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Systematic Review of Gamification and Digital Resources in the Teaching of Mathematics in Primary and Secondary Education

Revisión sistemática de la gamificación y recursos digitales en la enseñanza de las matemáticas en educación básica y media

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ABSTRACT

Gamification is a teaching strategy with the aim of improving student motivation, engagement, and academic performance. This study analyzed the application of gamification and digital resources in mathematics teaching at the primary and secondary levels. A systematic review following the PRISMA 2020 methodology was conducted to gather the key documents of this field of research. A Scopus search yielded a total of 3,643 records, of which 30 were selected after applying filters by year, language, document type, educational level, and thematic relevance. The results demonstrate significant improvements in academic performance, motivation, and student participation. It is concluded that gamification, integrated with digital resources, constitutes an effective strategy for strengthening mathematical learning.

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RESUMEN

La gamificación es una estrategia de enseñanza eficaz que mejora la motivación, la participación y el rendimiento académico del alumnado. El objetivo de este estudio es analizar la aplicación de la investigación sobre gamificación y recursos digitales en la enseñanza de las matemáticas en los niveles de primaria y secundaria. Se realizó una revisión sistemática siguiendo la metodología PRISMA 2020 para recopilar los documentos clave. Una búsqueda en Scopus arrojó 3643 registros, de los cuales se seleccionaron 30 tras aplicar filtros por año, idioma, tipo de documento, nivel educativo y relevancia temática. Los resultados demuestran mejoras significativas en el rendimiento académico, la motivación y la participación del alumnado. Se concluye que la gamificación junto con la aplicación de recursos digitales constituye una estrategia apropiada para fortalecer el aprendizaje de las matemáticas.

Palabras clave: gamificación, educación, matemáticas, educación básica, educación media

1. INTRODUCTION

Mathematics plays a fundamental role in school education, providing essential tools from an early age to solve everyday problems and connect knowledge across different disciplines (Guaypatin Pico et al., 2021). However, mathematics teaching continues to face significant challenges in contemporary educational contexts characterized by constant social and technological changes (González Martínez, 2024). Traditional teaching methods based on repetition and memorization limit students' understanding and reduce their ability to apply mathematical concepts to real-life situations (López Lattá, 2023). This situation has contributed to a persistent lack of motivation and interest among students, negatively affecting their

academic performance and participation in mathematics learning (Escobar Pullutasig, 2024).

In response to these challenges, innovative pedagogical approaches have emerged, particularly those that integrate Information and Communication Technologies (ICT), which facilitate more dynamic, flexible, and personalized learning environments (Pozo-Velasco et al., 2025; Early, 2023). Among these approaches, gamification has gained increasing relevance as a strategy that incorporates game elements, such as points, levels, and rewards, to enhance students' motivation and engagement.

Although academic research on gamification in education has increased, most studies have focused on higher education, leaving a gap in understanding its impact on primary and secondary education, particularly in mathematics. In this regard, it is necessary to systematize the existing evidence in order to identify trends, pedagogical approaches, and the impact of gamification combined with digital resources on mathematics teaching in secondary education.

The aim of this study is to analyze, through a systematic literature review based on the PRISMA 2020 methodology, the application of gamification and digital educational resources in the teaching of mathematics in primary and secondary education.

To achieve this objective, the following research questions are proposed:

- What are the main trends and teaching approaches in the use of gamification in mathematics education?
- What impact does gamification have on students' motivation, academic performance, and mathematical skills?
- What challenges and research gaps are identified in the literature?

These questions guide the analysis and interpretation of the studies selected in this systematic review.

2. THEORETICAL BACKGROUND

2.1. Teaching Mathematics

Mathematics education plays a central role in the development of logical thinking, problem-solving skills, and critical reasoning. However, traditional approaches centered on memorization and repetitive exercises have been widely questioned for their limited effectiveness in fostering meaningful learning (López Lattá, 2023). Recent perspectives emphasize the need to connect mathematical content with real-life contexts, enabling students to understand its relevance and practical applicability (Escobar Pullutasig, 2024).

2.2. Information and Communication Technologies (ICT) in Education

The integration of ICT in education has transformed teaching and learning by enabling more interactive, student-centered environments (Pozo-Velasco et al., 2025). Digital tools also enable the adaptation of learning processes to individual needs, thereby promoting personalized education (Early, 2023). The curricular integration of ICT constitutes one of the main purposes of the current transformation of teaching scenarios. In this regard, Hurtado and Escudero Benavides (2024) point out that the use of ICT in academic activities is not solely limited to incorporating technological elements; rather, it seeks to strengthen didactic practice and its development, aiming to consolidate an effective knowledge acquisition process within technological environments.

2.3. Gamification in Education

Gamification refers to the incorporation of game elements into non-game contexts, particularly educational environments, to increase motivation and engagement (Reif et al., 2024). Elements such as points, levels, badges, and rewards enhance students' motivation (Manzano-León et al., 2021). This process has positively transformed

instructional delivery by fostering dynamic, engaging experiences that make the educational model more stimulating for students. Thus, gamification strategies aligned with educational objectives enhance students engagement, motivation, and satisfaction. These findings provide valuable recommendations for designing digital gamification experiences that optimize both learning processes and students' educational experiences (Mendoza-Vega, 2025).

2.4. Gamification in Mathematics Education

Gamification has been increasingly used in mathematics education to address students' lack of interest and improve academic performance. Studies have shown that gamified digital resources enhance motivation and the understanding of mathematical concepts. However, its application in primary and secondary education remains less explored (Sarzosa & Toaza, 2025). Similarly, Párraga et al. (2024) argue that the use of didactic tools based on gamification makes mathematics learning more attracting and accessible to students. The authors emphasize that this strategy creates a digital connection in knowledge transmission and highlight that digital gamification is an engaging methodology that facilitates and supports mathematics learning. Furthermore, it helps reduce the gap between knowledge acquisition and its practical application.

3. METHOD

The present study was conducted in accordance with the PRISMA 2020 guidelines, which serve as a guiding framework for systematic reviews. PRISMA guidelines were followed to ensure a rigorous, transparent process across the identification, selection, evaluation, and synthesis of scientific evidence (Ciapponi, 2021).

3.1. Eligibility Criteria and Review Procedure

The review followed the PRISMA 2020 guidelines (Page et al., 2021). This method used a process of identification, screening, eligibility, assessment, and study inclusion. The literature review was conducted in the Scopus database from July 2025 to September 2025. The search string applied to all fields is gamification AND mathematics AND education.

The studies included in this review were selected as follows: (1) empirical research articles or conference proceedings indexed in the Scopus database; (2) studies focused on the application of gamification or gamified digital resources in the teaching of mathematics; (3) primary, secondary, or basic education contexts; (4) studies reporting results related to academic performance, motivation, student participation, mathematical reasoning, or the learning of mathematical content; (5) publications available in English or Spanish; and (6) studies published between January 2018 and July 2025.

Studies were excluded from the review when they met any of the following conditions: (1) publications prior to 2018; (2) postgraduate education, teacher training, or studies on non-school populations; (3) research primarily related to virtual reality, augmented reality, computer-assisted instruction, sustainability, COVID-19, clinical psychology, medicine, or other topics not directly aligned with the purpose of the review; (4) documents that did not report empirical evidence as data-based findings derived from an explicit research design, intervention, observation, or systematic data collection process, were excluded; and (5) duplicate records or studies that did not provide sufficient methodological information for analysis.

3.2. Review Procedure

The selection process was carried out in three stages. First, a title and abstract review was performed to determine the thematic relevance of the identified studies. Subsequently, the conclusions and methodological aspects of the potentially relevant works were analyzed.

Finally, a full reading of the eligible articles was conducted to verify compliance with all established inclusion and exclusion criteria.

The initial search identified 3,643 records. After removing 337 publications prior to 2018, 3,306 records were obtained. Subsequently, applying thematic filters reduced the sample to 2,766 documents. After screening and eligibility assessment, 59 studies were selected for full review; of these, 30 met the established inclusion criteria and were included in the descriptive synthesis.

3.3. Methodological Quality Assessment

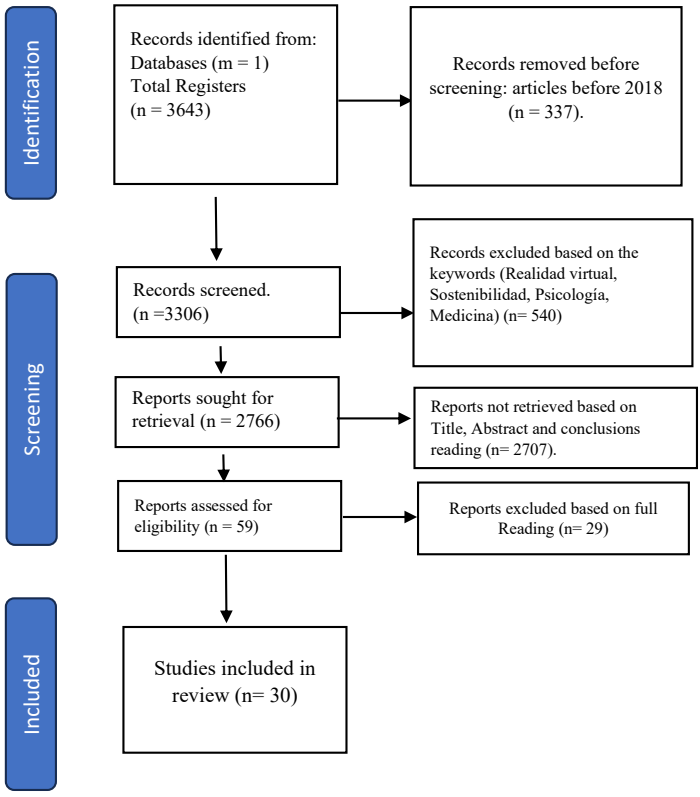
The eligible studies were assessed based on four aspects: clarity of research objectives, appropriate explanation and methodological design, description of the sample and educational context, and coherence between results and conclusions. Studies that did not provide sufficient information on these aspects were excluded during the eligibility phase.

3.4. Coding and Data Extraction Protocol

For data extraction and organization, an analysis matrix was designed in Microsoft Excel to record variables related to author, year of publication, country of the authors, purpose of the document, methodological design, sample size, gamification strategy employed, digital resources used, mathematical content addressed, results obtained, and limitations identified. Subsequently, the studies were coded and classified into six analytical categories: mathematics teaching, primary education, secondary education, gamification, digital educational resources, and academic performance. These categories guided the descriptive and comparative analysis of the collected evidence.

Figure 1 presents the PRISMA diagram. It outlines each stage of study identification, selection, inclusion, and exclusion, organizing the process with clarity and structure. This systematic approach maintains transparency, rigor, and consistency, while highlighting the criteria for each phase to help readers follow the review process.

Figure 1
PRISMA diagram process employed in this work



3.5. Descriptive Analysis of Scientific Production

A descriptive analysis of scientific production associated with the selected studies was conducted. The purpose of this analysis was to characterize publication trends, geographic distribution, institutional participation, journal quality, and citation impact of the research included in the review. The information was manually extracted from the 30 selected studies using the PRISMA method. For each publication, variables such as year of publication, authors' country of affiliation, institution of origin, journal of publication, Scopus

indexing quartile, and number of citations reported by the database at the time of data collection were recorded.

Subsequently, frequencies and descriptive statistics were calculated to identify publication patterns and academic visibility. Citation counts were used as an approximate indicator of scientific influence, while publication frequencies were used to examine the temporal evolution of research output. Furthermore, graphical representations were developed to facilitate the interpretation of trends observed in authors, institutions, countries, and journals.

4. RESULTS

The results are presented in two stages. Firstly, a general description of the publications identified is provided, including the geographical regions to which the studies belong. Secondly, a table of authors organized by categories is included.

4.1. General Description of the Publications Identified

This study identified 30 publications indexed in Scopus. It was considered relevant to describe the geographical origins of the experiences analyzed. This allows for a broader understanding of the implementation of educational solutions across different contexts. In this regard, the results show that most publications (40%) are from Asia, followed by Latin America (30%), Europe (20%), North America (7%), and the remaining 3% from Africa and Trinidad and Tobago.

4.2. Publication trends and citation impact

The descriptive analysis of the selected studies identified 30 publications and 3,482 citations attributed to the authors' countries of affiliation. This value exceeds the number of unique citations because some studies include authors from multiple countries. Based on this attributed count, Hong Kong and China together account for 73,5%

of the total country-attributed citations. Therefore, these values should be interpreted as citation contributions associated with country participation rather than as unique citation counts of the corpus.

In addition, productivity peaked in 2023, accounting for more than half of all publications, while citation impact was concentrated primarily in 2020 and 2021, accounting for nearly 80% of total citations. This pattern demonstrates that research is ongoing, as recent years have maintained strong output levels consistently.

The distribution of journal quality across quartiles shows a balance: 33,3% are ranked in Q1, 36,7% in Q2, and 30% in Q3. This demonstrates strong representation across these three levels in 2023 and indicates that the research output produced combines academic value with varied reach. Additionally, the most prominent publications appear in internationally recognized outlets such as *Sustainability*, *Educational Research Review*, and *Electronics,* all of wich feature elevated H-index scores, which help strengthen their standing within the educational and technological scholarship community.

The publishing landscape shows Elsevier's strong dominance, with a single article accounting for over 68% of total citations. However, when this publisher is excluded from the analysis, the citation impact is distributed more evenly among MDPI, Springer, and IAES, with an average of 60-90 citations per publication. These findings indicate a combined approach that involves rapid dissemination through various publishers while simultaneously establishing a presence in well-indexed, high-impact journals within the academic community.

Figure 2 presents the geographical distribution of the publications and citations recorded in the analyzed corpus along with how authors are distributed relative to the works that have been cited. It is important to note that country-level citation counts may exceed the total number of unique citations in the corpus because some studies involve authors from multiple countries. Therefore, the values presented in Figure 2 should be interpreted as country-attributed citations rather than as unique citation counts. Through this analysis, it is possible to identify 12 principal researchers, where four of them, Zainuddin,

Chu, Shujahat, and Perera, are responsible for representing more than 80% of the total citations. This indicates a high concentration of scientific influence, while the other researchers maintain a consistent presence in works with moderate visibility.

From a geographic perspective, East Asia is the region that dominates the research output, particularly Hong Kong and China which together make up 73,5% of all the citations that have been generated; however when these cases are excluded, countries such as Spain, Indonesia, Taiwan, the United States, Portugal, and Colombia show a balanced performance when it comes to volume and impact, and this reflects that there is an expanding regional diversification that is taking place across the field. However, since citation counts were attributed by country participation, these values should not be interpreted as unique citations of the total corpus, but rather as citation contributions associated with each country represented in the selected studies.

Figure 2
Geographical distribution according to the number of documents and citations (a and b) and most cited authors (c).

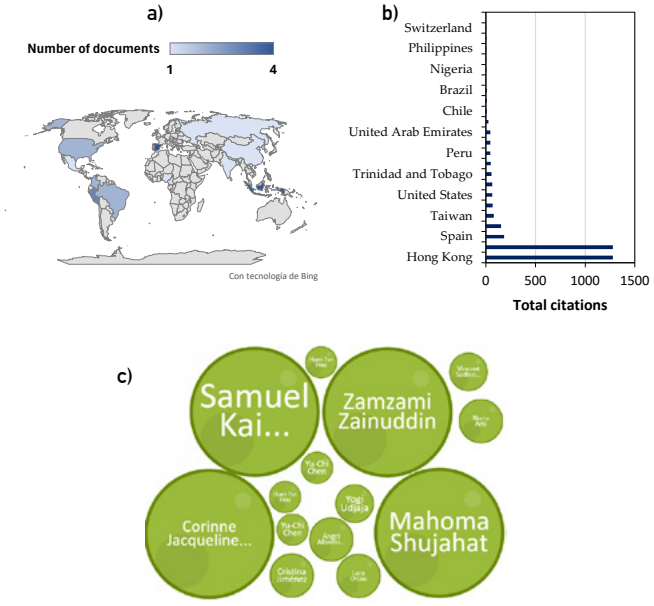
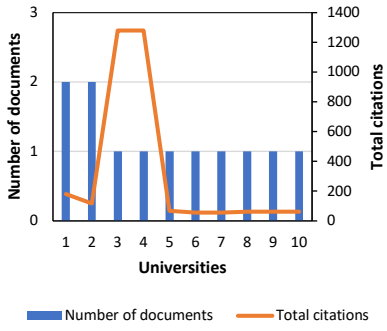


Figure 3 shows the 10 institutions with the highest visibility, measured by the number of documents and citation impact, within the selected corpus. Since some articles may include authors from more than one institution, the total number of institution-attributed citations may exceed the total number of unique citations in the corpus. In this case, the University of Hong Kong, along with Shangrao Normal University, has the highest citation rates, while the International University of La Rioja, located in Spain, and Bina Nusantara University from Indonesia exhibit notable consistency in publication volume.

Figure 3
Comparison among universities based on the number of documents and total citations.



No.	University
1	International University of La Rioja
2	Bina Nusantara University
3	The University of Hong Kong
4	Shangrao Normal University
5	National Taiwan University of Science
6	The University of the West Indies
7	Texas Tech University
8	University of Frankfurt
9	Universidade de Lisboa
10	University of Applied Science RheinMain

4.3. Categories Analysis

The literature review identified six main categories directly related to the research goals, focusing on the use of gamified digital resources to develop mathematical reasoning in secondary students. In this regard, mathematics teaching is the central discipline of this study, while gamification serves as an innovative method to boost motivation and increase participation among learners. Additionally, digital educational resources function as technological tools that make it easier to facilitate interaction and enhance the learning experience in a considerable way, and it is for these reasons that academic

performance provides a measure that allows for evaluating in a more precise manner how effective the pedagogical intervention has been in improving understanding and the learning processes that are related to mathematical reasoning.

Table 1 presents the distribution of the selected research across the established analysis categories: mathematical teaching, primary education, secondary education, gamification, digital educational resources, and academic performance. This organization enables the identification of thematic trends in literature and the recognition of the predominant approaches to using gamification as a strategy to strengthen mathematical learning.

Table 1
Distribution of research across the categories of mathematics teaching, education, gamification, DER and academic performance.

#	AUTHOR / CATEGORY	MATHEMATICS TEACHING	PRIMARY EDUCATION	SECONDARY EDUCATION	GAMIFICATION	DIGITAL EDUCATIONAL RESOURCE	ACADEMIC PERFORMANCE
1	Pradhan et al. (2024)	Yes	No	Yes	Yes	Yes	Yes
2	Setambah et al. (2024)	Yes	Yes	No	Yes	No	Yes
3	Young (2023)	Yes	Yes	Yes	Yes	Yes	Yes
4	Cubillos et al. (2023)	Yes	Yes	No	Yes	Yes	Yes
5	Chen, Chao, and Hou (2023a).	Yes	No	Yes	Yes	Yes	Yes
6	Chen et al. (2023b)	Yes	No	Yes	Yes	Yes	Yes
7	Rumangkit and Larasati (2023)	No	No	Yes	Yes	Yes	Yes
8	Holguin-Alvarez et al. (2023)	Yes	Yes	No	Yes	Yes	Yes
9	Lee et al. (2023)	Yes	No	No	Yes	Yes	Yes
10	Efendi and Qodr (2023)	No	No	Yes	No	Yes	Yes
11	De la Puente and Pérez (2023)	Yes	No	Yes	Yes	Yes	Yes
12	Vrcelj et al. (2023)	Yes	Yes	Yes	Yes	Yes	Yes

#	AUTHOR / CATEGORY	MATHEMATICS TEACHING	PRIMARY EDUCATION	SECONDARY EDUCATION	GAMIFICATION	DIGITAL EDUCATIONAL RESOURCE	ACADEMIC PERFORMANCE
13	Rincón-Flores et al. (2023)	Yes	No	Yes	Yes	Yes	Yes
14	Lisondra, et al. (2023)	Yes	No	Yes	Yes	Yes	Yes
15	Vysotskaya and Lobanova (2023)	Yes	Yes	No	No	Yes	Yes
16	Yeh, Yang and Chan (2023)	Yes	No	Yes	Yes	Yes	Yes
17	Kickmeier-Rust. and Niggli, (2023)	Yes	No	Yes	Yes	Yes	Yes
18	Ribeiro Filho, Cravino and Lopes (2023)	Yes	No	Yes	Yes	Yes	Yes
19	Negara, Wahyudin, Nurlaelah and Herman (2022)	Yes	No	Yes	No	Yes	Yes
20	Ortiz, Castillo, and Wong (2022)	Yes	No	Yes	Yes	Yes	Yes
21	Singh and Pathania (2022)	Yes	Yes	No	Yes	Yes	Yes
22	Prieto-Andreu, Gómez-Escalonilla-Torrijos, and Said-Hung (2022)	Yes	Yes	Yes	Yes	Yes	Yes
23	Kamalodeen et al. (2021)	Yes	Yes	No	Yes	No	Yes
24	Manzano-León et al. (2021)	Yes	Yes	Yes	Yes	Yes	Yes
25	Da Silva, et al. (2020)	Yes	Yes	No	Yes	Yes	Yes
26	Jiménez et al. (2020)	Yes	No	Yes	Yes	Yes	Yes
27	Zainuddin et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes
28	Gurjanow et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes
29	Sanabria and Ordoñez (2019)	Yes	Yes	No	Yes	Yes	Yes
30	Udjaja, Guizot and Chandra (2018)	Yes	Yes	Yes	Yes	Yes	Yes

Based on the selected articles, a descriptive analysis was done to explore the defined categories and identify relationships among the findings reported across the studies.

4.4. General description of the findings

Among the articles that were found through the Scopus database search using specific keywords, around 93,3% include mathematics education in their studies, and additionally 90% use gamification as a teaching tool. This reveals that there is a strong research focus on these academic areas, which are effectively integrated into school programs, demonstrating their growing acceptance and potential they show in learning environments.

A total of 80% of the selected studies link mathematics teaching to gamification using digital educational resources to support academic improvement. This finding shows that pedagogical strategies integrating gamification and digital tools foster students' motivation and engagement by generating more interactive and dynamic learning environments. Likewise, these strategies promote the significant development of cognitive and comprehension skills in the academic areas addressed by the studies.

Regarding the research population and samples, it is observed that sample sizes varied widely, from small groups of 10 participants (Singh and Pathania, 2022) to large groups of up to 4,092 (Pradhan et al., 2024). This shows the wide variety of contexts and the flexible ways that are used when one studies educational phenomena at different levels and in different settings, as these often appear in diverse forms and situations.

4.5. Gamification and school education

The reviewed studies indicate that most participants were school students. Also, that most of the selected research was conducted in school education contexts. According to the classification presented in Table 1, 29 of the 30 studies were associated with primary and secondary education, while 26 studies combined these educational levels with gamification-based approaches.

In Latin America, primary education is the stage that begins around the age of six and continues until children reach the age of

11 or 12, and on the other hand, secondary education is the one that covers approximately the ages between 12 and 17 years old and is often divided into lower and upper levels in many countries, this happens due to the fact that there are different curriculum structures and organizational approaches that are implemented. However, the nomenclature and duration of these stages vary across national education systems, making it necessary to clarify and contextualize these levels when analyzing research on teaching and learning.

4.6. Digital educational resources and gamification

Based on the selected articles, several authors aim to investigate how gamification and technological resources can improve mathematics learning and student motivation. Setambah et al. (2024) focused on the use of digital gamification cards to strengthen performance in fractions, while Lisondra et al. (2023) designed and evaluated a gamified mobile application for teaching arithmetic, with an objective similar to that proposed by Ortiz, Castillo, and Wong (2022), who developed a serious game for secondary school mathematics learning.

In this order of ideas, Pradhan et al. (2024), Chen et al. (2023b), Rumangkit and Larasati (2023), Holguin-Alvarez et al. (2023), Lee et al. (2023), De la Puente and Pérez (2023), Vrcelj et al. (2023), and Lisondra et al. (2023) demonstrate that when game-based digital tools are implemented in schools, they contribute to helping students improve their performance in mathematics at both primary and secondary educational levels, and additionally their results provide useful guidance that allows educators to develop more effective teaching methods.

Similar findings were reported by Vysotskaya and Lobanova (2023), Kickmeier-Rust and Niggli (2023), Negara et al. (2022), Ortiz et al. (2022), Manzano-León et al. (2021), Jiménez et al. (2020), and Sanabria and Ordoñez (2019), who agree that research studies employing digital tools within a gamification-based methodology

show specific improvements in academic performance in the areas addressed.

4.7. Gamification, motivation and student engagement

Several studies indicate that gamification plays a very important role in motivating students and keeping them engaged. In this regard, Rumangkit and Larasati (2023) found that when students experience enjoyment, they achieve significantly higher academic performance. These authors indicate that activities that include challenges and rewards have helped improve information retention and teamwork, as this method plays a crucial role in strengthening the overall learning experience.

Similarly, Prieto-Andreu et al. (2022) found that gamification, which encourages more active student participation, improves academic performance. Furthermore, Manzano-León et al. (2021) demonstrated that the use of elements such as points, badges, and rankings significantly increases student motivation and engagement. Moreover, this approach significantly improves performance and makes it easier to develop positive attitudes toward learning. Additionally, this makes it an effective teaching method that schools and universities can use, and it helps educators improve their learning experience in measurable, lasting ways.

The positive effects that gamification brings require a design that is done with great care so that it fits perfectly into specific situations, and it is precisely for this reason that Ribeiro Filho et al. (2023) highlight the fact that when fun is mixed together with learning goals, it becomes essential to make sure these methods are used in an effective way. Moreover, Vrcelj et al. (2023) note that further research is needed to clarify how these systems affect academic performance. However, Yeh et al. (2023) explain that achievement systems can help improve intrinsic motivation, which, in turn, can build confidence and encourage positive attitudes toward learning mathematics.

4.8. Gamified Structures and Pedagogical Conditions for Teaching Mathematics

10 key studies selected from the corpus were done to identify the pedagogical characteristics associated with the most representative gamification experiences. Table 2 presents the gamified structures used, the mathematical content addressed, the implementation conditions, the reported limitations, and the underlying didactic frameworks, allowing for a deeper understanding of the factors that influence their educational effectiveness.

Table 2.
Gamified Structures, Implementation Conditions, and Pedagogical Contributions Identified in the Analyzed Studies

Author (year)	Gamified structure	Mathematical content	Educational level	Implementation conditions	Reported limitations	Didactic-pedagogical approach
Chen et al. (2023)	Mobile game with cognitive scaffolding	Algebra and pattern recognition	Secondary education	Progressive feedback and teacher guidance	Dependence on technological resources	Cognitive scaffolding
Pradhan et al. (2024)	Gamified problem-solving platform	Algebra	Secondary education	Gradual sequencing of challenges	Difficulties with highly complex tasks	Adaptive learning
Setambah et al. (2024)	Non-digital gamified cards	Fractions	Primary education	Collaborative work and concrete manipulation	Limited applicability to specific content	Constructivism
Cubillos et al. (2023)	Digital game with multiple attempts	Mathematical problem-solving	Primary education	Immediate feedback	Requires access to devices	Self-regulated learning
Yeh et al. (2023)	Achievement and badge system	General mathematics	Secondary education	Progressive recognition of performance	Predominance of extrinsic motivation	Self-determination theory
Kamalodeen et al. (2021)	Gamified design for geometry	Geometry	Primary education	Integration with practical activities	Need for specialized teacher training	Design-based learning
Jiménez et al. (2020)	Digital escape room	Algebra	Secondary education	Collaborative challenge-solving	High planning demands	Problem-based learning
Ribeiro Filho et al. (2023)	Gamified quizzes (Quizizz)	General mathematics	Secondary education	Formative assessment in virtual environments	Dependence on connectivity	Digital formative assessment

Author (year)	Gamified structure	Mathematical content	Educational level	Implementation conditions	Reported limitations	Didactic-pedagogical approach
Singh and Pathania (2022)	Gamified mobile application	Fractions	Primary education	Autonomous practice and guided repetition	Focus restricted to a single content area	Mobile learning
Gurjanow et al. (2019)	Mathematics Trails	Contextualized mathematics	Primary and secondary education	Situated learning outside the classroom	Logistical complexity of implementation	Experiential learning

The studies analyzed show that no single gamified structure is effective across all educational contexts. The most frequent strategies correspond to educational digital games, achievement systems, quiz platforms, mobile applications, escape rooms, and non-digital gamified activities. However, their effectiveness depends on the characteristics of the mathematical content, students' ages, and the pedagogical conditions for implementation.

Regarding mathematical content, the evidence indicates that gamification has shown particularly appropriate results in algebra (Chen et al., 2023a; Pradhan et al., 2024; Jiménez et al., 2020), fractions (Setambah et al., 2024; Singh and Pathania, 2022), geometry (Kamalodeen et al., 2021), and mathematical reasoning (Negara et al., 2022).

Regarding age differences, primary school students respond favorably to concrete, visual, and hands-on elements, such as gamified cards, simple mobile applications, and reward systems. Conversely, secondary school students show greater effectiveness with strategies that incorporate complex challenges, problem-solving, escape rooms, and digital platforms that promote autonomy and critical thinking.

Studies indicate that gamification yields better results when accompanied by immediate feedback, clearly defined learning objectives, a gradual progression of challenges, and consistent teacher guidance. Simply adding points, badges, or rewards does not guarantee improved learning if these elements are not integrated into a coherent teaching approach.

On the other hand, different studies indicate a strong dependence on technological resources and connectivity, especially in digital experiences. Others warn that the excessive use of external rewards can promote short-term extrinsic motivation, reducing interest in learning once the game's stimuli disappear. Difficulties are also reported related to the time required to design high-quality gamified activities and the need for specific teacher training.

Finally, the reviewed studies demonstrate the presence of various underlying pedagogical frameworks, including constructivism, problem-based learning, experiential learning, self-determination theory, self-regulated learning, and cognitive scaffolding approaches. This suggests that the observed positive effects do not depend solely on gamification as an isolated strategy, but rather on its integration with sound pedagogical models that guide the teaching and learning process.

Beyond the reported results, these findings prompt consideration of why certain mathematical content areas benefit more from gamified strategies than others. Algebra, fractions, and geometry are domains in which conceptual understanding is typically developed through progressive processes of representation, visualization, and repeated practice. Gamification dynamics, including immediate feedback, sequential challenge resolution, and opportunities to repeat tasks without significant penalty, facilitate the consolidation of these learning processes. Research by Chen et al. (2023), Pradhan et al. (2024), and Jiménez et al. (2020) demonstrates that gamified experiences in algebra foster increased participation and persistence in complex tasks. In contrast, studies focusing on fractions and geometry report enhanced conceptual understanding through visual representations and interactive resources (Kamalodeen et al., 2021; Setambah et al., 2024; Singh and Pathania, 2022).

The observed effectiveness in these content areas may be attributed to their sequential and cumulative structure, where mastery of foundational skills is essential for acquiring new concepts. Progression mechanics, levels, scaffolded challenges, and continuous feedback

facilitate the monitoring of student progress and the prompt correction of conceptual errors. Additionally, these content areas are amenable to representation in visual environments, simulations, virtual objects, and challenge-based activities, all of which are consistent with the core principles of gamification. Nevertheless, current evidence is insufficient to determine whether these advantages are equally applicable to more abstract mathematical domains, such as formal proof or advanced mathematical reasoning. This topic warrants further investigation.

The differences observed between primary and secondary education can also be interpreted through the frameworks of cognitive development. The studies analyzed show that, in primary education, strategies based on visual and manipulative elements, as well as guided exploration experiences, tend to predominate, including gamified cards, board games, and mobile applications designed to teach basic concepts (Setambah et al., 2024; Singh and Pathania, 2022). In contrast, interventions developed in secondary education more frequently incorporate complex challenges, problem-solving, educational escape rooms, and digital platforms that promote autonomy and critical thinking (Chen et al., 2023a; Jiménez et al., 2020; Pradhan et al., 2024).

These differences are consistent with Piaget's stages of cognitive development, in which primary school students are predominantly in the concrete operational stage, whereas secondary school students are increasingly able to engage in formal, abstract thinking. Consequently, gamified experiences based exclusively on visual rewards or low-cognitive-complexity activities may be highly effective at earlier educational levels but insufficient to sustain the interest and intellectual engagement of older students. This suggests that the effectiveness of gamification depends not only on incorporating game elements but also on aligning strategies with students' developmental and cognitive characteristics.

Another relevant aspect concerns the sustainability of motivation generated by gamified experiences. Several of the reviewed studies

show that elements such as points, badges, rewards, and rankings initially increase students' participation and engagement (Yeh et al., 2023; Ribeiro Filho et al., 2023). However, the evidence also suggests that when these external stimuli are removed, motivational effects may decrease if the educational experience fails to foster deeper forms of intrinsic motivation. This situation raises an important tension within the literature on gamification: although external rewards may act as initial catalysts for engagement, there is a risk that students may associate learning solely with the attainment of incentives rather than with the intrinsic value of mathematical activity.

From the perspective of self-determination theory, the effects of gamification are potentially more sustainable when activities strengthen three fundamental psychological needs: autonomy, perceived competence, and meaningful social interaction. Along these lines, Yeh et al. (2023) indicate that reward systems yield better outcomes when integrated with opportunities for decision-making, challenges adjusted to students' skill levels, and experiences that allow learners to perceive real progress in their learning. Similarly, Cubillos et al. (2023) emphasize that continuous feedback and active participation in problem-solving foster more lasting learning processes than those sustained solely by external incentives.

Overall, the findings show that the effectiveness of gamification does not depend solely on the inclusion of playful elements, but rather on the interaction between the mathematical content addressed, students' cognitive characteristics, and the pedagogical approach guiding the intervention. The results suggest that the most successful gamified experiences are those that integrate game elements into structured didactic proposals grounded in constructivist principles, problem-based learning, and approaches centered on student autonomy. Therefore, the observed benefits appear to be associated less with the presence of rewards or competitive dynamics and more with gamification's capacity to promote active participation, timely feedback, and the meaningful construction of mathematical knowledge.

4.9. Limitations of literature

According to the work of Setambah et al. (2024), Young (2023), Cubillos et al. (2023), Chen et al. (2023a,b), and da Silva et al. (2020), a shared limitation is that research studies using digital educational resources to strengthen or improve academic performance in a given area of study face time constraints. In most cases, the implementation phase does not extend beyond one year, limiting the possibility of a more in-depth evaluation of the long-term effects and the sustainability of the results (Niño-Rojas, 2019). Due to the methodological structure of academic research in the field of education, Lizasoain Hernández (2024) points out that execution times generally do not exceed six months or a year, and in some cases, research on the implementation process of digital educational resources to observe improvements in academic performance lasts less than six months. Consequently, the identified conditions limit the ability to accurately assess the long-term effects of methodologies such as gamification, thereby hindering verification of their sustainability over time.

Some studies highlight small sample sizes as a limitation, which hinders generalization and extrapolation of findings to larger populations. For example, Chen et al. (2023b) worked with a sample of 36 students, Vysotskaya and Lobanova (2023) with 14, and Singh and Pathania (2022) with 10. Studies such as the ones conducted by Sanabria and Ordoñez (2019) which included 25 participants and Da Silva et al. (2020) with 30 participants indicate in these works that sample sizes range from 10 to 36 students. This represents a major methodological weakness that needs to be considered since the variability that exists restricts in a significant way how broadly the findings can be applied across different educational contexts.

Vysotskaya and Lobanova (2023), along with Ribeiro Filho et al. (2023), and Negara et al. (2022) were able to identify what is known as potential bias in the selection of participants, and this was recognized as a study limitation that has the capacity to affect the validity of the results obtained. Additionally, it was observed that essential variables such as the students' prior knowledge and their

motivation levels remained uncontrolled throughout the research process, and this lack of control influenced in a significant way both the development process and the effectiveness that ICT resources demonstrated when they were aimed at improving the academic performance of students.

Chen et al. (2023b), Vysotskaya and Lobanova (2023), and Negara et al. (2022) highlight that the main limitation found in their research has to do with the use of digital educational resources to improve academic performance in specific areas of study, however this approach fails to consider uncontrolled external factors such as the family environment and the educational support that comes from parents or guardians, and these factors have a direct influence on academic development and on the outcomes that are expected to be achieved.

Ribeiro Filho et al. (2023), Kamalodeen et al. (2021), and Sanabria and Ordoñez (2019) point out that among the main limitations that were identified are technology dependence and the unequal access that exists to electronic devices, this is due to the fact that equipment and training vary significantly across educational institutions, which creates barriers when it comes to implementing digital tools in an appropriate manner. Furthermore, the different ways in which students are able to access technological resources have an impact on how they use them and benefit from digital platforms, and this ultimately results in unequal outcomes once implementation takes place.

4.10. Challenges and further research direction

Based on the limitations identified in the research conducted by Setambah et al. (2024), Young (2023), Cubillos et al. (2023), Chen et al. (2023b), Da Silva et al. (2020), Kickmeier-Rust and Niggli (2023), Ribeiro Filho et al. (2023), Negara et al. (2022), and Sanabria and Ordoñez (2019), one of the main challenges for future research lies in the need to design longitudinal studies that allow for the evaluation of the impact of digital educational resources on

long-term academic improvement. This type of design would help overcome the limitations related to execution or implementation times, which, in most of the reviewed studies, are relatively short. Likewise, avoiding superficial understandings of learning, particularly in areas that students often perceive as complex, such as algebra, presents a challenge. These scenarios require research with more extended implementation periods and methodologies for progressive integration into the curriculum, as well as the application of assessments in stages following the intervention. In this way, it becomes possible to analyze the retention and transfer of knowledge over time (Guaña & Cevallos, 2024).

An important challenge identified across these investigations is the limited number of participants in each study. Additionally, this limitation makes it difficult to be able to draw broader and more generalizable conclusions from the findings that were obtained can be seen in research done by Young (2023), Chen et al (2023a,b), Rumangkit and Larasati (2023), Lisondra et al. (2023), Jiménez et al. (2020), Sanabria and Ordoñez (2019), Setambah et. al. (2024), Efendi and Qodr (2023), De la Puente and Pérez (2023), Rincón-Flores et al. (2023), Kickmeier-Rust and Niggli (2023), Ortiz, Castillo, and Wong (2022), CP Singh and Pathania (2022), Kamalodeen et al. (2021), Da Silva et al. (2020), Gurjanow et al (2019), Vysotskaya and Lobanova (2023), Ribeiro Filho et. al (2023), and Negara et. al (2022).

A significant challenge is the need to expand participant numbers, which would make it possible to apply findings to larger, more diverse populations while directly addressing the constraints of small-sample research. Furthermore, ensuring that the sample truly represents the population is essential, and this can be achieved by including diverse educational settings and academic fields, as well as various geographic and cultural areas. In addition, this broader approach enables stronger application of the findings across many contexts.

Chen et al. (2023a), Rumangkit and Larasati (2023), Lee et al. (2023), De la Puente and Pérez (2023), and Gurjanow et al. (2019)

highlight the fact that it is very important for future research to concentrate on combining those factors that are related to motivation and academic success, since this combination would make it possible to achieve a much deeper understanding of the phenomenon itself, and it would also allow researchers to explore in a more effective way how exactly these elements interact with each other. Therefore, this approach enables the development of more effective teaching methods through game-based activities, which, in turn, help enhance students' learning in a deeper, more meaningful manner.

Lee et al. (2023), Vysotskaya and Lobanova (2023), and Negara et al. (2022) explain that when it comes to studying how external factors such as the family environment and educational support, along with personal traits like age and previous experience in the field, can have a strong impact on students' academic performance. Furthermore, these authors point out that clearly understanding these links helps one to see in a better way how these factors strongly influence academic performance, and this in turn allows researchers to determine their impact in a more accurate manner.

Taking into account the limitations pointed out by Ribeiro Filho et al. (2023), Kamalodeen et al. (2021), and Sanabria and Ordoñez (2019), future research must delve more deeply into the heavy reliance on technology and the unequal access to digital devices since these factors can have a strong influence on the way educational interventions are designed, how they are implemented, and the kind of outcomes that they end up producing. Also, the differences in equipment and digital training availability across the different educational settings create major barriers that make it very hard to fully achieve the research goals. This makes it essential to develop strategies to reduce these gaps and promote fair access to digital educational resources (DERs), as they serve as key tools that encourage academic growth.

5. CONCLUSIONS

This systematic review analyzed recent scientific evidence on the use of gamification and digital educational resources in mathematics teaching, addressing research questions related to publication trends, implementation approaches, and reported educational effects in primary and secondary education. The results show a growing academic interest in integrating gamified strategies into mathematics education, demonstrating their potential to strengthen student motivation, engagement, and academic performance.

However, the findings suggest that the effectiveness of gamification depends on both the incorporation of game elements and the pedagogical and didactic conditions that guide its implementation. The analysis revealed that no single gamified structure is effective across all educational contexts. On the contrary, its impact varies depending on the mathematical content addressed, students' educational level, and the proposed learning objectives. The results were particularly favorable in subjects such as algebra, fractions, geometry, and problem-solving, especially when activities incorporated immediate feedback, gradual progression of challenges, and constant teacher guidance.

One of the key findings of this review lies in the identification of diverse gamified structures and the pedagogical frameworks that underpin their effectiveness. The studies selected show that digital games, gamified platforms, mobile applications, achievement systems, and challenge-based activities produce better results when integrated with approaches such as constructivism, problem-based learning, experiential learning, self-regulated learning, and self-determination theory. Thus, the evidence suggests that the observed benefits are not solely attributable to gamification as an isolated strategy, but rather to its integration with sound pedagogical models.

Furthermore, the review identified relevant differences across educational levels. While primary education predominantly features experiences supported by visual, manipulative, and playful exploration resources, secondary education shows a greater presence

of strategies focused on problem-solving, critical thinking, and autonomous learning. This finding provides a more contextualized understanding of the conditions under which gamification can promote mathematical learning.

The review addresses three central questions presented in the introduction. First, it identifies the use of educational digital games, gamified platforms, mobile applications, achievement systems, escape rooms, and challenge-based activities as key trends, with the highest production in East Asia and Latin America, particularly in 2023. Second, it demonstrates that gamification fosters motivation, engagement, and academic performance, although its effects depend on pedagogical conditions such as immediate feedback, gradual challenge progression, clear objectives, and teacher support. Third, it points to short implementation periods, small or biased sample sizes, unequal access to technology, and limited control over variables such as prior knowledge and family support as the main challenges.

Although the results obtained allow identification of consistent trends regarding the potential of gamification in mathematics teaching, it is important to acknowledge some limitations of the present study. In addition to the restrictions inherent in the analyzed corpus, the review was limited to documents indexed in the Scopus database and published between 2018 and 2025, potentially excluding relevant research available in other academic sources. Likewise, the diversity of educational contexts, methodological designs, and gamified structures identified makes direct comparison among studies difficult and limits the possibility of establishing absolute generalizations regarding the effectiveness of gamification across all mathematics teaching scenarios.

From an applied perspective, the findings offer relevant implications for mathematics teachers in Latin American contexts. The evidence reviewed suggests that the success of gamification does not depend solely on the incorporation of advanced technologies or sophisticated digital platforms, but rather on the ability to design learning experiences that align with clear pedagogical objectives, provide continuous

feedback, progressively challenge learners, and increase the level of challenge. In this regard, even low-cost gamified strategies, adapted to the institutional and technological conditions of each context, may help strengthen motivation, participation, and mathematical learning. Therefore, it is recommended that gamification proposals be conceived as didactic tools integrated into robust pedagogical models, rather than merely as mechanisms for reward or entertainment.

REFERENCES

Chen, Y.-C., Chao, C.-Y., & Hou, H.-T. (2023a). Learning pattern recognition skills from games: Design of an online pattern recognition educational mobile game integrating algebraic reasoning scaffolding. *Journal of Educational Computing Research, 61*(6), 1232-1251. https://doi.org/10.1177/07356331231171622

Chen, M. F., Chen, Y. C., Zuo, P. Y., & Hou, H. T. (2023b). Design and evaluation of a remote synchronous gamified mathematics teaching activity that integrates multi-representational scaffolding and a mind tool for gamified learning. *Education and Information Technologies*, *28*(10), 13207-13233. https://doi.org/10.1007/s10639-023-11708-6

Ciapponi, A. (2021). La declaración PRISMA 2020: una guía actualizada para reportar revisiones sistemáticas. *Evidencia, Actualización en la Práctica Ambulatoria, 24*(3), e002139. https://doi.org/10.51987/evidencia.v24i4.6960

Cubillos, C., Roncagliolo, S., & Cabrera-Paniagua, D. (2023). Learning and motivation when using multiple-try in a digital game for primary students in Chile. *Education Sciences, 13*(11), 1119. https://doi.org/10.3390/educsci13111119

Da Silva, J. B., Júnior, F. P., Ribeiro, R. C., & Mauro, R. C. (2020). Mathematical mission: A ludical and motivate educational game. In *2020 15th Iberian Conference on Information Systems and Technologies (CISTI)* (pp. 1-5). IEEE. https://doi.org/10.23919/CISTI49556.2020.9140985

De la Puente, M., & Pérez, H. (2023). Evaluación del impacto de Brilliant.org en la mejora del rendimiento académico en matemáticas entre estudiantes de secundaria en Colombia: Un estudio cuasiexperimental. *Revista de Investigación en Docencia de Matemáticas, 15*(2), 82-103. https://eric.ed.gov/?id=EJ1394390

Early, K. N. (2023). Gamification of mathematics instruction: A quantitative study on student growth and proficiency in a suburban middle school [Doctoral dissertation, Lee University]. *ProQuest Dissertations & Theses Global*. https://search.proquest.com/openview/a3177b745ed636dfa91a8e48f1e7396d/1

Efendi, A., & Qodr, T. S. (2023). Improving critical thinking skills of high school students through the implementation of mobile-based game applications. *International Journal of Education and Practice, 11*(3), 613-626. https://doi.org/10.18488/61.v11i3.3440

Escobar Pullutasig, G. E. (2024). Aprendizaje basado en problemas y operaciones básicas de la aritmética en los estudiantes de octavo año de Educación General Básica [Tesis de maestría, Universidad Técnica de Ambato]. Repositorio Institucional UTA. https://repositorio.uta.edu.ec/bitstreams/2cf7c388-6fc8-412f-82f2-c24ba1ad730e/download

González Martínez, L. (2024). Perspectiva de la didáctica de las matemáticas como disciplina científica [Trabajo de fin de grado, Universidad de Jaén]. Repositorio Institucional de la Universidad de Jaén. https://hdl.handle.net/10953.1/23125

Guaña, E. L. I., & Cevallos, P. A. E. (2024). La importancia del pensamiento crítico y la resolución de problemas en la educación contemporánea. *Revista Científica Kosmos, 3*(1), 4-18. https://doi.org/10.62943/rck.v3n1.2024.50

Guaypatin Pico, O. A., Fauta Ramos, S. L., Gálvez Cisneros, X. A., & Montaluis, D. (2021). La influencia de la matemática en el desarrollo del pensamiento. *Revista Boletín Redipe, 10*(7), 106-112. https://doi.org/10.36260/rbr.v10i7.1352

Gurjanow, I., Oliveira, M., Zender, J., Santos, P. A., & Ludwig, M. (2019). Mathematics trails: Shallow and deep gamification. *International Journal of Serious Games, 6*(3), 65-79. https://doi.org/10.17083/ijsg.v6i3.306

Holguin-Alvarez, J., Ruiz-Salazar, J., Manrique-Alvarez, G., Picoy Gonzales, J. A., & Holgado-Quispe, A. (2023). Mixed gamification with virtual tools modify poor school performance. *International Journal of Evaluation and Research in Education, 12*(3), 1663-1673. https://doi.org/10.11591/ijere.v12i3.25530

Hurtado, J. L., & Escudero Benavides, P. M. (2024). El impacto de las TIC en el ciclo de aprendizaje. *Polo del Conocimiento: Revista científico-profesional, 9*(1), 93-116. https://doi.org/10.23857/pc.v9i1.6370

Jiménez, C., Arís, N., Magreñán Ruiz, Á. A., & Orcos, L. (2020). Digital escape room, using Genial.ly and a breakout to learn algebra at secondary education level in Spain. *Education Sciences, 10*(10), 271. https://doi.org/10.3390/educsci10100271

Kamalodeen, V. J., Ramsawak-Jodha, N., Figaro-Henry, S., Jaggernauth, S. J., & Dedovets, Z. (2021). Designing gamification for geometry in elementary schools: Insights from the designers. *Smart Learning Environments, 8*, 36. https://doi.org/10.1186/s40561-021-00181-8

Kickmeier-Rust, M., & Niggli, C. (2023). Effects of gamifying mathematics lessons at high school level. In *Proceedings of the 17th European Conference on Games Based Learning* (pp. 319-326). Academic Conferences International. https://doi.org/10.34190/ecgbl.17.1.1593

Lee, J. Y., Pyon, C. U., & Woo, J. (2023). Digital twin for mathematics education: A study on the use of games and gamification for university mathematics education. *Electronics, 12*(15), 3207. https://doi.org/10.3390/electronics12153207

Lisondra, R. F., Jumawan, X. N. G., Anito, J. P. E., Abugan, G. R. B., Mira, R. J. T., & Patayon, U. B. (2023). eMATH: A gamified approach to arithmetic lessons. *In 2023 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies* (3ICT) (pp. 440-444). IEEE. https://doi.org/10.1109/3ICT60104.2023.10391559

Lizasoain Hernández, L. (2024). El análisis estadístico de datos en la investigación educativa. *Revista Electrónica Interuniversitaria de Formación del Profesorado, 27*(2), 217-232. https://doi.org/10.6018/reifop.608261

López Lattá, K. E. (2023). *Percepciones y perspectivas de los futuros maestros sobre las matemáticas: Un análisis antes y después del curso de didáctica de las Matemáticas en un programa de Licenciatura en Educación Infantil* [Tesis de maestría, Universidad Autónoma de Bucaramanga]. Repositorio Institucional UNAB. http://hdl.handle.net/20.500.12749/20814

Manzano-León, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). Between level up and game over: A systematic literature review of gamification in education. *Sustainability, 13*(4), 2247. https://doi.org/10.3390/su13042247

Mendoza-Vega, A. J. (2025). Los programas de gamificación en la educación: revisión sistemática. *Episteme Koinonía. Revista Electrónica de Ciencias de la Educación, Humanidades, Artes y Bellas Artes, 8*(16), 209-226. https://doi.org/10.35381/e.k.v8i16.4567

Negara, H. R. P., Wahyudin, W., Nurlaelah, E., & Herman, T. (2022). Improving students' mathematical reasoning abilities through social cognitive learning using GeoGebra. *International Journal of Emerging Technologies in Learning, 17*(18), 118-135. https://doi.org/10.3991/ijet.v17i18.32151

Niño-Rojas, V. M. (2019). *Metodología de la investigación: Diseño, ejecución e informe* (2.ª ed.). Ediciones de la U.

Ortiz, W., Castillo, D., & Wong, L. (2022). Mobile application: A serious game based in gamification for learning mathematics in high school students. In *2022 31st Conference of Open Innovations Association (FRUCT)* (pp. 220-228). https://doi.org/10.23919/FRUCT54823.2022.9770917

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Alonso-Fernández, S. (2021). Declaración PRISMA 2020: una guía actualizada para la publicación de revisiones sistemáticas. *Revista española de cardiología*, *74*(9), 790-799. https://doi.org/10.1016/j.recesp.2021.06.016

Párraga, A. P. B., Cedeño, E. L. H., Amores, C. G. R., Molina, A. D. A., Batioja, I. J. Z., Lloacana, M. Y. S., & Durán, V. D. R. C. (2024). La gamificación como estrategia pedagógica en la educación matemática. *Ciencia Latina. Revista Científica Multidisciplinar, 8*(3), 6435-6465. https://doi.org/10.37811/cl_rcm.v8i3.11975

Pozo-Velasco, A. J., Ramírez-Gutiérrez, C. V., & Martínez-Pérez, O. (2025). Use of active methodologies and information and communication technology (ICT) tools in education. *MQR Investigar, 9*(1), e1–e1. https://doi.org/10.56048/MQR20225.v9i1.1

Pradhan, S., Gurung, A., & Ottmar, E. (2024, March). Gamification and deadending: Unpacking performance impacts in algebraic learning. In *LAK '24*: *Proceedings of the 14th Learning Analytics and Knowledge Conference* (pp. 899-906). ACM. https://doi.org/10.1145/3636555.3636929

Prieto-Andreu, J. M., Gómez-Escalonilla-Torrijos, J. D., & Said-Hung, E. (2022). Gamification, motivation, and performance in education: A systematic review. *Revista Electrónica Educare, 26*(1), 251-273. https://doi.org/10.15359/ree.26-1.14

Reif, B. A., Schluifer, K., Mayas, C., & Hirth, M. (2024). Analysis of gamification elements in e-learning. In P. Zaphiris & A. Ioannou (Eds.), *Learning and collaboration technologies* (pp. 94-112). Springer. https://doi.org/10.1007/978-3-031-61685-3_8

Ribeiro Filho, R. J., Cravino, J. P., & Lopes, J. B. (2023). Experiência gamificada na aula remota de matemática com a plataforma Quizizz. *REICE. Revista Iberoamericana sobre Calidad, Eficacia y Cambio en Educación, 21*(3), 23-39. https://doi.org/10.15366/reice2023.21.3.002

Rincón-Flores, E. G., Santos-Guevara, B. N., Martínez-Cardiel, L., Rodríguez-Rodríguez, N. K., Quintana-Cruz, H. A., & Matsuura-Sonoda, A. (2023). Gamit! Icing on the cake for mathematics gamification. *Sustainability, 15*(3), 2334. https://doi.org/10.3390/su15032334

Rumangkit, S., & Larasati, H. (2023). The role of gamification, perceived playfulness, learning engagement, and learning motivation on academic achievement in hybrid learning. *E3S Web of Conferences, 426*, 02002. https://doi.org/10.1051/e3sconf/202342602002

Sanabria, L. F. M., & Ordoñez, L. M. V. (2019). Edumat: Herramienta web gamificada para la enseñanza de operaciones elementales. *Campus Virtuales, 8*(2), 9-17.

Sarzosa, S. M., & Toaza, H. G. (2025). Gamificación con herramientas digitales para potenciar el aprendizaje y la motivación en el entorno educativo. *Revista Social Fronteriza, 5*(1), 1-17. https://doi.org/10.59814/resofro.2025.5(1)620

Setambah, M. A. B., Adnan, M., Zaini, S. H., Mujiasih, M., Hidayat, R., Ibrahim, M. A., & Hanazono, H. (2024). Impact of "Donkey", "Snap" and "King" (DSK) non-digital gamification cards on fourth-grade students' math performance in fractions. *Infinity Journal, 13*(1), 175-196. https://doi.org/10.22460/infinity.v13i1.p175-196

Singh, C. P., & Pathania, M. (2022). A gamified approach to learning the mathematical fraction concept: Evaluating the effectiveness and efficiency of the application. In *2022 2nd International Conference on Innovative Practices in Technology and Management (ICIPTM)* (pp. 329-332). IEEE. https://doi.org/10.1109/ICIPTM54933.2022.9753922

Udjaja, Y., Guizot, V. S., & Chandra, N. (2018). Gamification for elementary mathematics learning in Indonesia. *International Journal of Electrical and Computer Engineering (IJECE), 8*(5), 3860-3865. https://doi.org/10.11591/ijece.v8i5.pp3860-3865

Vrcelj, A., Hoic-Božic, N., & Dlab, M. H. (2023). Use of gamification in primary and secondary education: A systematic literature review. *International Journal of Educational Methodology, 9*(1), 13-27. https://doi.org/10.12973/ijem.9.1.13

Vysotskaya, E. V., & Lobanova, A. D. (2023). Interstellar wanderers: Digital support for teaching place value within the activity approach framework. *Psychology in Russia: State of the Art, 16*(4), 21-36. https://doi.org/10.11621/pir.2023.0402

Yeh, C. Y. C., Yang, J. C. Y., & Chan, T. W. (2023). Design and implement an achievement system for enhancing students' interest and self-efficacy in mathematics. In *Proceedings – 2023 14th IIAI International Congress on Advanced Applied Informatics (IIAI-AAI 2023)* (pp. 703-704). IEEE. https://doi.org/10.1109/IIAI-AAI59060.2023.00142

Young, J. R. (2023). The role of technology in enhancing urban mathematics education. *Journal of Urban Mathematics Education, 16*(2), 1-13. https://doi.org/10.21423/jume-v16i2a589

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational Research Review, 30*, 100326. https://doi.org/10.1016/j.edurev.2020.100326

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