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AI-BASED GAMIFICATION IN LEARNING: AN ANALYSIS OF ITS IMPACT ON STUDENTS' ENGAGEMENT - A MIXED METHODS STUDY

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ABSTRAK

Penurunan keterlibatan siswa menjadi tantangan krusial dalam sistem pendidikan global di era transformasi digital, yang menuntut adanya intervensi inovatif seperti integrasi teknologi kecerdasan buatan (AI). Penelitian ini bertujuan untuk mengevaluasi dampak penerapan gamifikasi berbasis AI terhadap keterlibatan belajar siswa, mengingat urgensi kebutuhan strategi pembelajaran yang adaptif bagi generasi digital. Menggunakan desain penelitian metode campuran (mixed-methods) dengan strategi eksplanatori sekuensial, studi ini mengumpulkan data melalui survei kuantitatif terhadap 43 mahasiswa dan pendalaman kualitatif melalui wawancara. Analisis statistik menunjukkan adanya korelasi positif yang signifikan (r=0,560), di mana analisis regresi mengonfirmasi bahwa elemen gamifikasi berkontribusi sebesar 31,3% terhadap peningkatan partisipasi siswa. Temuan kualitatif memperkuat hasil ini dengan menunjukkan bahwa fitur seperti poin, lencana, umpan balik otomatis, dan personalisasi konten efektif dalam memicu motivasi intrinsik dan konsistensi belajar, meskipun elemen kompetitif seperti leaderboard perlu dikelola dengan bijak agar tidak menimbulkan tekanan berlebih. Secara keseluruhan, penelitian menyimpulkan bahwa gamifikasi berbasis AI merupakan strategi efektif untuk menumbuhkan keterlibatan kognitif dan emosional siswa, serta merekomendasikan pengembangan sistem penghargaan yang variatif dan adaptif guna menjaga motivasi belajar jangka panjang.

Kata kunci: *Gamifikasi; Kecerdasan Buatan; Keterlibatan Pembelajaran, Pembelajaran dan Pengajaran*

ABSTRACT

Declining student engagement is a crucial challenge in the global education system in the era of digital transformation, demanding innovative interventions such as the integration of artificial intelligence (AI) technology. This study aims to evaluate the impact of implementing AI-based gamification on student learning engagement, given the urgent need for adaptive learning strategies for the digital generation. Using a mixed-methods research design with a sequential explanatory strategy, this study collected data through a quantitative survey of 43 students and qualitative in-depth interviews. Statistical analysis revealed a significant positive correlation (r=0.560), with regression analysis confirming that gamification elements contributed 31.3% to increased student participation. Qualitative findings support this result by demonstrating that features such as points, badges, automated feedback, and content personalization are effective in stimulating intrinsic motivation and learning consistency, although competitive elements such as leaderboards need to be managed judiciously to avoid excessive pressure. Overall, the study concludes that AI-based gamification is an effective strategy for fostering student cognitive and emotional engagement and recommends the development of a varied and adaptive reward system to maintain long-term learning motivation.

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Keywords: *Gamification; Artificial intelligence; Learning Engagement, Learning and Teaching*

INTRODUCTION

Student engagement in the learning process has evolved into one of the most pressing challenges facing the global education system today. In the midst of an accelerating digital transformation era, educational institutions worldwide are confronted with the harsh reality of a significant decline in active student participation. Various field survey findings reveal an urgent need for new pedagogical strategies and tools capable of assisting educators in building conducive classroom environments that nurture an interest in learning. This engagement is not merely a supplementary factor but a crucial element that directly influences the quality of the learning experience and students' academic success. The situation is further exacerbated by the prolonged impact of the global pandemic, which forced a drastic shift from face-to-face meetings to online classes, ultimately undermining the three primary constructs of student engagement, particularly behavioral engagement. The declining frequency of student participation in class serves as a tangible indicator that this problem is not confined to a single country or region; rather, it is a systemic global issue demanding innovative, technology-based solutions (Kusrianto et al., 2025; Padingding & Gallego, 2025; Zenouzagh et al., 2023).

The state of student engagement in Indonesia presents challenges no less daunting than those in other nations, characterized by its own unique complexities. Market data indicates that revenue from online learning platforms in Indonesia is expected to reach hundreds of millions of dollars in the coming years and is projected to continue increasing steadily. However, a striking paradox exists where the success rate of students in state higher education institutions is among the lowest among OECD countries and partners with available data. Although a large portion of the productive-age population has completed upper secondary education or higher, this data indicates that rapid growth in digital educational infrastructure has not translated directly into student retention and engagement. The effectiveness of the education system, which should be evident in students' mastery of material, is often hindered by low literacy interest and a lack of variety in teaching methods. The fundamental challenge of maintaining student engagement remains a serious concern amidst national curriculum efforts to enhance learning interactions (Barber & Klauda, 2020; Rosyada & Wahyuni, 2025; Zenouzagh et al., 2023).

Current data indicate that student engagement issues are not transient phenomena that will vanish on their own, but rather a sustained trend requiring long-term strategic intervention. Ongoing research continues to highlight the dynamics of student engagement in synchronous online learning sessions, focusing on behavioral trends emerging during long periods of social restrictions. Efforts to link academic material with students' real lives and the utilization of technological power hold great potential to reignite a dampened enthusiasm for learning. This decline in engagement is particularly felt in higher education, where universities are required to take concrete steps to bridge the communication gap with students from Gen Z and Gen Alpha. Global statistics show that student engagement levels have consistently declined in recent years, with the most significant impact occurring in STEM fields and subjects demanding active participation, which also correlates closely with mental health issues and dropout rates (Khalid et al., 2023; Metaria & Cahyono, 2024).

The yawning gap between the ideal state of student engagement and the passive reality on the ground creates a sense of urgency to explore innovative solutions, specifically the

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application of Artificial Intelligence (AI)-based gamification. Although various strategies have been implemented to increase student engagement, most existing approaches remain conventional and have not fully utilized the adaptability potential of AI technology. Traditional gamification has indeed shown positive results in some limited contexts; however, its implementation is often one-way, non-personalized, and lacks the ability to adapt to the diverse individual needs of students. The integration of Artificial Intelligence in gamification offers a golden opportunity to create a learning experience that is far more dynamic, adaptive, and responsive, tailored to the unique characteristics of each learner. Nevertheless, there remains a significant research gap in understanding how AI elements can be effectively integrated into game elements to maximize engagement, especially within the Indonesian educational context, which possesses distinct cultural characteristics and learning systems (Arti et al., 2025; Kusrianto et al., 2025; Rosyada & Wahyuni, 2025).

The urgency to research AI-based gamification in learning is driven by several critical and interrelated factors. First, the accelerated adoption of digital technology in post-pandemic education creates the right momentum to explore innovative solutions previously considered futuristic. Second, the current generation of learners—Gen Z and Gen Alpha—has very different expectations of the learning experience; they demand interactions that are more personal, visual, and technologically enhanced. Third, there is external pressure to improve the quality of learning outcomes and the competitiveness of graduates in an increasingly competitive global labor market, where soft skills formed through active engagement are highly valued. Fourth, the availability of increasingly mature and accessible AI technology enables the implementation of gamification that is much more sophisticated and effective than before. The student engagement crisis demands solutions that can address the challenges of digital natives who have shorter attention spans, while simultaneously addressing factors causing underperformance and potential dropout (Chan & Lee, 2023; Ríos-Muñoz et al., 2025).

This research aims to delve deeply into how Artificial Intelligence technology can be integrated into gamification elements to create a more engaging and practical learning experience. The primary focus of this study is to conduct a comprehensive analysis of the impact of AI-based gamification implementation on various dimensions of student engagement, including behavioral, emotional, and cognitive engagement. A mixed-methods approach will be employed to gain a holistic understanding, combining quantitative analysis to statistically measure engagement levels and qualitative analysis to understand students' subjective experiences in depth. This study will also investigate moderating factors that may influence the effectiveness of AI-based gamification, including student demographic characteristics, individual learning styles, digital literacy levels, and specific learning contexts. The output of this research is expected to provide a theoretical contribution to the development of an AI-based gamification framework for education, while providing practical guidance for educators and technology developers in designing innovative, evidence-based learning solutions.

The research context in Indonesia adds significant value, given the unique characteristics of the local education system and its pluralistic learning culture. With a vast and diverse student population and a rapidly increasing rate of technology penetration, Indonesia represents an ideal laboratory to test the effectiveness of AI-based gamification on a substantial scale. This research will provide valuable insights not only for the Indonesian domestic context but also for other developing countries facing similar challenges in improving educational quality and engagement amidst resource constraints. The results of this study are expected to serve as an essential reference for the development of national digital education policies and

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contribute to the global body of knowledge regarding innovative educational technology and strategies for enhancing student engagement in a challenging digital era.

METHOD

This study employs a mixed-methods analytical framework to examine the effect of applying artificial intelligence-based gamification on the level of student participation in the learning process. This method integrates quantitative and qualitative approaches sequentially, supporting each other through a research design that is based on Sequential Explanatory Design. stated that the mixed-methods research procedure combines quantitative and qualitative techniques to obtain a broader and more comprehensive understanding of the issue being studied. This view aligns with Schoonenboom & Johnson, who assert that mixed research enables researchers to combine quantitative and qualitative strategies within a single study. Through this strategy, this study aims to describe a complex phenomenon, namely student involvement in AI-based gamification, compare results across different learning contexts, and produce a comprehensive and valid analysis that enriches data interpretation.

The respondents in this study were students who used AI-based gamification platforms with an age range of 16-25 years. The research population consists of all first- and third-semester students who actively use digital learning platforms. The study sample consisted of 43 participants, determined using the Slovin formula with a 5% error rate. All respondents were considered to have the same characteristics regardless of gender status. All participants participated in a learning program with the same duration and an equivalent background in digital technology knowledge. These participants are active students who have a similar background in understanding learning technology. The research instrument is in the form of a structured questionnaire, developed from a literature review, which includes both open-ended and closed-ended questions. It is first tested to measure its validity. Quantitative data are collected through online surveys, which facilitate distribution, while qualitative data are obtained from participatory observation and in-depth interviews. Qualitative data analysis was conducted using the results of interviews, and the data were further analysed using SPSS software to identify factors that affect student engagement.

Quantitative data were analysed using SPSS 27, employing correlation tests, simple linear regression, significance tests, and determination coefficients to test hypotheses regarding the influence of AI-based gamification on student learning engagement. The assumption test is carried out to verify the validity and homogeneity, ensuring the stability of the model. Qualitative analysis provides an in-depth understanding of students' subjective experiences, while quantitative analysis provides measurable evidence of the impact of AI gamification on learning engagement. The data triangulation process is employed to integrate qualitative and quantitative findings, thereby yielding richer and more comprehensive results. The research findings focus on the principles of AI gamification, the challenges of incorporating it in education, and the global implications for enhancing the quality of learning. This combination of methods provides stronger validity as it can capture the practical and theoretical dimensions of AI gamification in education. Thus, this study not only uncovers the empirical effectiveness of AI-based gamification but also explains how and why this approach affects student engagement more deeply.

RESULT AND DISCUSSION

Result

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Correlation Coefficients

Table 1. Correlation Coefficients

Correlations			
		AI-Based Learning	Student Engagement
AI-Based Learning	Pearson Correlation	1	,560**
	Sig. (2-tailed)		,000
	N	43	43
Student Engagement	Pearson Correlation	,560**	1
	Sig. (2-tailed)	,000	
	N	43	43
**. Correlation is significant at the 0.01 level (2-tailed).			

Source: Research data management, SPSS 27

According to the table 1 above, the correlation value between the AI-Based Learning variable (X) and Student Engagement (Y) is 0.560. The table above explains that the relationship between the two variables is significant at the 99% confidence level ($p < 0.01$). This means that the higher the level of AI-based learning utilisation, the higher the level of student involvement in the learning process. In other words, the use of AI-based platforms with gamification features has a positive impact on increasing student engagement, indicating a strong and significant relationship between the two variables.

Simple Linear Regression Analysis

Table 2. Simple Linear Regression Analysis

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	T	Itself.
		B	Std. Error	Beta		
1	(Constant)	20,480	13,562		1,510	,139
	AI-Based Learning Gamification	,643	,149	,560	4,326	,000
a. Dependent Variable: Engagement Mahasiswa						

Source: Research data management, SPSS 27

Based on the table 2 results of the simple linear regression analysis in the table above, a value of constant (a) of 20.480 was obtained. This value shows that if the AI-Based Learning Gamification variable (X) does not exist or has a value of zero, then the Student Engagement (Y) level remains at 20,480. Furthermore, the value of the regression coefficient (b) of 0.643 shows that every 1 unit increase in the use of AI-based gamification will increase student engagement by 0.643 points. Because the regression coefficient has a positive value, it can be said that the influence of AI-based gamification on student engagement is positive. The value of t is calculated = 4.326 with significance (Sig.) = 0.000 (< 0.05), so that H_0 is subtracted and H_a is accepted. This means that the variables of AI-based learning gamification have a significant effect on student engagement. Thus, the regression equation obtained is: Y = 20.480 + 0.643X. The equation explains that the higher the use of AI-based gamification, the higher the student involvement in learning.

Hypothesis Test Comparing Sig. Value with 0.05

Table 3. Significance Analysis

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Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Itself.
1	(Constant)	20,480	13,562		1,510	,139
	AI-Based Learning Gamification	,643	,149	,560	4,326	,000
a. Dependent Variable: Student Engagement						

Source: Research data management, SPSS 27

Based on the table 3 above, it is known that the significance value (Sig.) for the AI-Based Learning Gamification variable (X) is 0.000, which is smaller than 0.05. This shows that variable X has a significant effect on variable Y *(Student Engagement)*. Thus, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted. This means that there is a real influence between the application of AI-based learning gamification and the level of student involvement. The higher the application of gamification in learning, the higher the student engagement. Meanwhile, the significance value for the constant is 0.139 (> 0.05), which means that the constant has no statistically significant effect on student engagement. However, this did not affect the main conclusions of the study, as the focus was on the influence of the independent variable (X) on the dependent variable (Y).

Coefficient of Determination

Table 4. Coefficient of Determination

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,560a	,313	,297	11,524
a. Predictors: (Constant), AI-Based Learning Gamification				

Source: Research data management, SPSS 27

Based on the table 4 above, a value of R = 0.560 was obtained, which shows a positive relationship between the variables of AI-Based Learning Gamification (X) and Student Engagement (Y). The R-Square value = 0.313, which means that the use of AI-based gamification can explain 31.3% of the variation in student engagement. Meanwhile, the remaining 68.7% was influenced by other factors that were not studied in this study, such as internal student factors (intrinsic motivation, time management, interest in learning) and external factors (lecturer support, learning environment, or availability of technology facilities). The value of Adjusted R-Square = 0.297 indicates a correction for the number of variables and samples, which reinforces that the regression model is quite feasible to use, although there is still room for the influence of other variables outside the model. Thus, it can be concluded that AI-based gamification has a considerable contribution to increasing student engagement, although it is not the only determining factor.

Initial Experience Using the Platform

The results of the interviews showed that the respondents' first experience using an AI-based learning platform with gamification features began with a feeling of unfamiliarity with the appearance and mechanism. Respondents mentioned that the existence of a points, level, and leaderboard system initially required them to adjust because it was different from conventional learning methods commonly used. However, after conducting several

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experiments and interacting with the available features, respondents began to understand how the system works and felt a more engaging learning experience. This adaptation fosters a sense of interest in continuing to use the platform, as respondents see that it not only provides learning materials but also offers experiences that trigger active engagement.

Motivation from Points, Badges, and Rewards

One of the key findings is that gamification systems that incorporate points, levels, and badges can serve as a significant source of external motivation for respondents. Increasing points are perceived as indicators of learning progress, thereby fostering a sense of satisfaction and encouragement to continue learning activities until the target is reached. Respondents emphasized that the moment of obtaining the badge was a very memorable experience because the badge was considered a form of recognition for the efforts that had been made. Psychologically, this has a positive effect, in the form of pride and personal satisfaction, which motivates respondents to complete the following material. These findings align with the theory of uses and gratification, which posits that active users continue to use the media or platform when they perceive their needs are being met.

Leaderboard Impact

Leaderboards, as one of the competitive gamification elements, cause a motivating effect as well as pressure. Based on interviews, respondents stated that the existence of the leaderboard encouraged them to strive for improvement in their rankings to match those of other participants. The effect of competition creates a higher spirit of learning. However, respondents also revealed that when the ranking distance is too great, there is a feeling of difficulty keeping up, which tends to decrease motivation slightly. However, overall, the leaderboard is still viewed positively because it fosters a healthy competitive atmosphere and serves as a driver to increase the intensity of learning.

Challenges in Gamification

The challenge feature on the platform is one of the factors that strengthen respondents' involvement in the learning process. Respondents explained that the existence of challenges encouraged them to focus more, try to find solutions, and repeat experiments until they succeeded. The difficulties that arise are actually a trigger to help individuals survive the learning process and achieve the *expected* results. This indicates that challenges designed with the right level of difficulty can trigger learners' intrinsic motivation, increase perseverance, and strengthen active learning experiences.

Material Adjustments and Content Adaptations

Material adjustment (personalised learning) is one of the aspects considered most helpful by respondents. The material is presented gradually, according to the individual's ability, making the learning process more directed and less burdensome. Respondents affirmed that the adaptation of content provided by AI helps them understand difficult material through the provision of a variety of exercises and examples, until it is truly understood. These findings show that the application of AI technology, which can adjust the difficulty level of the material to the participants' abilities, can increase learning effectiveness and minimise frustration.

Feedback and Material Recommendations

The results of the interview also revealed that the automatic feedback provided by the system was very beneficial for respondents. With direct feedback, respondents can identify the error and correct it immediately. This makes the learning process faster and adaptive because participants can learn from mistakes without having to wait for manual explanations from the teacher. Additionally, the recommendations generated by the *AI* system are considered relevant

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and help expand the insights. Respondents mentioned that the recommendations not only fit the needs but also introduce new topics that were not previously planned to be studied, thus enriching the learning experience.

Progress Monitoring

The progress tracking feature has a positive impact on the learning consistency of respondents. A clear visualisation of developments encourages respondents to continue adding to their achievements until the set targets are met. According to respondents, seeing progress quantitatively provides a sense of satisfaction and strengthens motivation to continue learning. This aligns with the principle of self-regulated learning, where students are encouraged to set their own learning strategies to achieve the desired results.

Focus, Engagement, and Emotion

Learning with AI-based platforms and gamification also affects the way respondents interact with the material. Respondents stated that the system encourages them to think critically and analyse the material, rather than just memorise it. Emotionally, the learning experience feels more fun and less boring because it is equipped with interactive game elements. This factor also enhances the emotional and cognitive involvement of respondents in the learning process, making learning more meaningful.

Overall Evaluation

Overall, respondents assessed that the application of AI-based gamification had a positive influence on learning engagement. Respondents become more active, disciplined, and consistent in completing tasks. In addition, the existence of a reward system and adaptive features makes learning feel more interesting. However, respondents provided input to increase the variety of rewards, aiming to generate curiosity and maintain long-term motivation to learn.

Discussion

Inferential statistical analysis revealed a significant positive relationship between artificial intelligence-based learning and student engagement. A correlation coefficient value of indicates that the integration of gamification elements within AI platforms has a strong relationship with the active participation of learners. This finding is further bolstered by a linear regression equation showing that every increase in the intensity of game-based feature usage proportionally raises engagement scores. Specifically, the presence of competitive elements and digital reward systems has proven capable of triggering cognitive and emotional responses in students, causing them to become more attached to the instructional material. Statistical significance at a 99% confidence level confirms that this relationship pattern is not coincidental but rather reflects a systematic impact of technological intervention on learning behavior. This implies that motivational barriers often encountered in conventional learning can be overcome through an approach that is more interactive and responsive to the psychological needs of students, positioning technology not just as a tool, but as an effective catalyst for engagement (David & Weinstein, 2023; Pathan et al., 2024).

The contribution of AI-based learning variables to the variation in student engagement was recorded at 31.3% based on the coefficient of determination (). While this figure is categorized as moderate, it carries substantial practical implications within the complex context of educational research. It suggests that nearly a third of the engagement dynamics in the classroom can be explained by AI-supported gaming mechanisms, while the remainder is influenced by other external and internal factors such as academic self-efficacy and social support. The stability of the regression model, indicated by the adjusted R-square value, confirms that this model is reliable for predicting future engagement trends. These findings

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underscore the importance of viewing educational technology as part of a larger ecosystem. Although technological features provide a significant external push, long-term success still requires synergy with mature pedagogical design and a deep understanding of the learners' psychological conditions to ensure that technological interventions do not stand alone as partial solutions (Allen et al., 2024; Crompton et al., 2020; Steier & Davidsen, 2021).

Qualitative data provide deep insights into the psychological mechanisms behind these statistical figures, particularly regarding the role of points, badges, and leaderboards. Students perceive these elements as valid forms of external recognition for their hard work, which directly triggers a sense of pride and personal satisfaction. This mechanism aligns with the *uses and gratification theory*, where users continue to interact with media that can fulfill their psychological needs for achievement and competition. The existence of a leaderboard creates a healthy competitive atmosphere, encouraging students to increase their learning intensity to improve their social standing within the classroom community. However, gamification design must be managed carefully to maintain a balance between extrinsic and intrinsic motivation. The challenge lies in ensuring that the desire to chase points does not shift the primary focus away from understanding substantial material, so that learning remains meaningful rather than trapped in the mere pursuit of achievement symbols (John et al., 2023; Jose et al., 2024; Laak & Aru, 2024).

The most transformative aspect identified in this research is the capacity for material adaptation, or *personalized learning*, facilitated by artificial intelligence algorithms. Respondents reported that content tailored to individual ability levels significantly helped reduce cognitive load and prevented frustration caused by overly difficult material or boredom from material that was too easy. AI technology allows for the gradual presentation of material, providing appropriate scaffolding when students encounter difficulties. The system's ability to provide variations of exercises until a concept is truly mastered reflects the ideal principle of *mastery learning* (Ayeni et al., 2024; Kestin et al., 2025; Laak & Aru, 2024). Thus, this technology does not only present content but acts as an intelligent tutor that understands the learning profile of each individual. This creates a more targeted and personal learning experience, allowing students to learn within their zone of proximal development, which ultimately contributes significantly to increased learning effectiveness and long-term knowledge retention.

Automated feedback mechanisms and learning progress monitoring are crucial features that support student independence. In traditional learning environments, the time gap between completing an assignment and receiving corrections often hinders the process of improving understanding. Conversely, AI-based systems provide instant responses that allow students to perform self-correction on the spot. Visualizing learning progress through graphs or achievement indicators provides psychological satisfaction and helps students autonomously regulate their learning strategies, fostering *self-regulated learning* (Barth & Muehlfeld, 2021; Dignath et al., 2023; Sun et al., 2024). Relevant material recommendations also enrich students' insights beyond the standard curriculum. These features transform the role of students from passive recipients of instruction into active learners who have full control over their learning trajectory. Consistency in monitoring personal target achievements is the key to maintaining motivation and learning discipline throughout the semester.

Although there was an initial learning curve where students felt unfamiliar with the system interface, this adaptation process actually triggered deeper engagement through constructive cognitive challenges. The shift from initial confusion toward system mastery

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signifies the success of the interface design in facilitating user transition. Overall, the integration of AI-based gamification has proven to create a learning environment that is more enjoyable, challenges critical thinking, and reduces the boredom often associated with academic learning. The implications of this research suggest the need to develop more dynamic varieties of rewards to maintain long-term curiosity. In conclusion, the synergy between adaptive technology and game elements is not merely a trend, but a valid strategic solution to improve the quality of learning interactions, discipline students, and create a holistic educational experience that is responsive to the demands of the digital age.

CONCLUSION

This study confirms that the application of artificial intelligence-based gamification has a significant effect on increasing student involvement in the learning process. Quantitative analysis revealed a positive relationship with moderate to strong strength, where the use of gamification features explained 31.3% of the variations in student engagement. Meanwhile, qualitative findings show that elements such as points, badges, leaderboards, content personalization, and automated feedback encourage student motivation, consistency, and emotional and cognitive engagement. The scientific contribution of this research lies in the integration of an AI-based gamification framework that not only confirms the effectiveness of gamification but also broadens the understanding of how artificial intelligence can personalize learning experiences and facilitate self-regulated learning. This enriches the theory of uses and gratification as well as the principles of constructivist learning theory in the context of digital education. From a practical perspective, the results of this study provide guidance for educators and technology developers in designing digital learning platforms that are more adaptive, engaging, and inclusive. Gamification design needs to strike a balance between the competitive aspect and collaboration to maintain motivation without creating excessive academic pressure. This research also opens up opportunities for further exploration, particularly regarding external factors that influence student engagement, such as institutional support, psychological conditions, and digital literacy. The next direction of research could be to expand the study in a cross-cultural context or across different levels of education, and also to test the long-term sustainability of learning motivation through a more adaptive AI model. Thus, this study is not only relevant to the Indonesian educational context but also contributes to the development of a global discourse on the transformation of digital learning based on intelligent technology.

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