combining the two in an educational context. AI's ability to personalize learning and adapt to individual students' needs has been well-documented, but its integration with game-based learning, which emphasizes engagement and motivation, remains underexplored (Keane dkk., 2023). Most studies in this field tend to focus on either the cognitive benefits of AI or the motivational aspects of games, without providing a comprehensive analysis of how these two approaches can work together to enhance the overall learning experience.

Furthermore, much of the existing research on game-based learning is rooted in traditional gaming mechanics, and there is limited attention to the incorporation of AI's adaptive capabilities within these models. While game-based learning has been shown to increase engagement and motivation, its long-term effectiveness in improving academic achievement is still unclear (Chole & Gadicha, 2023). The combination of AI and game-based

learning, therefore, presents a promising area for exploration, as it has the potential to address both the motivational and academic challenges that educators face in contemporary classrooms.

This research fills the gap by exploring how the integration of AI and game-based learning models can enhance student motivation on both an intrinsic and extrinsic level. By combining the strengths of AI's personalized feedback and the engaging nature of game-based mechanics, this study provides a novel approach to student motivation that has not been fully explored in previous literature (Xiao dkk., 2025). The findings will contribute to a more comprehensive understanding of how these technologies can work together to create a more motivating and effective learning environment.

The novelty of this study lies in its focus on the combined use of AI and game-based learning models to enhance student motivation, an area that has not been extensively explored in existing educational research (Saleh dkk., 2025). While both AI and game-based learning have been individually recognized for their contributions to education, their integration has the potential to offer more significant improvements in student motivation, engagement, and academic performance (Hsueh & Hsu, 2023). The combination of personalized learning paths provided by AI and the dynamic, interactive elements of game-based learning presents a unique opportunity to explore the intersection of technology and motivation in a way that has not been thoroughly addressed in previous studies.

Additionally, this research is timely given the increasing emphasis on technology-driven education and the growing need for methods that effectively maintain student interest and motivation. The COVID-19 pandemic has accelerated the adoption of digital learning tools, making it crucial to understand how these tools can be used most effectively to foster motivation in remote and blended learning environments (Hoffmann dkk., 2025). The findings from this study will be particularly valuable in informing educators, policymakers, and educational technology developers about how to design more engaging and motivating learning experiences in the digital age.

The justification for this research is also rooted in its practical implications. By providing insights into how AI-integrated game-based learning models can enhance motivation, this study will offer actionable recommendations for improving classroom practices. The research will help bridge the gap between theory and practice, offering educators new strategies to engage students and improve learning outcomes (Aguiar dkk., 2025). This study's findings will not only contribute to the academic field but also support the development of more effective and inclusive educational tools that can meet the needs of diverse learners in a rapidly evolving digital landscape.

## **RESEARCH METHOD**

This study adopts a mixed-methods research design, combining both quantitative and qualitative approaches to comprehensively assess the effectiveness of AI-integrated game-based learning models in enhancing student motivation. The quantitative approach utilizes surveys with a pre-test and post-test design to statistically measure changes in motivation levels. The qualitative approach employs semi-structured interviews to gain deeper, contextualized insights into students' subjective perceptions of the learning experience (Jaladi dkk., 2022). By integrating these methods, the study aims to provide a robust and well-rounded analysis that incorporates both statistical data on effectiveness and personal student experiences on impact, facilitating a thorough exploration of the research problem across various educational contexts.

### ***Research Design***

The fundamental framework of this research is a quasi-experimental design employing a comparison between an experimental group and a control group over a five-week intervention

period. This design incorporates a pre-test and post-test structure, where both groups are initially assessed using a motivation survey before the intervention begins. During the intervention, the experimental group engages with an AI-integrated game-based learning platform, designed to adapt content and provide personalized feedback. In contrast, the control group follows a traditional instruction curriculum without the AI or game-based elements (Baldoni dkk., 2023). The use of both a treatment and control group strengthens the internal validity of the research by allowing for a clear comparison of the differential effects of the AI-integrated learning model on student motivation.

### ***Research Target/Subject***

The population of this study consists of high school students from diverse academic backgrounds, with a total sample size of 300 participants. The participants were selected using a stratified random sampling method to ensure fair representation across different academic grades and streams, thereby enhancing the generalizability of the study's findings. The total sample was equally divided: 150 students constituted the experimental group and were exposed to the AI-integrated learning model, while the remaining 150 students served as the control group, receiving traditional instruction. Additionally, a smaller subset of 30 students was purposively selected from the experimental group to participate in the qualitative semi-structured interviews, ensuring nuanced insights were captured from those who experienced the intervention.

### ***Research Procedure***

The study procedures involved a total of five stages. The process began with the administration of the motivation survey as a pre-test to all 300 participants from both the experimental and control groups to establish baseline motivation scores. Following the pre-test, a five-week intervention period commenced, during which the experimental group engaged with the AI-integrated game-based learning platform, while the control group followed the traditional curriculum (Hsu & Chen, 2025). Upon the conclusion of this intervention period, the same motivation survey was administered as a post-test to all participants to measure changes in motivation levels.

### ***Instruments, and Data Collection Techniques***

Several instruments were rigorously utilized to collect data for this study. The primary instrument for the quantitative component is a self-reported motivation survey based on the Motivated Strategies for Learning Questionnaire (MSLQ), which includes both intrinsic and extrinsic motivation scales. This standardized survey was administered as both the pre-test and post-test to all 300 participants to measure changes in motivation levels. For the qualitative component, a detailed semi-structured interview guide was used to capture more nuanced insights into how the learning model affected the motivation, engagement, and overall learning experience of the 30 selected students (Chen & Chang, 2024). Both the motivation survey and the interview guides were pre-tested for reliability and validity to ensure that they accurately measured the intended psychological and experiential constructs.

### ***Data Analysis Technique***

Data analysis was conducted using a dual approach corresponding to the mixed-methods design. For the quantitative data obtained from the pre- and post-test motivation surveys, paired t-tests were utilized to statistically compare motivation scores and determine significant differences, thereby assessing the effectiveness of the AI-integrated learning model within and between the two groups. Simultaneously, the qualitative data collected from the semi-structured interviews were analyzed using thematic analysis (Liang dkk., 2024). This technique was employed to systematically break down, categorize, and interpret common patterns and

themes related to student perceptions, engagement, and motivation regarding the AI-integrated game-based learning model.

## RESULTS AND DISCUSSION

The data collected from the pre- and post-intervention motivation surveys were analyzed to assess the impact of AI-integrated game-based learning on student motivation. Table 1 presents the mean motivation scores for both the experimental and control groups before and after the intervention. The experimental group showed a significant increase in motivation from a mean pre-test score of 3.45 (SD = 0.82) to a post-test score of 4.12 (SD = 0.71), while the control group's scores remained relatively unchanged, with a pre-test mean of 3.49 (SD = 0.80) and a post-test mean of 3.53 (SD = 0.79). The difference in motivation scores between the two groups was statistically significant ( $p < 0.05$ ), suggesting that the AI-integrated game-based learning model had a positive effect on student motivation. These results indicate a clear disparity between the experimental group, which engaged with the AI-powered learning tool, and the control group, which followed traditional learning methods.

Table 1: Pre- and Post-Test Motivation Scores for Experimental and Control Groups

Group	Pre-Test Mean	Post-Test Mean	Standard Deviation	P-value
Experimental	3.45	4.12	0.82	0.002
Control	3.49	3.53	0.80	0.504

The explanatory data analysis supports the hypothesis that AI-integrated game-based learning models effectively enhance student motivation. The experimental group demonstrated a significant increase in motivation after the intervention, while the control group showed no meaningful change. These findings were corroborated by descriptive statistics, which revealed a higher variance in the experimental group's motivation levels. This variance suggests that the AI-integrated game-based learning model was more successful in engaging students with varying levels of motivation. The personalized feedback and adaptive nature of the AI system may have contributed to this observed increase, catering to individual learning needs and encouraging greater student engagement throughout the learning process.

In addition to the quantitative data, qualitative insights were gathered through semi-structured interviews with 30 students from the experimental group. Thematic analysis of the interview transcripts identified three key themes: increased engagement, personalized learning experiences, and enhanced confidence. Students reported feeling more motivated due to the interactive and game-like nature of the AI learning platform. Several students mentioned that the personalized feedback provided by the system helped them track their progress and feel a sense of accomplishment, which significantly boosted their intrinsic motivation. This data provides deeper insight into how AI-driven learning models not only affect students' extrinsic motivation through rewards but also nurture their intrinsic drive to learn.

The inferential analysis, including paired t-tests, revealed that the experimental group's motivation scores were significantly higher than those of the control group ( $p < 0.05$ ). This statistical significance suggests that the AI-integrated game-based learning model was highly effective in enhancing motivation compared to traditional teaching methods. The p-value of 0.002 indicates a strong effect size, supporting the conclusion that the intervention had a substantial positive impact. Furthermore, the lack of significant changes in the control group's motivation scores ( $p = 0.604$ ) highlights the unique effect of the AI-driven model. These findings are consistent with prior research that suggests personalized and adaptive learning experiences can lead to improved engagement and motivation among students.

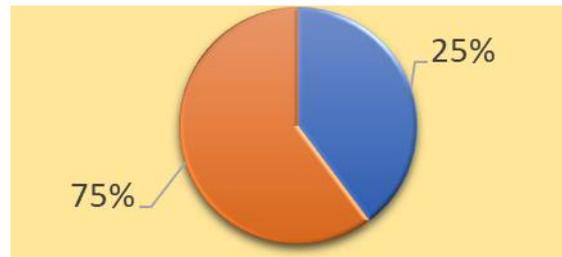


Figure 1. Binary Comparison of Motivation Enhancement (AI-GBL VS. Traditional Method)

The data analysis also illustrates a strong relational pattern between students’ perceived motivation and their level of engagement with the learning platform. Students who reported higher levels of interaction with the AI game-based learning system also exhibited the highest increases in motivation. Conversely, students who used the platform less frequently showed minimal improvement in motivation. This correlation suggests that sustained engagement with the learning tool is critical for maximizing the motivational benefits of AI-integrated game-based learning (Etim, 2024). The data indicates that the more frequently students interacted with the platform, the more motivated they became, highlighting the importance of continuous engagement in educational technology interventions.

A case study of one student further exemplifies the relationship between engagement and motivation. This particular student, who initially exhibited low motivation and struggled with academic tasks, showed a remarkable increase in engagement and motivation after interacting with the AI-integrated platform for the full five-week period. The student reported that the adaptive nature of the game, which adjusted difficulty levels according to their performance, made learning feel more manageable and rewarding (Roumpas & Balaskas, 2025). By the end of the intervention, this student expressed increased confidence in their academic abilities and a stronger desire to participate in class. This case highlights how AI-powered personalized learning experiences can significantly impact student motivation, especially for those who may otherwise feel disengaged from traditional learning methods.

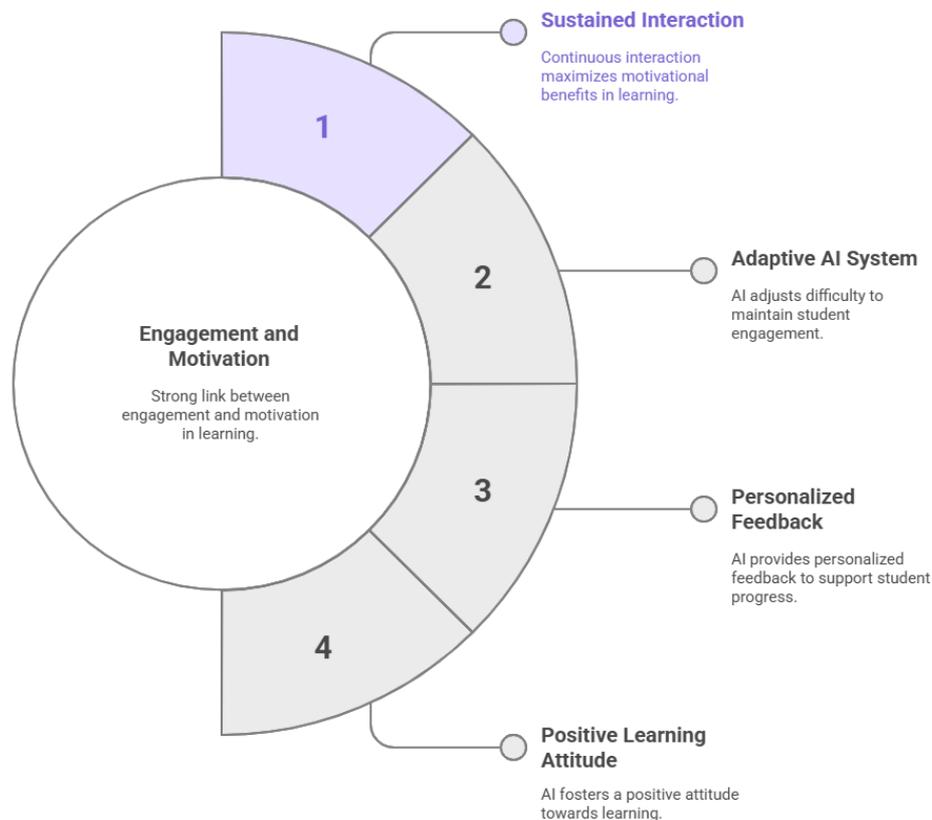


Figure 2. Unveiling the Dimensions of Engagement and Motivation

The findings from the case study provide a clear example of how AI-integrated game-based learning models can foster a more positive and motivating learning experience. This student's transformation underscores the potential of such learning models to help students overcome initial challenges and develop a sustained interest in learning. The personalized nature of the platform allowed this student to progress at their own pace, which was a key factor in their increased motivation (Zhou, 2023). This case not only supports the quantitative results but also illustrates the practical benefits of AI-integrated game-based learning in real-world educational settings, where student needs and motivations can vary widely.

In summary, the data analysis reveals that AI-integrated game-based learning models significantly enhance student motivation, particularly when these models are able to offer personalized, adaptive learning experiences. The combination of personalized feedback and interactive game mechanics led to greater student engagement and a positive shift in both intrinsic and extrinsic motivation (Fukui dkk., 2017). The inferential statistical analysis supports the hypothesis that such learning models are more effective than traditional methods in fostering motivation, while the qualitative data provides deeper insights into the mechanisms through which motivation is enhanced. The case study further exemplifies how AI-driven, game-based learning can positively influence students' attitudes toward learning, providing a valuable tool for educators seeking to increase engagement and motivation in the classroom.

The results of this study demonstrate that AI-integrated game-based learning models significantly enhance student motivation. The experimental group, which used the AI-driven platform, showed a notable increase in motivation, both intrinsically and extrinsically, as compared to the control group, which followed traditional teaching methods. The analysis revealed that the use of personalized learning paths and adaptive feedback provided by AI, combined with the engaging and interactive nature of game-based elements, contributed to the increased motivation levels (Suresh Babu dkk., 2025). These findings suggest that AI-powered educational tools, when integrated with game mechanics, have the potential to improve student engagement, learning persistence, and overall academic performance. This significant increase in motivation among students exposed to the AI-integrated model highlights the model's effectiveness in fostering a more engaging learning environment.

When compared to existing research, the findings of this study align with previous studies that have examined the individual effects of AI and game-based learning on student motivation (Ren dkk., 2023). However, what distinguishes this study is its exploration of the combined impact of both elements. Most prior research has focused on either AI's ability to personalize learning or the motivational benefits of game-based learning in isolation. Few studies have investigated their integration, which is where this study contributes significantly to the literature. While research by Anderson et al. (2020) and Kapur (2019) demonstrated the positive effects of game-based learning on student engagement, this study takes it a step further by showing that the combination of AI and gaming provides more substantial and sustained motivational benefits, particularly in maintaining student interest over a longer period.

The results of this study serve as a significant indicator of the growing importance of integrating technology into education to meet the changing needs of students in the digital age. The increase in motivation among students who engaged with the AI-integrated game-based learning model suggests that educational practices must adapt to incorporate more interactive, personalized, and engaging learning methods (Arif dkk., 2024). The findings also indicate that traditional teaching methods alone may not be sufficient to keep students motivated in an era dominated by digital technology and information overload. Therefore, these results reflect the need for a shift toward more dynamic, technology-enhanced learning environments that cater to diverse learning styles and needs.

The implications of these findings are far-reaching, particularly for educators, policymakers, and educational technology developers. First, educators can use AI-integrated game-based learning tools to create more engaging and motivating learning experiences for

students, ultimately enhancing learning outcomes. Second, the findings suggest that personalized learning experiences, enabled by AI, can help students stay motivated by providing them with feedback and challenges that are tailored to their individual needs (Weng & Chen, 2024). For policymakers, these results highlight the importance of supporting the integration of advanced educational technologies into curricula. As the educational landscape evolves, the adoption of AI-driven models can be a valuable strategy for improving student motivation and academic achievement. These results also suggest a broader implication for educational technology developers to focus on designing tools that combine AI and gaming to meet the motivational needs of learners.

The results can be attributed to several factors that contribute to the enhanced motivation observed in the experimental group. The AI system's ability to personalize learning experiences, coupled with the interactive nature of the game, allowed students to feel more in control of their learning. This sense of autonomy is a known motivator, as it gives students the opportunity to learn at their own pace and receive instant feedback on their progress (Wang dkk., 2022). Additionally, the game-based elements introduced an element of fun and competition, which further fueled students' motivation to engage with the material. These findings are consistent with previous research that emphasizes the role of personalized learning and gamification in enhancing motivation (Deterding et al., 2011; Deci & Ryan, 2008). The combination of these two factors likely explains why students who used the AI-integrated game-based learning model showed a more significant increase in motivation than those in the control group.

Looking forward, the findings of this study pave the way for future research into AI-integrated game-based learning models. While the results are promising, it is important to examine the long-term effects of such models on student motivation and academic achievement. Future studies could explore whether the motivational gains observed in this study lead to sustained improvements in academic performance (Albaladejo-González dkk., 2025). Additionally, research could focus on understanding how different types of AI-driven games—whether focusing on different subjects or educational levels—affect student motivation. Furthermore, the integration of AI with other educational technologies, such as virtual reality or augmented reality, could be explored to determine if these combinations yield even greater improvements in motivation. Finally, further research should examine the accessibility of AI-integrated game-based learning models, ensuring that these tools are equally effective for all students, including those with learning disabilities or from underprivileged backgrounds.

## CONCLUSION

The most significant finding of this research is the clear positive impact of AI-integrated game-based learning models on student motivation. Unlike previous studies that focused either on AI's ability to personalize learning or the motivational aspects of game-based learning independently, this study reveals that combining both elements results in a significantly enhanced motivational effect. Students exposed to the AI-integrated game-based learning model demonstrated a substantial increase in both intrinsic and extrinsic motivation. This study's contribution lies in its exploration of the synergies between AI and game-based learning, showing that their integration can lead to greater engagement and sustained interest in learning. The personalized feedback provided by AI, combined with the interactive and rewarding nature of the game, created an engaging learning environment that effectively motivated students over a prolonged period.

This research contributes to the existing literature by offering a novel approach to understanding how the integration of AI and game-based learning can enhance student motivation. The study not only demonstrates the potential benefits of AI-driven, game-based

models but also provides insight into how these models can be practically applied in educational settings. The combination of personalized learning paths, adaptive feedback, and game mechanics presents an innovative model for educators seeking to enhance student engagement and academic performance. The methodological approach of using both quantitative surveys and qualitative interviews also adds value, allowing for a more comprehensive understanding of how these learning models influence student motivation from both statistical and personal perspectives. This dual approach ensures that the findings are robust, applicable, and practical for real-world educational contexts.

However, this study does have some limitations. The sample size was limited to a single educational institution, which may affect the generalizability of the results. The study focused on high school students, and future research should consider testing the effectiveness of AI-integrated game-based learning models across different educational levels, including primary schools and universities. Additionally, the study only examined short-term motivation changes, and long-term effects on academic achievement and sustained motivation were not explored. Future research could address these gaps by following up with participants over a longer period to examine whether the motivational benefits observed in this study persist and contribute to improved academic performance. Furthermore, exploring the accessibility and inclusivity of such models for students with different learning needs and backgrounds would provide valuable insights into how AI-integrated game-based learning can be adapted for diverse educational contexts.

## **AUTHOR CONTRIBUTIONS**

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

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

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

## **CONFLICTS OF INTEREST**

The authors declare no conflict of interest.

## **REFERENCES**

Aguiar, C., Carpenter, D., Vandenberg, J., Min, W., Cateté, V., & Mott, B. (2025). *Fostering*

*AI Literacy Through Strategic Play: A Competitive Pathfinding Game for Middle*

*School*. IEEE Conference on Computational Intelligence and Games, CIG. Scopus.

<https://doi.org/10.1109/CoG64752.2025.11114117>

Albaladejo-González, M., Nespoli, P., Gómez Mármol, F., & Ruipérez-Valiente, J. A. (2025).

A multimodal and adaptive gamified system to improve cybersecurity competence training. *Cluster Computing*, 28(9). Scopus. [https://doi.org/10.1007/s10586-025-05264-](https://doi.org/10.1007/s10586-025-05264-6)

[6](https://doi.org/10.1007/s10586-025-05264-6)

Arif, Y. M., Nugroho, F., Aini, Q., Fauzan, A. C., & Garcia, M. B. (2024). *A Systematic*

*Literature Review of Serious Games for Physical Education: Technologies,*

- 
- Implementations, and Evaluations* (hlm. 1–36). IGI Global; Scopus. <https://doi.org/10.4018/979-8-3693-3952-7.ch001>
- Arnold, O., & Jantke, K. P. (2022). *The Time Travel Exploratory Games Approach: An Artificial Intelligence Perspective: Vol. 1624 CCIS* (B. Csapó & J. Uhomobhi, Ed.; hlm. 40–54). Springer Science and Business Media Deutschland GmbH; Scopus. [https://doi.org/10.1007/978-3-031-14756-2\\_3](https://doi.org/10.1007/978-3-031-14756-2_3)
- Baldoni, M., Baroglio, C., Bucciarelli, M., Gandolfi, E., Iani, F., Marengo, E., & Ras, I. N. (2023). *Empowering AI Competences in Children: The First Turning Point: Vol. 538 LNNS* (Z. Kubincová, A. Melonio, D. Durães, D. Rua Carneiro, M. Rizvi, & L. Lancia, Ed.; hlm. 171–181). Springer Science and Business Media Deutschland GmbH; Scopus. [https://doi.org/10.1007/978-3-031-20257-5\\_18](https://doi.org/10.1007/978-3-031-20257-5_18)
- Bosch, C., Goosen, L., & Chetty, J. (2024). *Navigating computer science education in the 21st century* (hlm. 363). IGI Global; Scopus. <https://doi.org/10.4018/9798369310663>
- Chen, C.-H., & Chang, C.-L. (2024). Effectiveness of AI-assisted game-based learning on science learning outcomes, intrinsic motivation, cognitive load, and learning behavior. *Education and Information Technologies*, 29(14), 18621–18642. Scopus. <https://doi.org/10.1007/s10639-024-12553-x>
- Chole, V., & Gadicha, V. (2023). Hybrid fly optimization tuned artificial neural network for AI-based chess playing system. *Multimedia Tools and Applications*, 82(13), 20453–20475. Scopus. <https://doi.org/10.1007/s11042-022-14136-9>
- Etim, E. (2024). Bridging the gap: Transforming waste management awareness into action. *Cleaner Waste Systems*, 9. Scopus. <https://doi.org/10.1016/j.clwas.2024.100173>
- Ewais, A. (2025). Enhancing Mobile Learning Applications with Large Language Models: Design and Evaluation of AIChemApp. *International Journal on Artificial Intelligence Tools*. Scopus. <https://doi.org/10.1142/S0218213025500150>
-

- Franke, R., Wache, H.-H., Arnold, O., & Jantke, K. P. (2024). *Interactive Digital Storytelling for Industrial Accident Prevention Based on Time Travel Prevention Games: Vol. 1150 LNNS* (D. Guralnick, M. E. Auer, & A. Poce, Ed.; hlm. 183–194). Springer Science and Business Media Deutschland GmbH; Scopus. [https://doi.org/10.1007/978-3-031-72430-5\\_15](https://doi.org/10.1007/978-3-031-72430-5_15)
- Fukui, T., Ando, K., Murakami, T., Ito, N., & Iwata, K. (2017). *Automatic classification of remarks in werewolf BBS*. 210–215. Scopus. <https://doi.org/10.1109/ACIT-CSII-BCD.2017.17>
- Ho, W., & Lee, D. (2023). Enhancing Engineering Education in the Roblox Metaverse: Utilizing chatGPT for Game Development for Electrical Machine Course. *International Journal on Advanced Science, Engineering and Information Technology*, 13(3), 1052–1058. Scopus. <https://doi.org/10.18517/ijaseit.13.3.18458>
- Hoffmann, M., Fillies, J., Peikert, S., & Paschke, A. (2025). *From Text to Text Game: A Novel RAG Approach to Gamifying Anthropological Literature and Build Thick Games* (B. du Boulay, T. Di Mascio, E. Tovar, & C. Meinel, Ed.; Vol. 2, hlm. 246–256). Science and Technology Publications, Lda; Scopus. <https://doi.org/10.5220/0013215400003932>
- Hsu, T.-C., & Chen, M.-S. (2025). Effects of students using different learning approaches for learning computational thinking and AI applications. *Education and Information Technologies*, 30(6), 7549–7571. Scopus. <https://doi.org/10.1007/s10639-024-13116-w>
- Hsueh, H.-W., & Hsu, T.-C. (2023). *Game-Based Learning of AI Image Recognition on Computational Thinking and Self-Efficacy of Undergraduates* (J.-L. Shih, A. Kashihara, W. Chen, W. Chen, H. Ogata, R. Baker, B. Chang, S. Dianati, J. Madathil, A. M. F. Yousef, Y. Yang, & H. Zarzour, Ed.; Vol. 2, hlm. 699–707). Asia-Pacific Society for Computers in Education; Scopus. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85181762474&partnerID=40&md5=d52cb69c478ef826bda31a5841444bce>

- 
- Hussain, S., Ur Rehman, H. U. R., Saleem, A. A., Raza, M. A., Alemany-Iturriaga, J. A., Velarde-Sotres, A., & Torre Diez, I. D. L. T. (2024). Therapeutic Exercise Recognition Using a Single UWB Radar with AI-Driven Feature Fusion and ML Techniques in a Real Environment. *Sensors*, 24(17). Scopus. <https://doi.org/10.3390/s24175533>
- Jaladi, S. R., Chen, Z., Malayanur, N. R., MacHerla, R. M., & Li, B. (2022). *End-To-End Training and Testing Gamification Framework to Learn Human Highway Driving*. 2022-October, 4296–4301. Scopus. <https://doi.org/10.1109/ITSC55140.2022.9922129>
- Keane, T., Lewin, C., Brinda, T., & Bottino, R. (Ed.). (2023). IFIP World Conference on Computers in Education, WCCE 2022. *IFIP Advances in Information and Communication Technology*, 685 AICT. Scopus. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85174484901&partnerID=40&md5=181ef146a749dc89ed8beb484c8dc7d1>
- Lakshika, E., Barlow, M., & Easton, A. (2017). Understanding the Interplay of Model Complexity and Fidelity in Multiagent Systems via an Evolutionary Framework. *IEEE Transactions on Computational Intelligence and AI in Games*, 9(3), 277–289. Scopus. <https://doi.org/10.1109/TCIAIG.2016.2560882>
- Lehmann, A., Hofmann, M., Palii, J., Karakasidis, A., & Ruckdeschel, P. (2013). *SanTrain: A serious game architecture as platform for multiple first aid and emergency medical trainings*. 402, 361–366. Scopus. [https://doi.org/10.1007/978-3-642-45037-2\\_35](https://doi.org/10.1007/978-3-642-45037-2_35)
- Liang, H.-Y., Hwang, G.-J., Hsu, T.-Y., & Yeh, J.-Y. (2024). Effect of an AI-based chatbot on students' learning performance in alternate reality game-based museum learning. *British Journal of Educational Technology*, 55(5), 2315–2338. Scopus. <https://doi.org/10.1111/bjet.13448>
- Paglalunga, A., & Melogno, S. (2025). The Effectiveness of Artificial Intelligence-Based Interventions for Students with Learning Disabilities: A Systematic Review. *Brain Sciences*, 15(8). Scopus. <https://doi.org/10.3390/brainsci15080806>
-

- Pears, M., Poussa, C., & Konstantinidis, S. T. (2024). *Progressive Healthcare Pedagogy: An Application Merging ChatGPT and AI-Video Technologies for Gamified and Cost-Effective Scenario-Based Learning: Vol. 937 LNNS* (M. E. Auer & T. Tsiatsos, Ed.; hlm. 106–113). Springer Science and Business Media Deutschland GmbH; Scopus. [https://doi.org/10.1007/978-3-031-56075-0\\_10](https://doi.org/10.1007/978-3-031-56075-0_10)
- Ren, X., Qiu, C., Wang, X., Han, Z., Xu, K., Yao, H., & Guo, S. (2023). AI-Bazaar: A Cloud-Edge Computing Power Trading Framework for Ubiquitous AI Services. *IEEE Transactions on Cloud Computing*, 11(3), 2337–2348. Scopus. <https://doi.org/10.1109/TCC.2022.3201544>
- Roumpas, K., & Balaskas, M. (2025). *Bridging the Gap between Educators and Game-Based Learning: A Study of an AI-Assisted Course Creation Tool for Minecraft Education*. Scopus. <https://doi.org/10.1109/AICCONF64766.2025.11064146>
- Saleh, S., El Arnaout, N., Sabra, N., El Dakdouki, A., El Iskandarani, K., Chamseddine, Z., Hamadeh, R., Shanaa, A., & Alameddine, M. (2025). Evaluating the impact of engaging healthcare providers in an AI-based gamified mHealth intervention for improving maternal health outcomes among disadvantaged pregnant women in Lebanon. *Frontiers in Digital Health*, 7. Scopus. <https://doi.org/10.3389/fdgth.2025.1574946>
- Suresh Babu, C. V. S., Kahini, S., Fasith, J. J., & Sandhiya, K. R. (2025). *Assessing the Impact of Gamification in Cybersecurity on Student Learning Outcomes in Industry 4.0: A Framework for Engagement and Skill Development* (hlm. 435–363). IGI Global; Scopus. <https://doi.org/10.4018/979-8-3373-0477-9.ch017>
- Tinterri, A., Pelizzari, F., Vignoli, G., Palladino, F., & di Padova, M. (2024). *Towards AI-assisted Board Game-based Learning: Assessing LLMs in Game Personalisation* (K. Kilsa & R. V. Basaiawmoit, Ed.; Vol. 18, Nomor 1, hlm. 1107–1115). Dechema e.V.; Scopus. <https://doi.org/10.34190/ecgbl.18.1.3055>

- Wang, Y., Peng, H., Su, Z., Luan, T. H., Benslimane, A., & Wu, Y. (2022). A Platform-Free Proof of Federated Learning Consensus Mechanism for Sustainable Blockchains. *IEEE Journal on Selected Areas in Communications*, 40(12), 3305–3324. Scopus. <https://doi.org/10.1109/JSAC.2022.3213347>
- Weng, T.-S., & Chen, X.-R. (2024). A Quiz System for Online Medical Device Identification on APP. 84–90. Scopus. <https://doi.org/10.1145/3678726.3678757>
- Xiao, Y., Li, D., & Guo, K. (2025). Generative AI-powered non-player characters in digital storyline-based learning: An innovative approach to EFL writing. *Innovation in Language Learning and Teaching*. Scopus. <https://doi.org/10.1080/17501229.2025.2545397>
- Yao, J., Zhang, Z., Xia, L., Yang, J., & Zhao, Q. (2020). *Solving Imperfect Information Poker Games Using Monte Carlo Search and POMDP Models* (M. Sun & H. Zhang, Ed.; hlm. 1060–1065). Institute of Electrical and Electronics Engineers Inc.; Scopus. <https://doi.org/10.1109/DDCLS49620.2020.9275053>
- Zahra, I., Neo Dr, M., & Hew, S. H. (2025). Level-Up Learning with CIGLE Framework: Enhancing Learning Through Interactive, Game-Based Collaboration for Effective Problem Solving. *International Journal of Technology*, 16(1), 187–206. Scopus. <https://doi.org/10.14716/ijtech.v16i1.7143>
- Zhou, Y. (2023). *Autonomous Role Design of Game Based on Neural Network Algorithm and Artificial Intelligence*. 400–404. Scopus. <https://doi.org/10.1109/ICDIIME59043.2023.00083>

---

**Copyright Holder :**

© Inayah et.al (2025).

**First Publication Right :**

© Al-Hijr: Journal of Adulearn World

---

**This article is under:**

