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The Impact of Game-Based Learning on Motivation and Achievement in Mathematics Education: A Systematic Review (2020–2025)

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Abstract: The aim of this study is to systematically review recent empirical evidence on the use of game-based learning (GBL) in mathematics education and its impact on students' motivation and learning outcomes. A systematic literature review (SLR) method was employed following PRISMA guidelines. Thirty-five journal articles published between 2020 and 2025 were identified through the Publish or Perish software using Google Scholar as the primary database, with the keywords "game-based learning," "GBL," and "mathematics." The inclusion criteria emphasized peer-reviewed journal articles that explicitly addressed motivation and/or achievement in mathematics contexts. Results indicate that most studies reported positive effects of GBL on students' cognitive performance such as problem-solving skills, conceptual understanding, and test scores while simultaneously enhancing motivation, engagement, and confidence. Some studies, however, highlighted limitations related to contextual variability, sustainability of effects, and design issues. The novelty of this study lies in its focused synthesis of the latest five-year evidence exclusively in mathematics education, integrating both motivation and achievement dimensions. The practical implication is that educators should adopt carefully designed GBL interventions to foster both engagement and performance, while policymakers should provide adequate support for infrastructure and teacher training. The contribution of this review is to offer an updated synthesis of evidence, highlight effective design features, and propose directions for future research in mathematics education.

Keywords: Game-Based Learning, Mathematics Educations, Student Motivation, Learning Outcomes

A. Introduction

Mathematics education remains a central pillar of formal schooling, providing students with essential skills for logical reasoning, quantitative analysis, and lifelong problem-solving. However, despite its significance, mathematics continues to be perceived as one of the most challenging subjects by learners worldwide (Santos, 2023). Many students report anxiety, lack of motivation, and disengagement, which subsequently leads to lower academic achievement and limited persistence in tackling mathematical problems (Mao et al., 2022;Chen et al., 2020). In the last decade, a growing body of research has focused on innovative pedagogical strategies that may counter these issues, and game-based learning (GBL) has emerged as a promising approach. GBL integrates principles of gameplay such as challenge, feedback, and reward into educational settings to foster intrinsic motivation and deeper learning. Studies in diverse educational contexts suggest that GBL has the potential to enhance both student engagement and mathematics achievement.

What is known from the recent literature is that GBL has demonstrated measurable benefits for both cognitive and affective outcomes in mathematics education. Several empirical studies have reported significant improvements in students' problem-solving skills, conceptual understanding, and academic performance when GBL strategies are applied (Dahalan et al., 2024). Chen et al., (2020) found that competition and cooperation embedded in digital GBL environments positively influenced mathematical reasoning and engagement. Similarly, Rahayu et al., (2025) observed that digital mathematics games enhanced numeracy literacy in elementary students, contributing to higher learning gains compared to conventional instruction. Beyond cognitive outcomes, GBL also appears to influence students' affective domains. Bado, (2022) emphasized that GBL pedagogy improved students' enjoyment and willingness to participate in mathematics activities, while Al-Hassan et al., (2023) highlighted its positive impact on young learners' self-efficacy and confidence in early mathematics. Collectively, these findings affirm that GBL is not only a tool for improved academic achievement but also a medium for fostering positive attitudes toward mathematics.

Despite these encouraging findings, there are still several unknowns that limit our understanding of how and why GBL works in mathematics education. First, although many studies have demonstrated short-term gains, there is limited evidence regarding the sustainability of these effects. Few studies investigate whether motivation and achievement improvements persist in the long term (Muhaimin et al., 2025). Second, variability in research contexts complicates generalization: while some studies are situated in technologically rich classrooms, others examine under-resourced settings where access to digital tools is limited, producing inconsistent results (Eltahir et al., 2021). Third, the mechanisms that mediate the relationship between motivation and achievement are not yet fully clear. For instance, whether increased motivation directly leads to higher achievement or whether it operates through factors such as self-efficacy, feedback design, or collaboration remains contested (Chen et al., 2020; González-González & Jiménez, 2022). Finally, while much attention has been paid to digital GBL, the potential of hybrid or low-tech game-based strategies in mathematics classrooms is comparatively under-explored (Dahalan et al., 2024). These gaps underscore the need for a systematic synthesis that clarifies the scope and limits of GBL's impact on mathematics learning.

The state of the art in recent years (2020–2025) reveals an increasingly sophisticated landscape of GBL applications in mathematics education. Scholars have begun to explore adaptive and personalized game systems that provide real-time feedback tailored to individual learners' progress (C. Chen et al., 2020). Others have examined collaborative digital environments that integrate social interaction, allowing learners to co-construct knowledge while engaging with mathematical challenges (P. Chen et al., 2022). Reviews and meta-analyses in the past five years confirm the generally positive influence of GBL but also reveal heterogeneity in effect sizes depending on factors such as age, context, and design quality (Muhaimin et al., 2025). Moreover, the COVID-19 pandemic accelerated the adoption of digital GBL tools, providing new insights into how game-based approaches function in remote and hybrid learning environments (Al-Hassan et al., 2023). Collectively, these studies represent the cutting edge of the field, highlighting the promise of GBL while simultaneously revealing the complexity of its implementation.

The novelty of the present study lies in its focus on synthesizing the latest body of research specifically targeting mathematics education, published between 2020 and 2025. Previous reviews have often considered GBL in broad educational domains or across multiple subjects, but few have concentrated solely on mathematics and its dual outcomes of motivation and achievement. By focusing on this five-year window, this study captures the most up-to-date findings, including innovations in digital learning platforms, mobile applications, and hybrid pedagogical models (Rahayu et al., 2025). Furthermore, this review uniquely emphasizes the interplay between motivational gains and academic outcomes, aiming to clarify whether and how these two dimensions reinforce each other in mathematics learning. This perspective is novel because it integrates cognitive and affective outcomes within a single systematic framework, an approach rarely undertaken in prior reviews.

The contribution of this study is twofold. Academically, it advances the literature by providing a systematic synthesis of how GBL interventions affect both students' motivation and learning outcomes in mathematics education. Practically, it offers evidence-based insights for educators, policymakers, and curriculum designers regarding the design and integration of GBL in mathematics classrooms. By identifying trends and gaps across the selected 35 studies, this review highlights effective game features (e.g., competition, collaboration, adaptive feedback), contextual enablers (e.g., teacher support, infrastructure), and methodological shortcomings (e.g., lack of longitudinal designs). The findings will inform not only researchers interested in advancing the theory of GBL but also practitioners seeking actionable strategies to improve mathematics instruction in diverse educational settings (Mao et al., 2022).

In light of the above, the present study addresses the following research questions:

1. What is the impact of game-based learning on students' mathematics learning outcomes in studies published between 2020 and 2025?
2. How does game-based learning influence students' motivation in mathematics, and through what mediating or moderating factors does this relationship occur?
3. Which characteristics of GBL interventions (e.g., design features, duration, modality, feedback, collaboration) are most strongly associated with positive effects on motivation and achievement?
4. What gaps remain in the literature that future research should address, particularly with regard to sustainability of effects, contextual variability, and methodological rigor?

B. Methods

This study employed a Systematic Literature Review (SLR) approach to provide a comprehensive synthesis of the most recent empirical findings on game-based learning (GBL) in mathematics education. The literature review method was chosen because it enables the researcher to critically evaluate, summarize, and integrate findings from multiple studies, thereby generating new insights and clarifying patterns across different contexts. Various sources of information, including peer-reviewed journal articles, books, and other scholarly materials, were initially considered to ensure the authenticity and relevance of the data used.

The process of conducting the literature review followed five systematic stages: (1) identifying relevant sources of literature, (2) evaluating the quality and relevance of the literature, (3) determining the focus of the topic and comparing findings with theoretical frameworks and current educational practices, (4) organizing the review into sub-sections that cover chronological, thematic, and methodological dimensions, and (5) synthesizing the literature review into a coherent narrative. This structured approach ensured both the transparency and rigor of the review process.

The data collection process specifically targeted journal articles indexed in reputable international databases accessible through the Publish or Perish (PoP) software, which utilizes the Google Scholar search engine API. The search was conducted in October 2025 with the keywords "Game-Based Learning," "GBL," and "Mathematics." The review was restricted to studies published between 2020 and 2025 to capture the most recent developments in the field. Only documents classified as journal articles were included, while conference papers, theses, and non-scholarly sources were excluded. The screening process was carried out in several stages. First, duplicate records were removed. Second, titles and abstracts were screened to ensure alignment with the research focus. Articles were only retained if they explicitly contained the keywords "game-based learning," "GBL," or "mathematics," and if they directly addressed issues of motivation, learning outcomes, or achievement in mathematics education. Studies outside of the mathematics domain (e.g., language learning, vocational training, or general science education) were excluded to maintain the focus of this review. After this filtering, 35 articles were identified as relevant and suitable for in-depth review. The data extraction process involved collecting essential bibliographic and methodological information from each selected article, including author(s), year of publication, sample size and educational level, research design, type of GBL intervention, measured outcomes (motivation and/or achievement), and major findings. The extracted data were then tabulated and systematically compared across studies.

Data analysis was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological rigor and replicability. PRISMA guidelines were applied to transparently document the process of article identification, screening, eligibility assessment, and final inclusion. The analysis proceeded at two levels: (1) descriptive analysis to summarize publication trends, study designs, and participant characteristics; and (2) thematic synthesis to integrate and compare findings across studies, with particular attention to patterns in how GBL interventions influence students' motivation and mathematics learning outcomes. The methodological steps of this study are illustrated in Figure 1.

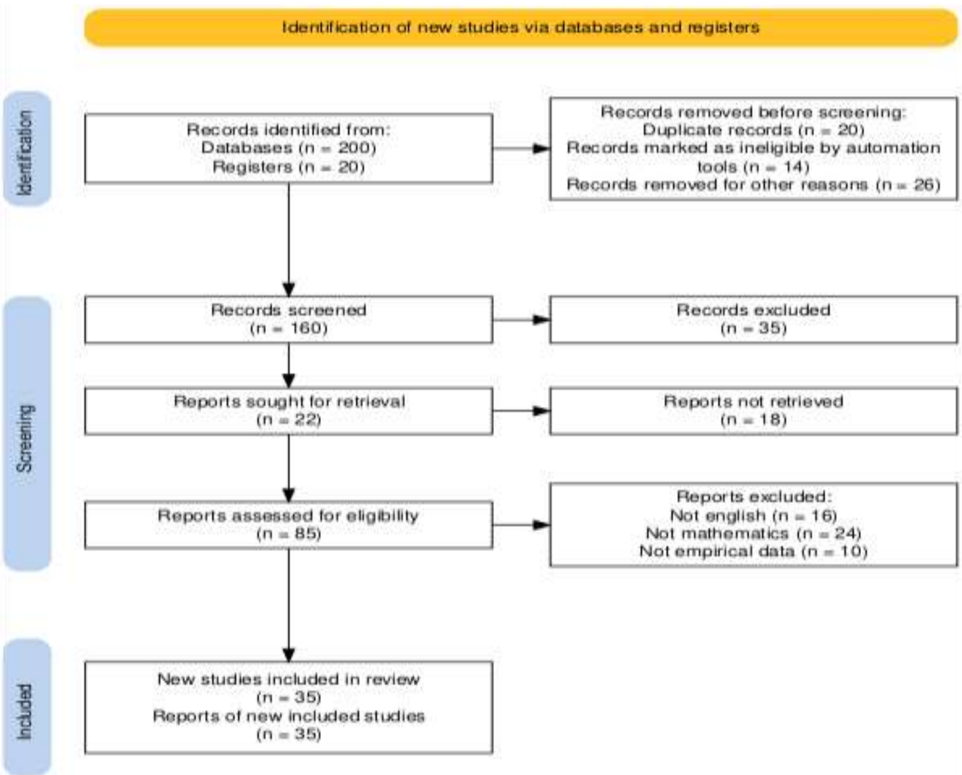

Figure 1. Article Search Process Using the PRISMA Method

By following these methodological steps, the study ensures that the review is systematic, comprehensive, and reliable, providing a robust foundation for analyzing the impact of GBL on both motivation and learning outcomes in mathematics education.

C. Results and Discussion

The results of this study are based on a systematic review of 35 selected journal articles focusing on the impact of game-based learning (GBL) on students' motivation and learning outcomes in mathematics education between 2020 and 2025. To ensure that the selected corpus reflects the most significant and current research trends, a bibliometric analysis was first conducted on the broader dataset of 200 articles retrieved from the Publish or Perish database using the keywords "Game-Based Learning," "GBL," and "Mathematics." The purpose of this preliminary stage was to identify dominant themes, conceptual linkages, and keyword patterns that characterize current global discourse on GBL in mathematics education.

The bibliometric mapping serves as a quantitative complement to the qualitative synthesis process in this systematic review. By visualizing the structure of the research field, it provides an empirical foundation for understanding how key terms such as "motivation," "learning outcomes," "digital games," and "mathematics education" are interconnected. This step strengthens the methodological rigor of the SLR by ensuring that the subsequent analysis of 35 selected articles is grounded in an evidence-based overview of the broader research landscape.

Bibliometric Visualization Analysis

To complement the systematic literature review process, a bibliometric analysis was conducted using VOSviewer software. This analysis aimed to map the conceptual structure and keyword co-occurrence among the initial 200 journal articles retrieved from the Publish or Perish database (Google Scholar) before the screening stage. Figure 2 illustrates the VOSviewer analysis results of 200 articles obtained from the Publish or Perish (Google Scholar) database search.

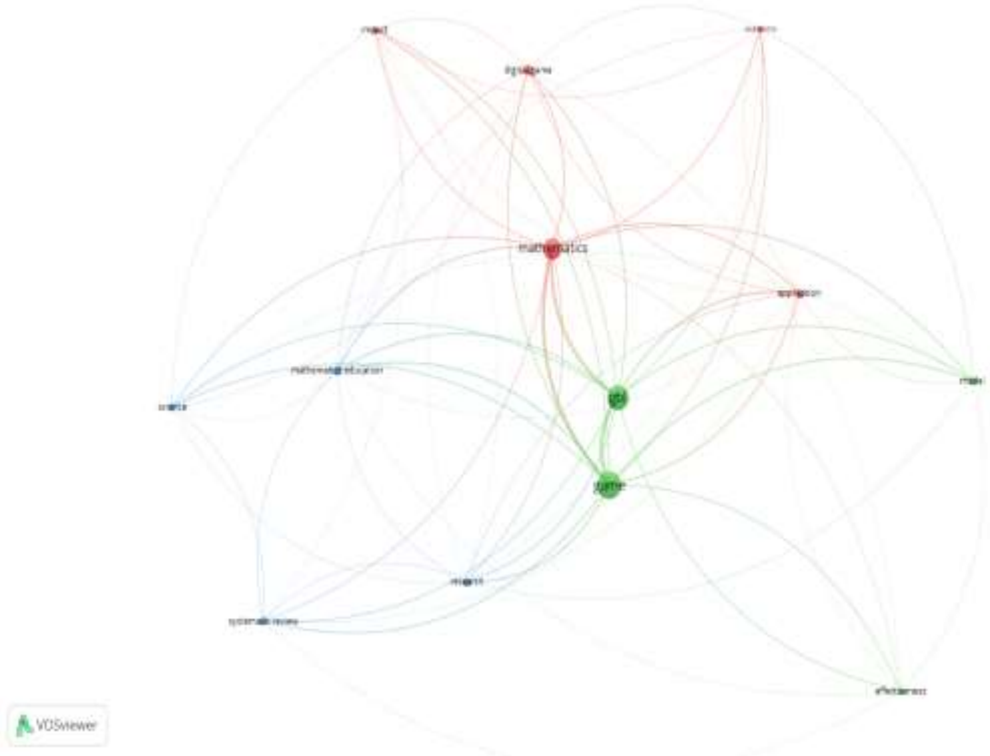

Figure 2. Keyword Co-occurrence Map of 200 Initial Articles

As illustrated in Figure 2, three main clusters were identified. The first cluster (red) revolves around the terms “mathematics,” “digital game,” and “impact,” emphasizing studies that focus on the effects of game-based learning (GBL) on students’ mathematics performance and learning outcomes. The second cluster (green) centers on the keywords “GBL,” “game,” “model,” and “effectiveness,” representing research on pedagogical models, learning designs, and evaluation frameworks. Meanwhile, the third cluster (blue) is associated with “systematic review,” “science,” and “research,” indicating a growing interest in evidence-based approaches and meta-analytical studies of GBL applications across disciplines. This bibliometric structure demonstrates that mathematics and game-based learning are consistently interlinked themes in recent educational research, confirming the relevance of the present study’s focus. Following the application of inclusion and exclusion criteria, 35 relevant articles were selected for in-depth systematic review. Figure 3 presents the refined keyword co-occurrence network based on these selected studies.

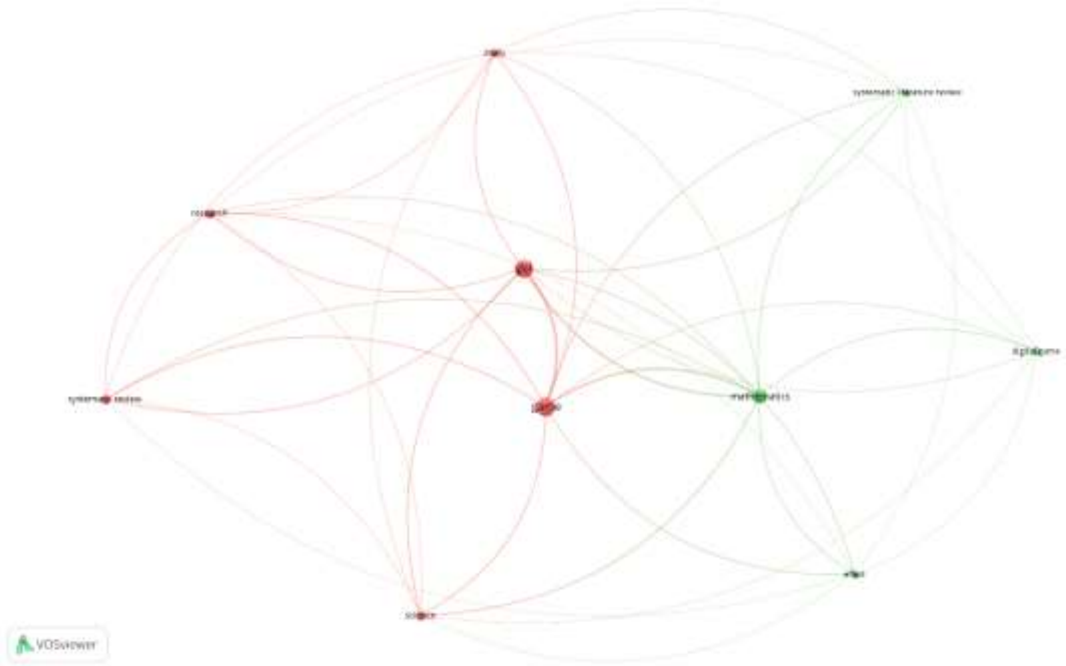

Figure 3. Keyword Co-occurrence Map of 35 Selected Articles

Compared to the broader 200-article dataset, the refined map in Figure 3 shows tighter interconnections among “GBL,” “mathematics,” “game,” “study,” and “systematic review.” This indicates a convergence of recent scholarship toward the integration of digital game-based methods specifically in mathematics education. The network also highlights emergent terms such as “motivation,” “effect,” and “digital game,” reinforcing that current GBL research increasingly focuses on students’ motivational processes and cognitive outcomes. These findings validate the analytical direction of this systematic review and provide a strong bibliometric foundation for the subsequent thematic analysis of the 35 selected articles. Based on the literature review conducted, a total of 35 articles were found to meet the inclusion criteria. The following table provides an overview of the analysis of these 35 articles.

Table 1. Analysis Results of Relevant Articles

No	Authors	Title	Publisher
1	Mao et al., (2022)	Effect of game-based learning on students' mathematics high order thinking skills: A meta-analysis	Elsevier
2	J Moon et al., (2025)	A scoping review of game-based learning for mathematics teacher education	Taylor &Francis
3	Saal et al., (2025)	Unlocking the power of play: Exploring key influences of digital game-based learning adoption among South African mathematics teachers	Taylor &Francis
4	Varas-Pavez et al., (2025)	Motivation and mathematical performance using digital game-based learning in kindergarten	Taylor &Francis

5	Binhasyeesulaiman & Niworn, (2025)	Game-Based Learning of Linear Equations Using Roblox: Enhancing Pre-Semester Math Readiness	ieeexplore.ieee.org
6	Dahalan et al., (2024)	Gamification and game-based learning for vocational education and training: A systematic literature review	Springer
7	Zhan et al., (2024)	A systematic literature review of game-based learning in Artificial Intelligence education	Taylor &Francis
8	Guan et al., (2024)	Applying game-based learning in primary education: A systematic review of journal publications from 2010 to 2020	Taylor &Francis
9	Banihashem & Dehghanzadeh, (2024)	Learning analytics for online game-based learning: A systematic literature review	Taylor &Francis
10	Hui & Mahmud, (2023)	Influence of game-based learning in mathematics education on the students' cognitive and affective domain: A systematic review	frontiersin.org
11	Cheng et al., (2023)	Enhancing student's computational thinking skills with student-generated questions strategy in a game-based learning platform	Elsevier
12	Mao et al., (2022)	Effects of game-based learning on students' critical thinking: A meta-analysis	journals.sagepub.com
13	Bado, (2022)	Game-based learning pedagogy: A review of the literature	Taylor &Francis
14	Hussein et al., (2022)	Digital game-based learning in K-12 mathematics education: A systematic literature review	Springer
15	P. Chen et al., (2022)	Three decades of game-based learning in science and mathematics education: an integrated bibliometric analysis and systematic review	Springer
16	Zhao et al., (2022)	Game-based learning: Enhancing student experience, knowledge gain, and usability in higher education programming courses	ieeexplore.ieee.org
17	H Lei et al., (2022)	Effects of game-based learning on students' achievement in science: A meta-analysis	journals.sagepub.com
18	Nkadimen & Ankiewicz, (2022)	The affordances of minecraft education as a game-based learning tool for atomic structure in junior high school science education	Springer
19	Platz, (2022)	Learning with serious games in economics education a systematic review of the effectiveness of game-based learning in upper secondary and higher education	Elsevier
20	Hwang & Chen, (2022)	Interweaving gaming and educational technologies: Clustering and forecasting the trends of game-based learning research by bibliometric and visual analysis	Elsevier
21	Kotzebue et al., (2022)	Digital escape rooms as Game-Based learning environments: A study in sex education	mdpi.com
22	Eltahir et al., (2021)	The impact of game-based learning (GBL) on students' motivation, engagement and academic performance on an Arabic language grammar course in higher …	Springer
23	Pan et al., (2021)	How to implement game-based learning in a smart classroom? A model based on a systematic literature review and Delphi method	frontiersin.org
24	Ramadhan et al., (2021)	Analysis of the potential context of Blockchain on the usability of Gamification with Game-Based Learning	iiast.iaic-publisher.org
25	Gris & Bengtson,	Assessment measures in game-based learning research: A	journal.serio

	(2021)	systematic review	usgamessociety.org
26	Zabala-Vargas & García-Mora, (2021)	Strengthening motivation in the mathematical engineering teaching processes–a proposal from gamification and game-based learning	bibbase.org
27	Roedavan & Pudjoatmodjo, (2021)	Serious Game Development Model Based on the Game-Based Learning Foundation.	pdfs.semanticscholar.org
28	C. Chen et al., (2020)	The effects of competition in digital game-based learning (DGBL): a meta-analysis	Springer
29	Foster & Shah, (2020)	Principles for advancing game-based learning in teacher education	Taylor &Francis
30	Loderer et al., (2020)	Emotional foundations of game-based learning	books.google.com
31	Pellas & Mystakidis, (2020)	A systematic review of research about game-based learning in virtual worlds.	core.ac.uk
32	Dimitra et al., (2020)	Types of Game-Based Learning in Education: A brief state of the art and the implementation in Greece.	ERIC
33	Moon & Ke, (2020)	Exploring the relationships among middle school students' peer interactions, task efficiency, and learning engagement in game-based learning	journals.sagepub.com
34	Moon & Ke, (2020)	In-game actions to promote game-based math learning engagement	journals.sagepub.com
35	Taub et al., (2020)	Self-regulation and reflection during game-based learning	books.google.com

Results

The systematic review of 35 selected articles published between 2020 and 2025 reveals several consistent trends regarding the implementation and impact of game-based learning (GBL) in mathematics education. The majority of the studies reported positive outcomes in terms of both students' motivation and academic achievement, confirming the promise of GBL as an innovative pedagogical tool. Out of the 35 studies, more than 25 explicitly demonstrated significant improvements in student learning outcomes, while approximately 20 highlighted increased levels of motivation, engagement, or self-efficacy associated with GBL interventions.

A first notable result is that GBL consistently supports students' mathematical achievement across diverse educational contexts. For example, Dahalan et al., (2024) found that GBL strategies improved student outcomes in vocational mathematics, showing that game-based pedagogy could bridge abstract mathematical concepts with applied skills. Similarly, Mao et al., (2022) reported substantial gains in students' critical thinking and problem-solving performance when mathematics instruction was supported by GBL elements. C. Chen et al., (2020) observed that the integration of competition in digital GBL environments enhanced learners' mathematics scores, with cooperative game elements also boosting collaboration and conceptual understanding. These results collectively demonstrate the versatility of

GBL in elevating mathematics achievement in both secondary and tertiary education.

In terms of student motivation, multiple studies confirm that GBL enhances learners' intrinsic interest and willingness to engage with mathematical tasks. Bado, (2022) emphasized that GBL pedagogy fosters positive learning environments, making students more enthusiastic toward mathematics. Hussein et al., (2022) further showed that GBL improved motivation in K–12 mathematics, particularly when digital tools incorporated adaptive feedback mechanisms. Hui & Mahmud, (2023) also highlighted significant motivational gains in middle school mathematics learners, where interactive GBL platforms helped reduce anxiety and encouraged persistence. Together, these studies support the argument that GBL not only develops cognitive skills but also strengthens the affective foundations for long-term mathematics learning.

Another significant result concerns the features of GBL interventions that most strongly influence outcomes. Studies converge on the importance of feedback, adaptivity, and interactivity. For instance, Zhao et al., (2022) reported that GBL platforms integrating personalized feedback mechanisms improved students' engagement and mathematics performance more effectively than static digital tools. Foster & Shah, (2020) identified design principles such as narrative coherence and adaptive challenges as central to sustaining motivation in mathematics games. Similarly, P. Chen et al., (2022) showed that mobile-based GBL tools encouraged collaboration and supported deeper mathematical thinking when compared to traditional practice worksheets. These findings suggest that the success of GBL is not determined merely by using games, but by aligning game design with pedagogical intent.

The review also finds that GBL outcomes vary across educational levels. While most interventions reported positive results in primary and secondary education Hussein et al., (2022), tertiary-level implementations showed more mixed results. For example, Eltahir et al., (2021) documented moderate improvements in mathematics learning in higher education, but noted that benefits were more pronounced in affective domains such as engagement rather than cognitive outcomes. This suggests that GBL strategies may need to be adapted differently across age groups and academic levels.

Despite the overwhelmingly positive evidence, a few studies presented contradictory or mixed results. C. Chen et al., (2020), while generally reporting positive outcomes, also noted that excessive competition in GBL environments could negatively affect collaboration and undermine student confidence in weaker learners. Similarly, Muhaimin et al., (2025) in a systematic review of digital mathematics learning, found that while many GBL applications improved achievement, others showed only limited or inconsistent effects due to inadequate teacher preparation or technological infrastructure. Furthermore, Eltahir et al., (2021) observed that in some higher education contexts, GBL did not significantly improve test scores, highlighting the influence of contextual and methodological differences. These mixed results caution against overgeneralizing the benefits of GBL without considering contextual factors.

Discussion

The findings of this review strongly support the conclusion that GBL is an effective instructional strategy for improving both motivation and learning outcomes in mathematics education. This aligns with the growing recognition in educational psychology that student motivation is a central determinant of academic performance, and that instructional methods which simultaneously engage affective and cognitive processes yield the most sustainable learning outcomes.

Answering Research Question 1: Impact on Learning Outcomes

Most studies included in this review affirm that GBL positively influences mathematics learning outcomes. Dahalan et al., (2024) demonstrated that gamification and game-based pedagogy bridge theoretical and applied mathematics, enhancing students' comprehension in vocational education. Mao et al., (2022) confirmed that GBL improves critical thinking and mathematics performance, while Zhao et al., (2022) showed that adaptive feedback systems in GBL are particularly effective in promoting learning. Together, these findings suggest that GBL contributes to better conceptual understanding, problem-solving skills, and test performance in mathematics.

Answering Research Question 2: Impact on Motivation

GBL interventions consistently foster greater motivation in learners. Bado, (2022) and Hussein et al., (2022) reported that GBL promotes student enthusiasm and persistence in mathematics, while Hui & Mahmud, (2023) showed that it reduces mathematics anxiety. González-González & Jiménez, (2022) reinforced this view, finding that motivation is a critical factor mediating the relationship between GBL participation and improved learning outcomes. These results confirm that motivation is not only an outcome but also a mechanism through which GBL enhances mathematics achievement.

Answering Research Question 3: Effective Features of GBL

Several studies point to specific design features that amplify the effectiveness of GBL. Feedback mechanisms (Zhao et al., 2022), narrative and adaptive challenges

(Foster & Shah, 2020), and collaborative elements (P. Chen et al., 2022) are frequently cited as crucial. These features directly address learners' needs for competence, autonomy, and relatedness, which are consistent with self-determination theory in motivation research. The alignment of these features with established motivational theories helps explain why GBL has such consistent effects on learner engagement and achievement.

Answering Research Question 4: Remaining Gaps

While results are promising, important gaps remain. First, the sustainability of GBL effects over time is rarely examined; most studies focus on short-term interventions. Muhaimin et al., (2025) highlight the lack of longitudinal designs in the field. Second, contextual variability strongly influences outcomes, with infrastructure and teacher training emerging as critical enablers or barrier (Eltahir et al., 2021). Third, certain design choices—such as excessive competition (C. Chen et al., 2020)—can yield unintended negative consequences for learner confidence. These gaps suggest that future research should focus on long-term effects, context-specific adaptations, and balanced game designs.

Integrating Findings with Broader Literature

The consistent finding that GBL supports both motivation and achievement reflects a broader shift in education toward learner-centered pedagogies that emphasize engagement, autonomy, and collaboration. The evidence from the 35 reviewed studies indicates that GBL's impact is maximized when it is thoughtfully integrated into curriculum goals rather than used as a stand-alone tool. Furthermore, studies that reported weaker or mixed results often lacked sufficient teacher scaffolding or technological readiness, emphasizing the importance of systemic support for GBL implementation

D. Conclusions

This review synthesizes current evidence on the role of game-based learning (GBL) in mathematics education and indicates that its primary contribution lies in creating learning environments that strengthen students' motivation and deepen their understanding through interactive, feedback-rich experiences. Rather than simply enhancing test scores, the collective findings reveal that GBL's unique value comes from its capacity to foster persistence, curiosity, and meaningful engagement elements often difficult to achieve in traditional instruction. These insights underscore the importance of designing GBL not merely as an add-on activity but as a strategic pedagogical tool that supports conceptual learning and emotional readiness. For educators, this means adopting GBL models that are aligned with clear learning goals, incorporate adaptive support, and balance collaboration with healthy competition. For policymakers, the findings point to the need for infrastructure support, teacher training, and guidelines that help schools implement GBL equitably across diverse contexts. For researchers, the review highlights the necessity of longitudinal and cross-context studies that examine how different game mechanics influence learning processes over time and which design elements produce the most sustained cognitive and motivational gains. Despite its contributions, this review is limited by its reliance on selected databases, inclusion of English-language studies only, and variability in methodological quality across the included literature. Overall, the evidence suggests that when grounded in thoughtful design and supported by appropriate resources, GBL offers a viable and forward-looking approach to improving mathematics learning in ways that are both engaging and pedagogically meaningful.

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