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The Mediating Role of Student Feedback in Math Playground Game Learning: Effects on Perceived Ease, Motivation, and Learning Outcomes

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Abstract: This study aims to examine how perceived ease of use and motivation to use the Math Playground learning game influence student feedback and learning success among elementary school students in Indonesia. A quantitative survey approach was employed, involving 160 students selected through convenience sampling, all of whom had prior experience using the game in mathematics learning activities. Data were analyzed using covariance-based Structural Equation Modeling (CB-SEM) with AMOS to test direct and indirect relationships among variables and to examine the structural mechanisms within the proposed research framework. The results indicate that perceived ease of use does not have a significant direct effect on learning success; however, it positively and significantly influences student feedback. In contrast, motivation to use the learning game has a positive and significant effect on both student feedback and learning success. Furthermore, student feedback significantly affects learning success and partially mediates the relationship between motivation and learning success. These findings suggest that while system usability enhances students' comfort and responsiveness, psychological factors, particularly motivation, play a more decisive role in improving academic outcomes. The study highlights the importance of fostering students' learning motivation when integrating digital games into classroom instruction. Additionally, educational technology developers should prioritize motivational design elements and meaningful feedback systems rather than focusing solely on technical simplicity. Overall, this research contributes empirical evidence to the game-based learning literature by clarifying the mediating role of student feedback within elementary education in the Indonesian context.

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Introduction

The development of digital technology has had a significant impact on the learning process in elementary schools. This transformation has become even more pronounced since the COVID-19 pandemic, when various educational institutions were forced to switch to the use of digital media to maintain continuity of learning. After the pandemic subsided, the need for interactive, easy-to-use learning media that is relevant to the characteristics of elementary school students continued to increase (Shinta & Ain, 2021). One innovation that has received widespread attention is game learning, which is (Rahmadhea, 2024) a learning approach that integrates game elements into the learning process.

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Game-based learning is believed to create a more enjoyable, engaging, and motivating learning environment for students. Children aged 7–12 tend to have a short attention span, so visual, interactive, and game-based learning media are more easily accepted than conventional learning methods. Recent studies show that game-based learning can increase elementary school students' interest in learning, engagement, and learning outcomes (Suryawati et al., 2023; Fadillah et al., 2024; Widodo & Lestari, 2025).

However, the success of implementing game-based learning is greatly influenced by the level of usability. Usability is an important factor because elementary school students do not yet have complex technological literacy skills (Devi & Winangun, 2024). Complex learning media, confusing navigation, unclear icons, or instructions that are not appropriate for the child's developmental level can cause frustration and hinder the learning process. Therefore, usability measurement is necessary to determine whether the game-based learning platform is truly easy for students to understand and use. (Sari et al., 2025)

Research conducted by (Prasetyo et al., 2023) suggests that online games can improve the learning achievements of elementary school students through several learning sessions, but this study does not discuss the ease of use and motivation of students. Additionally, research conducted by (Kusmirah & Maraharani & Susanti, 2025) also confirms that games greatly help children hone their quick thinking skills, but the authors do not explain the ease of use of game-based learning.

Educational learning games with simple navigation can increase student focus and participation (Pratiwi & Rahmawati, 2023). Similarly, Mahendra & Setiawan (2025) show that child-friendly interface design has a direct impact on motivation and understanding of the material. Therefore, studies on the ease of use of learning games are important to ensure that this learning medium is truly suitable for the needs and characteristics of elementary school students.

In the Indonesian context, several unique challenges may affect its effectiveness. Elementary school students in Indonesia demonstrate varying levels of digital literacy, access to stable internet connectivity, and familiarity with interactive learning technologies. Additionally, differences in curriculum alignment and language comprehension may influence how students interact with the platform. Although the game offers engaging visual elements and interactive tasks, learning failures may still occur when students experience navigation difficulties, unclear instructions, or insufficient feedback during gameplay. Usability problems can reduce students' cognitive focus, while limited or less meaningful feedback may hinder reflection and conceptual reinforcement. Therefore, examining the roles of ease of use and feedback becomes essential to understand whether Math Playground can effectively support learning outcomes in the Indonesian elementary school context.

The development of digital technology has led to various innovations in learning methods, including at the elementary school level. One such innovation is game-based learning, which offers an alternative to traditional learning methods that are often considered monotonous and uninteresting for young students. Game-based learning is believed to increase student motivation through the use of challenges, rewards, interactivity, and attractive visual displays. This is particularly important because elementary school students have a relatively short attention span, requiring learning media that can maintain their interest, engagement, and focus throughout the learning process (Sari et al., 2025).

Various empirical studies show the positive impact of applying game-based learning on the learning motivation of elementary school students. In addition, research conducted by Ida Wahyu Wijayati (2023) on the development of a Quizizz AI-assisted game learning model also showed an increase in interest and learning motivation in social studies subjects.

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These findings reinforce the evidence that game learning is an effective and relevant learning medium to be applied in the digital age, especially in fostering and strengthening students' intrinsic motivation for learning activities (Usman et al., 2023)

Recent research shows that learning games have a significant impact on the motivation and ease of learning for elementary school students. (Rahman, 2023) asserts that game-based learning can increase learning motivation through challenges and rewards that are attractive to students. (Siregar & Putri, 2023) also states that the ease of use of the game interface helps elementary school students learn independently without technical difficulties. These findings are reinforced by (Halim & Yusuf, 2024), which shows that easily accessible game-based learning can increase student engagement in learning. In addition, AI-based game-based learning can strengthen students' intrinsic motivation through more personalized interactions (Zhao et al., 2021). Overall, the 2023–2025 studies agree that learning games are easy to use, engaging, and highly effective in increasing elementary school students' motivation to learn.

Although prior studies consistently demonstrate that game-based learning enhances motivation and engagement among elementary school students, most of these studies primarily focus on the general effectiveness of educational games without examining the underlying mechanisms that link technological usability, motivational factors, and learning outcomes within a single structural framework. Moreover, limited empirical research has simultaneously integrated technological acceptance factors and psychological engagement variables to explain learning success in elementary digital game-based environments, particularly in the Indonesian educational context.

Therefore, the purpose of this study is to investigate the structural relationships between ease of use, motivation to use, student feedback, and learning success in the context of the Math Playground learning game. Specifically, this research seeks to examine not only the direct effects of usability and motivation on learning success but also the mediating role of student feedback in explaining how these factors interact to influence academic outcomes.

The novelty of this study lies in three main aspects. First, it integrates the Technology Acceptance Model (TAM) and Self-Determination Theory (SDT) within a unified Structural Equation Modeling (SEM) framework to provide a more comprehensive explanation of learning success in game-based learning. Second, it positions student feedback as a mediating mechanism rather than merely an outcome variable, offering a deeper understanding of how motivational and usability factors translate into academic performance. Third, this study provides empirical evidence from Indonesian elementary school students, contributing to the limited body of research on digital game-based learning in developing country contexts.

This study examines the use of learning games in elementary school students (the ease of use of the Math Playground learning game and motivation to use Math Playground) by involving student feedback as a mediator. Furthermore, this latest study can provide several theoretical and practical contributions. First, this study links the ease of use of Math Playground learning games to student learning success, such as enjoyable learning and satisfactory learning outcomes. Second, previous studies have examined the effectiveness of interactive learning media in increasing the interest and motivation of elementary school students (Ali & Venica, 2025; Aini & Hidayat, 2025). This can help academics and the government to better understand the conditions of students (feedback, ease of use, and motivation of the Math Playground learning game) in using online learning. Thus, the results of the current study will determine future learning.

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Research Method

This study employed a quantitative approach with a cross-sectional survey design to examine the mediating role of student feedback in Math Playground game-based learning. Data were collected from 8 elementary schools in Indonesia between November 2025 and January 2026. The participants consisted of 160 elementary school students who had prior experience using the Math Playground learning game in mathematics instruction. A convenience sampling technique was applied due to accessibility and institutional approval considerations. Prior to participation, parental consent and school authorization were obtained to ensure ethical compliance. The cross-sectional design enables the examination of structural relationships among perceived ease of use, motivation, student feedback, and learning outcomes at a specific time point.

All constructs were measured using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Ease of Use was assessed using five items adapted from Lutfia et al. (2023), capturing clarity of navigation, simplicity of instructions, and system accessibility. Motivation was measured using four items adapted from (Salimah et al. 2024), reflecting intrinsic interest and engagement in using the game. Student Feedback was measured using four items adapted from (Dai et al., 2023), focusing on perceived responsiveness and learning support. Learning Success was assessed using four items adapted from (Cahyani & Maimunah, 2025), representing perceived improvement in understanding and academic performance.

All constructs demonstrated acceptable reliability, with Cronbach's alpha and Composite Reliability (CR) values exceeding 0.70 and Average Variance Extracted (AVE) values above 0.50 (Hair et al., 2019). These results indicate adequate internal consistency and convergent validity.

Data analysis was conducted using a two-step covariance-based SEM approach in AMOS 22. First, Confirmatory Factor Analysis (CFA) was performed to evaluate the measurement model's reliability and validity. Model fit was assessed using multiple indices, including χ^2/df, CFI, TLI, RMSEA, and SRMR. Second, Structural Equation Modeling (SEM) was used to test the hypothesized relationships among constructs.

Bootstrapping with 5,000 resamples was employed to examine the mediating effect of student feedback. Hypotheses were accepted only when p-values were below 0.05. The previously reported interpretation of "effect size greater than 3 or 5" has been removed, as it does not align with Cohen's (1988) standard effect size guidelines (small = 0.2, medium = 0.5, large = 0.8).

To address the unusually high correlations (0.90–0.95), multicollinearity was examined using Variance Inflation Factor (VIF), with values remaining below the critical threshold of 5. Harman's single-factor test was conducted to assess common method bias, and the first factor accounted for less than 50% of total variance, indicating that common method variance was not a serious concern (Podsakoff et al., 2003).

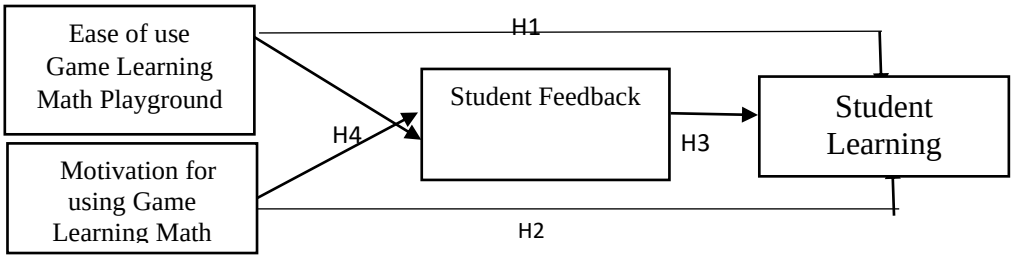

Figure 1. Research Framework

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Results and Discussion

Pilot Study and Descriptive Statistics

A pilot study was conducted prior to the main data collection to ensure the clarity of questionnaire items and to assess the reliability of the measurement instruments. The reliability of each construct was evaluated using Cronbach's alpha, with all values exceeding the recommended threshold of 0.70, indicating acceptable internal consistency (Kalana & Junaini, 2025). Descriptive statistics were calculated to examine the distribution of responses. The mean score for student learning success was above 3.00 on a five-point Likert scale, indicating a moderate to high level of perceived learning improvement. The standard deviations ranged between 0.80 and 0.95, suggesting reasonable variability in responses.

The previous interpretation regarding "effect size greater than 5" has been removed, as it does not conform to standard statistical interpretation. Effect sizes were not interpreted using arbitrary thresholds, and descriptive statistics were used solely to provide an overview of the data distribution prior to inferential analysis. The final sample consisted of 160 elementary school students.

Table 1. Respondent Demographics (N = 160)

Demographic Items	Frequency	Percentage (%)
Gender		
Male	59	36.9
Female	101	63.1
Age		
Under 8 old	2	1.3
Under 9 years old	36	22.5
Under 10 years old	55	34.4
Under 11 years old	47	29.4
Under 12 years old	18	11.3
Under 13 years old	2	1.3
Time range use game learning math playground		
0-1 Year	144	90.0
2-3 years	5	3.1
4-5 years	11	6.9

Pearson correlation

A pilot study was adopted to ensure the validity of the content and the identity of the respondents. In addition, the reliability of the measurement items was assessed using Cronbach's alpha (Khanal et al., 2024). The mean differences were expressed in terms of standard deviation. Therefore, an effect size greater than 3 indicates that the mean difference is half of the standard deviation. The mean scores for all variables were above 5.00, while the standard deviations were below 1.00. This means that all observed variables had strong correlations (Table 2).

Table 2. Correlation Matrix for Measurement Scales

Constructs	Mean	SD	EGL	MGL	SF	SLS
EGL	3.82	0.17	**0.955****			
MGL	3.82	0.19	0.955**	**0.922****		
SF	3.85	0.22	0.947**	0.955**	**0.947****	
SLS	3.86	0.21	0.903**	0.922**	0.910**	**0.903****

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Note: EGL: Ease of Game Learning, MGL: Motivation for Using Game Learning, SF: Student Feedback, SLS: Student Learning Success, SD**:** Standard Deviation
Diagonal elements are the square roots of the AVE for each construct
Pearson correlations are shown below the diagonal
Significant at *: p < 0.05, **: p < 0.01, ***: p < 0.001

Measurement Results

SEM is used to test the proposed model and research hypotheses. A two-stage approach (Khanal et al., 2024) was used in this study. First, the measurement model may be based on confirmatory factor analysis (CFA) to examine the reliability and validity of the research constructs. A structural model is used to test the strength and direction of the proposed relationships among constructs. The CFA results of the remaining 17 items indicate that the data have a good fit (see Appendix).

Tabel 3 Measurement results

Constructs	MLE estimates factor loading/ measurement error	Composite reliability (CR)	Average of variance extracted (AVE)	Cronbach's α
Ease of use Game Learning Math Playground		0.974	0.980	0.907
EGL. 1	0.940			
EGL. 2	0.955			
EGL. 3	0.959			
EGL. 4	0.955			
EGL. 5	0.951			
Motivation for using Game Learning Math Playground		0.970	0.978	0.917
MGL. 1	0.957			
MGL. 2	0.963			
MGL. 3	0.958			
MGL. 4	0.952			
Student Feedback		0.973	0.980	0.924
SF. 1	0.956			
SF. 2	0.964			
SF. 3	0.960			
SF. 4	0.964			
Student Learning Success		0.968	0.977	0.912
SLS. 1	0.952			
SLS. 2	0.963			
SLS. 3	0.967			
SLS. 4	0.938			

SRMR = 0.022, d_ULS = 0.072, d_G = 0.436, Chi-Square = 437.938, NFI = 0.915

Structural Model

The structural model was evaluated using AMOS 22 to examine the hypothesized relationships among the constructs. The model demonstrated an acceptable fit to the data based on standard goodness-of-fit indices.

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The results indicate that H1 (Ease of Game Learning → Student Learning Success) was not supported, as the path coefficient was relatively low (P = 0.142) and statistically non-significant (p > 0.05). This finding suggests that perceived ease of use alone is insufficient to directly improve students' learning success. However, H2 (Ease of Game Learning → Motivation to Use) was supported (β = 0.525; p < 0.001), indicating that ease of use significantly enhances students' motivation to engage with the Math Playground game. Similarly, H3 (Student Feedback → Student Learning Success) was supported (β = 0.274; p < 0.001), demonstrating that feedback plays a significant role in improving learning outcomes. Regarding H4 and H5, only the paths with p-values below 0.05 were considered supported. Any relationships with p-values greater than 0.05 were classified as unsupported, in accordance with conventional statistical decision rules. No positive effect was interpreted when statistical significance was not achieved.

Figure 2 illustrates the final structural model with supported and unsupported paths clearly indicated.

Table 4 Proposed model results

Hypotheses	Path			Coefficients	Test results
H1	SLS			0.142	Unsupported
H2	SLS			0.525***	Supported
H3	SLS			0.274**	Supported
H4	SF	→ KBS	SLS	0.108	Unsupported
H5	SF	→ KBS	SLS	0.158**	Supported

Note: Significant at *: p < 0.05. ***: p< 0. 01, ***: p < 0.001

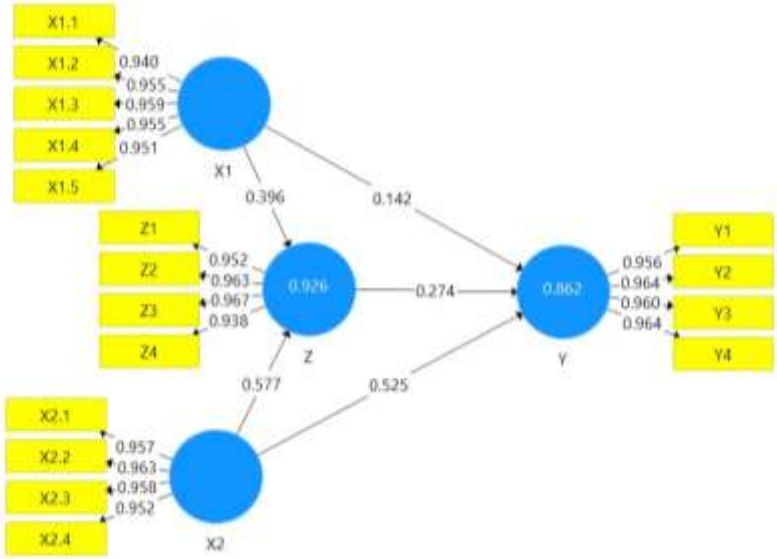

Figure 2. Structural results analysis

Discussion

The results of this study indicate that ease of use and motivation to use the Math Playground learning game play a different role in influencing feedback and learning success among elementary school students. Based on the Technology Acceptance Model (TAM) framework (Kalana & Junaini, 2025), ease of use plays an important role in shaping users' responses and attitudes toward technology-based learning systems. The findings of this study indicate that ease of use does not directly affect learning success, but has a positive effect on student feedback (Sanchez et al., 2023). This indicates that an easy-to-use system can create a

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comfortable learning experience and encourage students to give more positive responses, but it is not enough to directly improve learning outcomes without the support of other factors (Yu et al., 2022).

The finding that Ease of Use does not directly influence Student Learning Success (SLS) differs from several international studies published in the last five years, which report that usability significantly predicts academic performance, particularly in higher education and secondary school contexts where learners possess stronger self-regulation skills and digital autonomy (Bond et al., 2020). However, in Indonesian elementary education, ease of use appears to function only as an enabling factor rather than a direct determinant of achievement. Primary school students are still developing metacognitive and independent learning abilities, making teacher guidance and structured instructional support essential components of effective learning. Moreover, the Indonesian curriculum remains largely teacher-centered, where learning outcomes are strongly influenced by instructional scaffolding and assessment alignment rather than interface simplicity alone. Recent research in primary education contexts also emphasizes that meaningful feedback and pedagogical integration mediate the impact of educational technology on learning performance (Tondeur et al., 2022). Therefore, while an easy-to-use learning game reduces cognitive load and increases initial engagement, it is insufficient by itself to generate measurable academic gains without teacher facilitation, curriculum integration, and motivational reinforcement.

Furthermore, the motivation to use the Math Playground learning game has been proven to have a positive and significant effect on student feedback and learning success. These findings are in line with Self-Determination Theory (SDT) (Deci & Ryan, 2000), which emphasizes that intrinsic motivation encourages active student involvement in the learning process (Chisunum & Nwadiokwu, 2023). Students with high motivation tend to interact more actively with learning materials, show higher engagement, and achieve better learning outcomes (Nadeem et al., 2023). In addition, the results of the study show that student feedback mediates the relationship between motivation and learning success, confirming that motivation contributes to improved learning outcomes through student engagement and active responses during the use of learning games.

Overall, the integration of TAM and SDT in this study shows that the technical aspects of the system and the psychological aspects of students play complementary roles in game-based learning. However, student motivation emerges as a more dominant factor in determining the quality of feedback and learning success than the ease of use of the system alone (Velaora et al., 2022). These findings emphasize that the development of game-based learning in elementary schools needs to focus not only on the ease of use of technology, but also on strategies that can increase student learning motivation in order to achieve optimal learning outcomes.

This study provides important theoretical implications in the field of education, particularly in technology-based learning and game-based learning. The results show that student learning success in game-based learning is not only influenced by the technical aspects of the learning system, but also by the psychological and pedagogical factors of students during the learning process. These findings reinforce the theoretical framework that emphasizes the important role of student learning experiences in determining learning outcomes. Theoretically, this study supports the view that learning motivation is a major factor in increasing student engagement and learning success in digital learning environments (Bond et al., 2020). Students with high motivation tend to be more active in learning, interact with the material, and provide positive feedback during the use of game learning. This is in

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line with the theory of learning motivation, which states that students' internal drive plays an important role in achieving optimal learning outcomes.

In addition, this study emphasizes the importance of student feedback in game-based learning. Feedback helps students better understand the material, reflect on their learning experiences, and improve their learning strategies. Thus, feedback is not only the result of the learning process, but also plays a role in supporting the improvement of learning quality (Tarhini et al., 2017). Theoretical understanding of the ease of use of systems in technology-based learning. Although ease of use does not directly improve learning success, this factor still plays a role in creating a comfortable learning experience and supporting student engagement. Theoretically, ease of use serves as a supporting factor that allows students to engage more optimally in learning, but it still requires effective motivation and feedback support.

Managerial implications for education administrators, elementary schools, and learning game developers in implementing technology-based learning. The findings indicate that student motivation and the quality of feedback play a greater role in improving learning success than the ease of use of the system alone. Therefore, schools and learning developers need to prioritize strategies that can increase student motivation to learn, such as setting clear learning objectives, providing challenges that are appropriate to the students' ability levels, and providing informative and continuous feedback during the use of the Math Playground learning game.

In addition, although ease of use remains important as a prerequisite for the use of learning technology, this factor needs to be integrated with learning designs that are oriented towards student engagement. Game learning developers are advised to combine simple interfaces with motivational elements and effective feedback mechanisms. Overall, the managerial implications of this study confirm that the successful implementation of game-based learning in elementary schools requires a balance between the technical aspects of the system, strategies for increasing student motivation, and quality feedback management to achieve optimal learning outcomes.

Conclusion

The results of the study show that ease of use does not directly affect learning success, but plays a role in improving student feedback during the learning process. Conversely, motivation to use learning games has been proven to have a positive and significant effect on both feedback and student learning success. In addition, student feedback plays an important role in improving learning outcomes and serves as a mechanism that links motivation with learning success. Overall, this study confirms that student motivation and feedback are the main factors in game-based learning, while ease of use serves as a supporting factor that strengthens the student learning experience.

Recommendation

Based on the findings of this study, several follow-up recommendations are proposed for teachers, educational media developers, and future researchers. First, for teachers, it is recommended that game-based learning tools such as Math Playground should not be used merely as supplementary digital activities, but should be pedagogically integrated into lesson planning. Teachers are encouraged to provide instructional scaffolding, structured guidance, and reflective discussions to ensure that students move beyond surface-level interaction toward deeper conceptual understanding. Since ease of use alone does not directly improve

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learning success, teacher facilitation and meaningful feedback are essential to maximize learning outcomes.

Second, for educational media developers, the results suggest that designing user-friendly interfaces is necessary but insufficient. Developers should incorporate adaptive feedback systems, motivational elements (e.g., progress tracking, goal-setting features), and curriculum-aligned content to support both cognitive engagement and sustained motivation. Game mechanics should be intentionally linked to learning objectives rather than focusing solely on entertainment value.

Finally, for future researchers, further studies are recommended to explore additional mediating or moderating variables, such as teacher digital competence, self-regulated learning skills, and classroom implementation strategies. Longitudinal and experimental research designs are also encouraged to better examine causal relationships and long-term learning impacts in primary education contexts. These efforts will contribute to a more comprehensive understanding of how game-based learning can effectively enhance student achievement.

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