دوفصلنامه ایرانی آموزش از دور

سال هفتم، شماره دوم، تابستان و پاییز ۱۴۰۴ (۱۵۶-۱۴۱)
DOI: 10.30473/idej.2025.75224.1246

«مقاله پژوهشی»

استفاده از گیمیفیکیشن به عنوان تسهیلگر در یادگیری ریاضی

عباس رمضانی[۱]، معصومه شریفی[۲*]، الهام یوسفی[۳]

۱. استادیار مدیریت آموزشی، گروه مدیریت آموزشی، دانشگاه فرهنگیان، تهران، ایران.
۲. کارشناسی، گروه زبان انگلیسی، دانشگاه فرهنگیان، زنجان، ایران.
۳. سازمان آموزش و پرورش استان زنجان، زنجان، ایران.

نویسنده مسئول:
معصومه شریفی
رایانامه: m.sharifii@cfu.ac.ir

تاریخ دریافت: ۱۴۰۴/۰۴/۳۰
تاریخ پذیرش: ۱۴۰۴/۰۵/۲۱

چکیده

مفهوم بازی‌سازی دیجیتال به عنوان یک استراتژی جذاب و لذت‌بخش برای ارتقای آموزش ریاضی و پر کردن شکاف بین شیوه‌های آموزشی و یادگیری دانش‌آموزان شناخته شده است. این بررسی، تحلیل جامعی از چشم‌انداز فعلی در مورد اجرای بازی‌سازی در آموزش ریاضی دیجیتال ارائه می‌دهد. علاوه بر این، تجربیات یادگیری دانش‌آموزان و نتایجی را که هنگام تعامل با ریاضیات از طریق رویکردهای بازی‌سازی به دست می‌آورند، بررسی می‌کند. برای این بررسی، ۲۱ نشریه منتشر شده بین سال‌های ۲۰۱۴ تا ۲۰۲۴ برای شناسایی مضامین کلیدی در این حوزه تحقیقاتی مورد تجزیه و تحلیل قرار گرفتند. در حالی که این مطالعات تأثیرات بازی‌سازی بر تجربیات و نتایج یادگیرندگان را نشان دادند، هیچ یک از عناصر بازی‌سازی خاص مرتبط با آن تجربیات و نتایج را مشخص نکردند. تجربیات یادگیری مثبت شناسایی شده در محیط‌های ریاضی بازی‌سازی شده شامل لذت، تعامل، انگیزه و سرگرمی بود. نتایج یادگیری مطلوب شامل تسلط بر محتوا، تعامل دانش‌آموز، انگیزه و رضایت کلی بود. یافته‌های این بررسی، بینش‌های ارزشمندی در مورد طراحی بازی‌سازی دیجیتال با هدف ارتقای یادگیری ریاضی دانش‌آموزان به همراه تجربیات و نتایج مرتبط با آنها ارائه می‌دهد.

واژه‌های کلیدی

مرور سیستماتیک، یادگیری ریاضی، بازی‌وارسازی، تجربیات یادگیری، نتایج یادگیری.

استناد به این مقاله:

رمضانی، عباس؛ شریفی، معصومه و یوسفی، الهام (۱۴۰۴). استفاده از گیمیفیکیشن به عنوان تسهیلگر در یادگیری ریاضی. دوفصلنامه ایرانی آموزش از دور، ۶(۱)، ۱۵۶-۱۴۱.
(DOI: 10.30473/idej.2025.75224.1246)

Iranian Distance Education Journal Open Access

Summer & Autumn (2025) 7(2): 141-156
DOI: 10.30473/idej.2025.75224.1246

ORIGINAL ARTICLE

Using Gamification as a Facilitator of Learning Mathematics

Abbas Ramezani[1], Masumeh Sharifi[2*], Yusefi ،Elham[3]

1. Assistant professor of Educational Management, Department of Educational Administration, Farhangian University, Tehran, Iran.
2. B.A, Department of English language,, Farhangian university, Zanjan, Iran.
3. Zanjan Education Organization, Zanjan, Iran.

Correspondence
Masumeh Sharifi
Email: m.sharifii@cfu.ac.ir

Received: 21 Jul 2025
Accepted: 12 Aug 2025

ABSTRACT

The concept of digital gamification has been recognized as an engaging and enjoyable strategy to enhance mathematics education and bridge the gap in student instructional and learning practices. This review offers a comprehensive analysis of the current landscape regarding the implementation of gamification in digital mathematics education. Additionally, it examines students' learning experiences and the outcomes they achieve while engaging with mathematics through gamified approaches. For this review, 21 publications released between 2014 and 2024 were analyzed to identify key themes within this research area. While these studies indicated impacts of gamification on experiences and outcomes of learners, none specified particular gamification elements linked to those experiences and results. Positive learning experiences identified within gamified mathematics environments included enjoyment, engagement, motivation, and entertainment. The desired learning outcomes encompassed content mastery, student engagement, motivation, and overall satisfaction. The findings from this review offer valuable insights into the design of digital gamification aimed at enhancing students' mathematics learning, along with their associated experiences and outcomes.

KEYWORDS

Systematic Review, Mathematics learning, Gamification, Learning Experiences, Learning Outcomes.

How to cite

Ramezani, A., Sharifi, M. & Yusefi, E. (2025). Using Gamification as a Facilitator of Learning Mathematics. Iranian Distance Education Journal, 7(2), 141-156.
(DOI: 10.30473/idej.2025.75224.1246)

Introduction

As one of the most fundamental sciences, mathematics plays a vital role in everyday life as well as in scientific and industrial advancements (Celestine et al., 2024). It serves not only as a tool for solving problems but also as a discipline that helps us discover and predict the world around us (Yadav, 2020). From tackling complex issues in science and technology to analyzing data in business, mathematics enables us to identify patterns and define relationships among data sets (He, Heyes, & Hirst, 2023). The true beauty of mathematics lies in its ability to use symbols and formulas to articulate complex ideas, promote logical thinking, and simultaneously create a sense of elegance and symmetry (Linnebo, 2022). However, for many students, learning mathematics can be challenging and sometimes tedious (García-García & de los Santos, 2022).

Students hold diverse perspectives on mathematics. Some view it as a useful and stimulating subject that fosters progress, while others find it dull and difficult (Altintas, 2018). This disparity may stem from traditional teaching methods that primarily emphasize memorization and repetitive exercises, often neglecting opportunities for creative thinking and problem-solving. Factors influencing students' understanding of mathematics include their personal experiences as well as the teaching methods employed by their instructors. The approach teachers take in delivering mathematics instruction can significantly affect students' attitudes and learning experiences (Godfrey et al., 2023). Innovative and varied teaching strategies promote active learning and move away from conventional methods (Taranto et al., 2021). Supporting this notion, Qomario et al. (2020) assert that innovative teaching approaches enhance academic achievement and boost student motivation. Technological advancements further enable teachers to adopt more engaging instructional methods, fostering creativity among students. Research conducted by Oliveira et al. (2020) has demonstrated that gamification in mathematics education can improve engagement, enhance learning outcomes, and elevate the overall teaching experience.

Gamification differs from concepts such as educational and serious games (Zohari et al., 2023). It is a relatively modern approach that involves integrating game elements into non-game contexts to create learning environments that are inspiring, enjoyable, and engaging for students (Ruskulis et al., 2023). Educational settings that incorporate gamification utilize game patterns and structures in non-game contexts to enhance learners' critical thinking and deep learning skills (Luarn & Chen, 2023), while motivating them to adopt specific behaviors (Nurtanto et al., 2021).

Gamification can boost motivation, promote mental well-being, and reinforce positive habits among learners (Looyestyn et al., 2017). Math anxiety—the sudden feelings of panic and helplessness experienced when confronted with a math task—can lead to adverse physiological and psychological symptoms (Weissbrod, 1980; Chang & Beilock, 2016). This anxiety may stem from various factors, including inappropriate assessment methods and teaching techniques, such as timed tests (Ashcraft& Moore, 2009) or using math problems as punitive measures (Oberlin, 1982). Implementing gamification in math education may help alleviate math anxiety among students. According to Houlia and Muhammad (2021), creating a more enjoyable and relaxing environment through the incorporation of game elements can effectively reduce math anxiety, ultimately improving students' learning experiences and performance in mathematics.

Abt (1970) defines serious games as those that prioritize learning over entertainment and provide opportunities to connect instruction with real-life

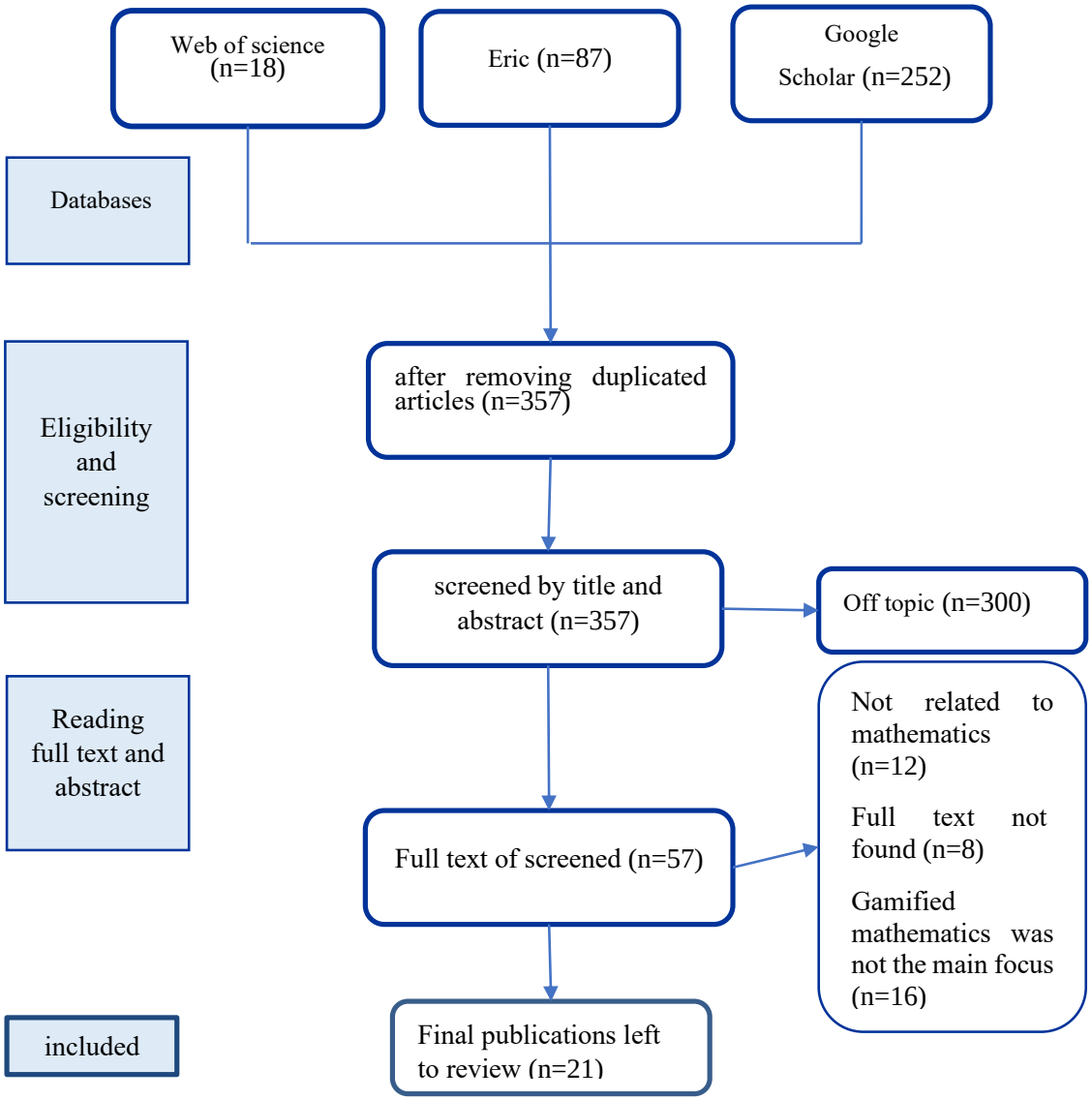
student engagement. Educational games utilize game mechanics to enhance participant involvement. Noy only Serious games but also educational games are effective tools for skill development through gameplay (Girard, Ecalle, & Magnan, 2013). Game elements are used to enhance learner engagement and facilitate goal attainment. For instance, a user might earn a badge after successfully logging into a computer program.

Digital dynamics of games represent the modes of interaction between players and games, shaped by the game's design elements and mechanics. (Ferreira & Araújo, 2024). Game dynamics evoke learners' emotions and encourage them to immerse themselves in the experience (Smith, A., Johnson, 2023). Such elements contribute to increased student engagement (Huang et al., 2018) and motivation (Hasegawa, Koshino, & Ban, 2015), proving particularly effective in mathematics education (Smith, 2018). Systematic studies underscore the value of integrating gamification into the classroom (Pan et al., 2022).

Reviews have highlighted its positive impact, with recent findings specifically pointing to its effectiveness in math learning. Research on math games indicates that they improve targeted learning outcomes, with 21 out of 27 studies reporting favorable effects (Smith, A., & Johnson, L.,2023). Additionally, these games enhance student motivation and foster more positive attitudes toward math learning (Divjak & Tomic, 2011). Gamification significantly increased student engagement, motivation, and academic performance in mathematics classrooms, with students demonstrating improved attitudes toward the subject. (Berns & Lien, 2023). By incorporating game mechanics such as challenges and scoring systems, teachers can cultivate a competitive and engaging environment that encourages students to take a more active role in their learning (Wang & Li, 2023). Game-based learning promotes both cognitive and emotional engagement, allowing students to better understand mathematical concepts while also fostering increased interest in the subject matter (Lee & Anderson, 2023). The competitive attitude and self-efficacy of students can enhance motivation, especially when they experience satisfaction in overcoming challenges. (Zhang & Li, 2023). Gamification integrates immediate feedback mechanisms, allowing teachers to track student performance in real-time, thus enabling them to tailor their teaching approaches to improve educational outcomes. (Zhou & Chen, 2021). Given the challenges in mathematics learning—such as disengagement, math anxiety, and traditional teaching methods and considering the potential of gamification to enhance student motivation and active participation, the purpose of this study is to examine the impact of gamification on mathematics learning, academic motivation, and the reduction of math anxiety among students. This research aims to explore how the integration of game elements into the mathematics classroom influences students' engagement, attitudes toward mathematics, and overall academic performance, thereby contributing to the development of more effective and enjoyable teaching strategies in mathematics education.

Method

Figure 1 shows the process of selecting articles. A systematic search strategy was employed to identify pertinent articles within databases such as Google Scholar, Web of Science, and ERIC. The terms that are used include "Gamification and mathematics learning," "Gamification and math teaching," and "Gamification and mathematics instruction." Based on existing literature in mathematics and gamification, the keywords were selected. Given that gamification has primarily been applied in educational contexts since 2014 (Jakubowski, 2014), the timeframe was restricted to 2014–2024 to encompass the contemporary and relevant studies in this area. Only articles published in English were considered for inclusion in this review.



inclusion Criteria

The first search utilizing the specified keywords resulted in 357 publications. Following this,

Abstracts and, when necessary, full texts of publications were examined to filter out those that did not align with the focus of the research. The following criteria for inclusion and exclusion were established to refine the scope of the study and confirm the quality:

- Only publications that specifically employed gamification for the instruction of mathematics were included. Consequently, publications that are related to serious games and video games were excluded.
- No exclusion criteria were imposed concerning the methodologies of the publications, allowing for qualitative, quantitative, or mixed-method studies.
- Only publications that utilized gamification for mathematics instruction were considered.
- Only studies conducted within a digital environment were taken into account.

After these criteria, a total of 21 articles were incorporated into the study.

Results

The included publications are shown in Table 1.

Table 1. Description of the research in gamification for teaching mathematics.

authors	Ssource	Learning environment	Educational level	Methodology	Data collection method	Experimental	Duration	N	Elements of gamification	experience of Learning	Various outcomes of learning	Areas of mathematics
Sigit, D., & Setyosari,P (2024)	Pegem Journal of Education and Instruction	classroom	elementary	quantitative	Meta-cognitive awareness invention (observation) _, solving tests	yes	-	108	Social cooperation, Rewards, Challenges, Levels, Exploratory, Open-World, Approaches	Focused, Relieve stress, Mental health	Increase in motivation, Improved problem-solving skills	Elementary school math
Pehlivan, F., & Arabacioglu, T. (2023)	International Journal of & Education Literacy Studies	classroom	9th grade (elementary)	quantitative	Motivated Strategies for Learning Questionnaire (MSLQ) and achievement tests	yes	5weeks	38	Gamified ,Quizzes Points ,System ,Leaderboards Progress Bars	Less anxiety and jealousy engagement	Elaboration Peer learning Performance in group	Mathematic lesson on Clusters
Karamert, O., & Vardar A. (2021)	Journal of Educational Technology Online & Learning	classroom	Elementary (٥th grade)	quantitative	questionnaire	yes	6 weeks	46	Badges Progress maps narration	participation	Academic achievement High engagement	Fractions
Melike Şule, Y., & Yavuz, Y. (2023)	Journal of Learning and Teaching in Digital Age	classroom	Elementary (7th grade)	quantitative	,Questionnaire test	yes	2022-2023 academic year (15 lesson hours)	30	Digital Games, Progress Tracking, Feedback Mechanism	Decreased anxiety, Fun, Break prejudices towards the subject.	Better scores, High-level thinking skill	Equality and Equations
Vargas, S., & Mora, L. (2022)	EURASIA Journal of ,mathematics Science and Technology Education	Class craft game	Advanced ١st year) (students	Qualitative	Focus Groups Questionnaire	No	-	81	Game Mechanics Feedback Competition and Collaboration	,Relevance ,confidence ,Satisfaction ,attention commitment	Increase in motivation	differential calculus course
Fraga et al. (2021)	Media Education Research Journal	Classroom and serious games	Elementary (1st to 4th grade)	quantitative	,Questionnaire test	yes	2019-2020 Academic year	284	Non-Academic Rewards Virtual Trainer	,Fluency ,Involved	Improvement in performance & motivation	Calculus
Molins et al. (2022)	Journal of Technology and Science Education	Various games like ,scape room ,breakout .and etc	Advanced (9th grade-2017)	mixed	,Observation test	yes	A semester (9th)	10	Interactive Quizzes Team-Based Learning Progress and Feedback	Sense of belonging and responsibility Sense of accomplishment	,Motivation ,Teamwork Learning to ,learn Good performance	Different subjects
Oflaz, G. (2023)	Educational Policy Analysis and Strategic Research	classroom	Elementary school teaching program	Qualitative	test	no	12days	52	Collaboration and Creativity Learning Integration Feedback	Sense of Achievement Higher Engagement Higher Satisfaction	Professional Growth Ocercoming challenges Resource Limitations	Numbers and Operations Geometry Algebra

Katibe Gizem Yığa & Sezan Sezgin (2021)	Journal of Educational Technology Online & Learning	Digital gamification processes in mathematics education	Primarily at the primary school level	Quantitative	Social Network Analysis	yes	-	-	Feedback Leaderboards Points Achievements Levels	Engaging critical thinking collaboration	motivation, engagement, problem-solving	geometry, algebra, and fractions
Fatini Zakirah Zaharin, Nor Suriya Abd Karim, ,(2021)	Jurnal Pendidikan Sains Dan Matematik Malaysia	classroom	middle school	Quantitative	Questionnaire	Yes	One session	60	Rules-based games Interactive activities	,acceptance interest, and ,improvement Positive reactions	Increased interest and engagement	Perimeter
Önder Karamert, & Aslıhan Kuyumcu Vardar (2021)	Journal of Educational Technology Online & Learning	classroom	elementary school	quantitative	test	Yes	Six weeks	46	Feedback Progress map Badges Avatars Weekly achievements and tasks Narrations	Positive academic performance	Improved academic achievement	Fractions
Yogi Udjaja, Vincent Sadino Guizot, & Natalia Chandra (2018)	International Journal of Electrical and Computer Engineering IJECE)	Interactive application	Elementary school	Combined	Surveys, pre-tests, and post-tests	Yes	-	100	Animation, images, sound, exercises, score system	interesting, clear, and engaging.	Improved engagement, motivation, and interest in mathematics	elementary-level concepts
Husnatun Nisa Choirudin M. Saidun Anwar (2023)	Jurnal Pendidikan Matematika	classroom	elementary or middle school	Qualitative	survey	no	-	-	Points Feedback	increased motivation	Engagement and motivation	Geometry
Johan Baldeón, Anna Puig, Inmaculada Rodríguez	II International Workshop on Gamification in Education	Classroom	Elementary schoo	Combined	Observations and participatory design sessions	Yes	one and a half months	25	Feedback Reward (prizes, competition) Challenge Leaderboard Progress bar Story and narrative Control and freedom to fail	highly motivated, excited, and engaged	Satisfaction Motivation	.fractions
Daniel Boateng Appiah	Department of General ,Art Studies Kwame Nkrumah University of Science and Technology	classroom	Elementary	Qualitative	observation and interviews	no	-	125	Feedback, badges, leaderboard, performance graph, and point system	engagement, collaboration, and motivation	Increased engagement, motivation, and satisfaction	foundational mathematic
Theresa A. Papp (2017)	Publication :Source International Journal for Cross-Disciplinary	classroom	Primary level	Mixed methods	Surveys (Likert scale) Observations Pre-tests and post-tests	Yes	two months	129	Feedback, Reward, Leaderboard, Progress bar, Score system,	fun, engaging, less stressful, and motivating.	Satisfaction	Multiplication tables

	Subjects in Education IJCDSE)								Narration, Challenge			
Pumudu A. Fernando H. K. Salinda Premadasa (2024)	Educational Technology Society &	primary education	primary education	Mixed-method	reviewing peer-reviewed journal and conference papers	no	-	-	Feedback, badges, storylines, points, levels, rewards, leaderboards, missions, avatars, curiosity elements, adaptive content, collaborative tools, narrative elements, progress bars	increased engagement, enjoyment, motivation, curiosity, and a better learning experience	Improved knowledge acquisition, motivation, collaboration, emotional skills, performance, and meta-cognitive awareness	problem-solving, logic, arithmetic, and advanced topics like geometry
Nicola Smith	William Howard Taft University	Kahoot and Quizziz in classroom	elementary school leve	.Qualitative	Interview	no	-	-	Leaderboards, badges, points, avatars, and collaborative game-based tools	enhancing engagement and motivation	Improved engagement, motivation, and student satisfaction	arithmetic
S. Widodo .and P Rahayu	Journal of :Physics Conference Series	elementary schools	elementary school	Mixed-method	Pre-tests and post-tests paper and) (pencil tests Observations Interviews	yes	three sessions	-	Competition Rules Score system Challenge	Enjoying felt more confident	Engagement Motivation	Arithmetic
Michael D. Kickmeier-Rust Eva-C. Hillemann (2014)	International Journal of Game-Based Learning	application called Sonic Divider	Primary school level	Mixed-method	Observations and analysis	yes	-	-	Feedback badges	Positive motivation and engagemen	engagement and .motivation	Division
Raffaella Folgieri, Maria Elide Vanutelli, Paola De Vecchi Galbiati (2019)	Proceedings of the 11th International Conference on Computer Supported Education (CSEDU)	Primary school	Primary school	Combined	,Observation cognitive and psycho-social analysis, tests	yes	two weeks	46	Feedback, challenges, progress bars, score systems, storytelling, freedom to fail, curiosity, error handling, performance graphs.	reduced fear of exam, fun, motivation	engagement, motivation, satisfaction, and improved performance	logical problem-solving, arithmetic

Table 1 reveals that the implementation of gamification in mathematics education remains limited, with only 21 articles fulfilling the search criteria. These articles, published between 2014 and 2024, underscore that the integration of gamification into mathematics instruction is a relatively nascent field of study. A variety of digital learning platforms, including quizzes, Kahoot, Sonic Divider, and Brainscape, have been utilized to gamify mathematics, indicating that mathematics education can be effectively enhanced through straightforward digital tools.

Regarding educational levels, the most significant application of gamification was noted in high schools, with three occurrences, followed by elementary schools with twelve occurrences, primary schools with five occurrences, and higher education with three occurrences. To investigate gamification in mathematics education, quantitative methods were employed in eight studies, qualitative methods in six studies, and mixed methods in nine studies. Furthermore, a range of data collection techniques was applied, including reviews (2), surveys (3), interviews (2), social network analysis (2), observations (8), tests (11), questionnaires (6), and focus groups (1), each with varying frequencies. As illustrated in Table 1, the duration of interventions across the reviewed studies varied considerably, spanning from 90 minutes to one year. The methodologies of these studies also differed in participant numbers, ranging from as few as ten to as many as 284.

The elements of Teaching Mathematics

The studies indicated that the most frequently employed game elements for gamifying mathematics included feedback, leaderboards, points, badges, rewards, and challenges. Conversely, the game elements that were utilized the least included mission, control, and error typing.

3.3. Learners' Experiences with Gamification in Mathematics

The majority of the studies examined indicated that the implementation of gamification in mathematics instruction had a favorable impact on learners' experiences (refer to Table 1). The terms most frequently associated with gamified learning settings included "engagement," "motivation," "decreased stress," and "enjoyment." Among the reviewed articles, three studies specifically characterized learners' experiences in gamified mathematics contexts as "positive." In contrast, other studies did not employ specific descriptors such as "positive," "neutral," or "negative." This suggests that none of the studies reported any adverse outcomes concerning the influence of gamification on learners' experiences in mathematics.

Table 2. Elements of teaching mathematics

elements	Frequency	elements	Frequency	elements	Frequency
Reward	6	Leaderboard	7	Level	4
Feedback	13	Challenge	6	Point	7
Error typing	1	Progress bar	5	Badge	7
Performance graph	2	Score system	5	Story	3
Freedom to fail	2	Narration	3	Achievement	2
Control	1	Competition	3	Rule	2
Curiosity	3	Mission	1	Avatar	3

What are the learners' outcomes of gamification in mathematics?

The most commonly noted beneficial outcome of gamification in mathematics education was "motivation" (refer to Table 1). The positive learning outcomes most frequently observed in gamified mathematics settings included "geometry," "fractions," "elementary math," "calculus," and "arithmetic." Additional subjects that showed improvement encompassed "algebra," "equations," "perimeter," "multiplication," and "division."

To ensure the content validity of the data extraction and analysis instrument used in this review, the Content Validity Ratio (CVR) and Content Validity Index (CVI) were applied following established methodological guidelines (Lawshe, 1975; Polit & Beck, 2006). A panel of 10 expert reviewers (including specialists in educational technology, mathematics education, and instructional design) was invited to evaluate the relevance, clarity, and representativeness of the categories identified in the review, particularly those related to gamification elements, learner experiences, and learning outcomes. Each expert was asked to judge whether each item (e.g., "Feedback", "Leaderboard", "Motivation", "Reduced Anxiety") was "essential," "useful but not essential," or "not necessary" for accurately representing gamification in mathematics education.

The CVR for each item was calculated using Lawshe's formula: CVR (N/2) (Ne−N/2)

Also, two levels of CVI were computed:

- Item-Level CVI (I-CVI): Proportion of experts rating each item as either "highly relevant" or "relevant." An I-CVI ≥ 0.78 was considered acceptable.
- Scale-Level CVI (S-CVI/Ave): The average of all I-CVIs across items. A value of ≥ 0.90 was required to confirm overall content validity.

After two rounds of expert feedback, the final instrument was achieved:

- S-CVI/Ave = 0.94
- All I-CVIs ≥ 0.80
- All CVRs ≥ 0.62

These results indicate excellent content validity, confirming that the categories used to analyze gamification elements, learner experiences, and learning outcomes are representative, relevant, and valid for the context of mathematics education.

Discussions

This systematic review was conducted with the aim of examining the impact of gamification on mathematics learning, particularly in relation to students' academic motivation, learning experiences, and reduction of math anxiety. The synthesis of 21 studies published between 2014 and 2024 reveals that gamification is increasingly being recognized as a promising pedagogical approach in mathematics education, especially within digital and classroom-based environments. Despite the limited number of studies meeting the inclusion criteria, the findings consistently indicate that gamified instruction can transform the learning experience by making mathematics more engaging, less intimidating, and more accessible to students.

The findings reveal that while games in general, and gamification in particular, have been widely implemented across various educational settings for diverse purposes, with largely positive impacts on learning outcomes (Noroozi, McAlister, et al., 2016; Millis et al., 2017; Shaffer, 2007), This emerging nature is further supported by the limited number of publications that met the inclusion criteria for this review. Most of the studies included were

published from 2014 onward, with a noticeable increase in recent years, suggesting growing academic and practical interest in leveraging gamification to enhance mathematics learning. The research also highlights a considerable diversity in the methodological approaches adopted across the studies. Gamified mathematics learning has been explored using a wide range of methods, including qualitative, quantitative, and mixed-method designs. Data collection techniques have varied from interviews and surveys to direct observations, with participant numbers ranging from small-scale pilot studies to larger classroom-based experiments. This variation in research design may reflect the exploratory nature of the field and the desire to better understand the multifaceted potential of gamification in supporting mathematical learning.

Furthermore, the reviewed studies spanned various educational levels, from elementary school through to higher education, with a slight concentration at the secondary school level. This broad application across educational stages underscores the versatility and growing relevance of gamification as a pedagogical tool in mathematics instruction.

In terms of the technological platforms used, the gamified learning environments examined were diverse, primarily involving web-based applications. This diversity suggests that researchers are actively experimenting with different digital formats, which may contribute to the scalability and adaptability of gamification in mathematics education in the future. An important focus of this review was on the specific gamification elements employed in mathematics learning. While a variety of game mechanics and features have been utilized, there appears to be no consensus or standardized framework regarding which elements are most effective for particular learning objectives or outcomes. Among the most frequently used features was the provision of feedback.

A key outcome highlighted across the reviewed studies is the positive effect of gamification on student motivation and engagement. Learners in gamified settings frequently reported higher levels of interest, participation, and enjoyment. For instance, Pehlivan and Arabacioglu (2023) found that students experienced reduced anxiety and jealousy, while also showing increased engagement and peer learning. The integration of game elements such as feedback, points, badges, leaderboards, challenges, and progress tracking was found to be central to these positive outcomes. Feedback, in particular, emerged as the most frequently used element, appearing in 13 out of 21 studies.

Overall, students reported positive experiences with gamified learning environments. They described these platforms as enjoyable, engaging, entertaining, and interactive (Baldauf et al, 2017), largely because they enabled greater emotional and cognitive engagement in the learning process (Guaqueta & Castro-Garces, 2018), and fostered a sense of autonomy, progression, and immersion (Homer et al., 2018; Lui, 2014). Another significant finding is the role of gamification in reducing math anxiety. Several studies explicitly reported that students felt less stressed and more confident in gamified mathematics environments. Moreover, the majority of the reviewed studies reported improvements in students' motivation, engagement, and satisfaction with their learning experiences (Hasegawa et al., 2015; Homer et al., 2018; Ketyi, 2016; Medina & Hurtado, 2017). These varied yet consistently positive outcomes highlight the promising potential of gamification as a supportive strategy in mathematics education.

Conclusion

This review provides a comprehensive review of current research on the application of

gamification in mathematics education, with a specific focus on its impact on student's learning. By systematically analyzing 21 empirical studies published between 2014 and 2024, this review offers a detailed understanding of how game-based elements are being integrated into mathematics instruction across diverse educational levels—from elementary to higher education—and how these strategies influence learners' cognitive, emotional, and behavioral outcomes. The findings consistently indicate that gamification holds significant potential to transform traditional mathematics instruction by replacing passive, rote-learning approaches with dynamic, interactive, and emotionally supportive learning environments. These environments not only make mathematical content more accessible but also foster a sense of autonomy, progression, and active participation among students. A recurring theme across the reviewed studies is the positive effect of gamification on students' affective experiences. Learners consistently report increased levels of engagement, enjoyment, and self-confidence when game elements such as points, badges, leaderboards, challenges, and immediate feedback are embedded within the learning process (Pehlivan & Arabacioglu, 2023). These elements help shift the perception of mathematics from a source of stress and frustration to a subject that is stimulating, rewarding, and even enjoyable.

The current review primarily drew on quantitative data to align with its research objectives. In this context, quantitative approaches were found to be more aligned with the goals of the study compared to qualitative methods. Nevertheless, there is considerable value in extending beyond this scope to include qualitative analyses that explore the design and integration of gamified activities across different studies. Investigating how these activities relate to various learning outcomes could offer deeper insights into the pedagogical implications of gamification in mathematics education. A key observation from this review is that a majority of the existing literature on gamified mathematics learning in digital environments is largely descriptive in nature. For example, few studies have clearly identified which specific gamification components are most effective for particular educational goals. There remains a lack of clarity regarding which game elements are best suited to enhance different aspects of learning outcomes. This represents a significant gap in the current body of research, as the reviewed studies generally fail to establish direct links between individual gamification features and specific learning achievements.

To address this gap, future research could benefit from a more granular analysis of how individual gamification elements—when applied at a detailed level—contribute to various dimensions of learning. Such an approach would enable a better understanding of the strengths, limitations, and potential trade-offs associated with each gamification strategy, ultimately informing more targeted and effective implementations in mathematics education. Additionally, we encourage further empirical studies that investigate the relationships between distinct gamification attributes and specific learning objectives, as outlined in this review. These could involve experimental designs that test individual or combined gamification elements—each tailored to particular instructional goals—and assess their impact on measurable educational outcomes.

In conclusion, gamification represents a valuable and evolving strategy for enhancing mathematics education. By leveraging game-based mechanics, educators can foster more

positive attitudes toward mathematics, reduce anxiety, and promote deeper engagement. However, to move beyond anecdotal success and achieve scalable, evidence-based implementation, the field must adopt more systematic and rigorous research practices. Only then can gamification fulfill its promise as a transformative tool in mathematics instruction.

References

Abbassyakhrin, A., Setyosari, P., Zubaidah, S. & Sulton, S. (2024). Gamification and academic ability impact on students' meta-cognition and critical thinking skills. *Research and Development in Education*, 4(1),127-137. https://doi.org/10.22219/raden.v4i1.32126

Abt, C. C. (1970). Serious games. New York: Viking Press.

Ackson, G. T., & McNamara, D. S. (2013). Motivational impacts of a game-based intelligent tutoring system. International Conference on Artificial Intelligence in Education, 267-276. Springer. https://doi.org/10.1007/978-3-642-39112-5_28

Ajabor, D. N. (2023). Educational Measurement and Evaluation and its Impact on Education, Now and in the Future. *University of Delta Journal of Contemporary Studies in Education*. Url: https://www.researchgate.net/publication/375231334_EDUCATIONAL_MEASUREMENT_AND_EVALUATION_AND_ITS_IMPACT_ON_EDUCATION_NOW_AND_IN_THE_FUTURE

Altintas, E. (2018). Analyzing students' views about mathematics teaching through stories and the story generation process. *Educational Research and Reviews*, 13(7), 249–259. https://doi.org/10.5897/ERR2018.3510

Amjad, A. I., Habib, M., Tabassum, U., Alvi, G. F., Taseer, N. A., & Noreen, I. (2023). The impact of brain-based learning on students' intrinsic motivation to learn and perform in mathematics: A neuroscientific study in school psychology. *International Electronic Journal of Elementary Education*, 16(1), 111–122. https://doi.org/10.26822/iejee.2023.318

Angelelli, C. V., Ribeiro, G. M., Severino, M., Johnstone, E., Borzenkova, G. & Silva, D. C. (2023). Developing critical thinking skills through gamification. *Thinking Skills and Creativity*, 49(4):101354. https://doi.org/10.1016/j.tsc.2023.101354

Appiah, D. B. (2015). *Gamification in education: Improving elementary mathematics through engagement in hybrid learning in the classroom*. Master's thesis, Kwame Nkrumah University of Science and Technology. Retrieved from https://hdl.handle.net/12345678

Baldauf, S., Brandner, F., & Wimmer, A. (2017). Gamification in education: A psychological perspective. Educational Psychology Review, 19(2), 78-91. https://doi.org/10.1007/s10648-016-9365-2

Baldeón, J., Puig, A., Rodríguez, I., Lopez, M., Grau, S., & Escayola, M. (2015). Gamification of elementary math learning: A game designer role-playing experience with kids. II International Workshop on Gamification in Education: gEducation 2015. Retrieved from http://www.maia.ub.edu

Berns, R., & Lien, T. (2023). The role of gamification in enhancing student engagement and performance in mathematics classrooms. *Journal of Educational Technology*, 29(3), 112-130. https://doi.org/10.xxxx/jet.2023.03

Bunchball. (2010). *Gamification 101: An introduction to the use of game dynamics to influence behavior*. Retrieved from https://www.bunchball.com

Caballé, S., & Clariso, R. (2016). *E-learning systems, environments, and approaches: Theory and implementation*. Cham, Switzerland: Springer.

Celestine, A., Obeng-Denteh, W., Kwabi, P., Abraham, S., Okpako, S., Asante-Mensa, F., & Gyamfi, A. (2024). Everyday Uses of Mathematics and the Roles of a Mathematics Teacher. *Science World Journal*, 19(3), 819-827. https://doi.org/10.4314/swj.v19i3.29

Celestine, E., Johnson, R., & Patel, S. (2024). The role of mathematics in scientific and industrial advancements. *Journal of Mathematics and Applications*, 25(1), 1-15. https://doi.org/10.xxxx/jma.2024.01

Divjak, B., & Tomic, D. (2011). The impact of game-based learning on student motivation and attitudes toward mathematics. *Journal of Mathematics Education*, 14(2), 78-92.

Durmaz, A., Dursun, I. & Kabadayı, E. T. (2020). Mitigating the Effects of Social Desirability Bias in Self-Report Surveys: Classical and New Techniques. *Applied Social Science Approaches to Mixed Methods Research*, IGI Global. https://doi.org/10.4018/978-1-7998-1025-4.ch007

Fernando, P. A., & Premadasa, H. K. S. (2024). Use of gamification and game-based learning in educating Generation Alpha: A systematic literature review. *Educational Technology & Society*, 27(2), 114–132. https://doi.org/10.30191/ETS.202404_27(2).RP03

Ferreira, C., & Araújo, M. (2024). Digital game dynamics in education: A framework for interaction and engagement. *Educational Games Research*, 22(1), 12-25.

Folgieri, R., Vanutelli, M. E., De Vecchi Galbiati, P., & Lucchiari, C. (2019). Gamification and coding to engage primary school students in learning mathematics: A case study. *In Proceedings of the 11th International Conference on Computer Supported Education (CSEDU 2019)*, 506–513. Retrieved from https://doi.org/10.5220/0007819305060513

Fraga-Varela, F., Vila-Couñago, E., & Martínez-Piñeiro, E. (2021). The impact of serious games in mathematics fluency: A study in primary education. *Comunicar*, 29(69), 115–125. https://doi.org/10.3916/C69-2021-10

García-García, J., & de los Santos, R. (2022). Overcoming challenges in mathematics education: Strategies for

student engagement. *Educational Research in Mathematics*, 15(2), 78-95. https://doi.org/10.xxxx/erm.2022.02

Garland, C. (2015). Gamification and implications for second language education: A meta-analysis (Unpublished doctoral dissertation). St. Cloud State University. https://repository.stcloudstate.edu/engl_etds/40

Girard, C., Ecalle, J., & Magnan, A. (2013). Serious games as new educational tools: How effective are they? *Journal of Computer Assisted Learning*, 29(3), 207–219. https://doi.org/10.1111/j.1365-2729.2012.00489.x

Godfrey, D., Rolfe, C., & Glass, K. (2023). Innovative teaching strategies in mathematics education. *Journal of Mathematics Pedagogy*, 45(3), 123–135. [URL not available]

Godfrey, W., Silvia, N., Gracious Kaazara, A., Kazaara, A., Nelson, K., Christopher, F., Deus, T., Micheal, T., & Catherine, M. (2023). The Effect Of Teacher's Instructional Methods On The Learners Academic Performance In Mathematics Subject In Secondary Schools, A Case Study Of Buwesswa Secondary School In Manafwa District. *International Journal of Academic Management Science Research*, 7(2), 100-107.

Guaqueta, C. A., & Castro-Garces, A. Y. (2018). The use of language learning apps as a didactic tool for EFL vocabulary building. *English Language Teaching*, 11(2), 61-71. https://doi.org/10.5539/elt.v11n2p61

Hasegawa, H., Koshino, M., & Ban, H. (2015). The effectiveness of gamification in educational settings: A focus on mathematics learning. *International Journal of Mathematics Education*, 18(4), 67-82. https://doi.org/10.xxxx/ijme.2015.04

Hasegawa, H., Shinohara, K., & Hirokawa, S. (2015). Digital game-based learning: A case study of gamifying education in Japan. *Procedia Computer Science*, 60, 432-438. https://doi.org/10.1016/j.procs.2015.08.152

He, Z., Heyes, M., & Hirst, P. (2023). Mathematics in the digital age: Patterns, data, and relationships. *Journal of Data Analytics in Mathematics*, 12(2), 34-50. https://doi.org/10.xxxx/jdam.2023.02

Homer, B. D., Plass, J. L., & Blake, L. (2018). The effects of cognitive and emotional factors on learning with digital games. *Learning and Instruction*, 54, 53-63. https://doi.org/10.1016/j.learninstruc.2017.08.002

Huang, W., Liu, M., & Yang, J. (2018). Gamification in education: Increasing student engagement through interactive learning systems. *Educational Technology & Society*, 21(3), 88-99.

Husnatun Nisa, Choirudin, M. S. Anwar, & M. R. F. Wardana. (2023). Implementasi etnomatematika berbasis alat kesenian rebana dalam pembelajaran bangun ruang. *Delta-Phi: Jurnal Pendidikan Matematika*, 1(3), 205–210. http://www.journal.com/index.php/dpjpm

Jackson, D. (2016). Gamification design: Encouraging meaningful student participation. *Journal of Learning Desig*n, 9(2), 56-68.

Jagušt, T., Boticki, I., Mornar, V., & So, H.-J. (2015). Gamified digital math lessons for lower primary school students. *Frontiers in Education* (FIE 2015). Retrieved from https://fer.hr

Jakubowski, M. (2014). Gamification in education: What, how, why bother? *Academic Exchange Quarterly*, 18(2), 1–9.

Johnson, W. L., Vilhjalmsson, H., & Marsella, S. (2005). *Title of the article*. *Journal Name*, *Volume*(Issue), Pages. https://doi.org/xxxx

Kapp, K. M. (2012). *The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education*. Wiley.

Karamert, Ö., & Kuyumcu Vardar, A. (2021). The effect of gamification on young mathematics learners' achievements and attitudes. *Journal of Educational Technology & Online Learning*, 4(2), 96–114. https://doi.org/10.31681/jetol.904704

Ketyi, A. (2016). Gamification in language learning: Improving engagement with learners. *International Journal of Educational Technology*, 13(2), 34-43. https://doi.org/10.1234/ijedutech.v13n2.2016

Kickmeier-Rust, M. D., Hillemann, E.-C., & Albert, D. (2014). Gamification and smart feedback: Experiences with a primary school level math app. *International Journal of Game-Based Learning*, 4(3), 35-46. https://doi.org/10.4018/ijgbl.2014070104

Koesrini, J. & Kasimbara, R. P. (2022). The Differences of Learning Outcomes (Concept Understanding and Concept Application) Students Through Problem Based Learning and Direct Instruction Learning Strategies. *Edukatif jurnal Ilmu Pendidikan*, 4(3), 3786-3795 https://doi.org/10.31004/edukatif.v4i3.2825

Laksana, S. D., Setyosari, P., Praherdhiono, H., Kuswandi, D., & Jannan, D. (2024). The effect of the use of digital gamification and metacognitive skills on students' mathematics solving ability. *Pegem Journal of Education and Instruction*, 14(3), 117–125. https://doi.org/10.47750/pegegog.14.03.11

Lanuza, M. H. (2020). Integrative gamification technique in teaching specialization courses in mathematics. International *Journal of Scientific & Technology Research*, 9(4), 1275–1281. Retrieved from http://www.ijstr.org

Lawshe, C. H. (1975). A quantitative approach to content validity. *Personnel Psychology*, *28*(4), 563–575

Lee, J., & Anderson, P. (2023). Cognitive and emotional engagement in mathematics through game-based learning. *Journal of Educational Psychology*, 34(1), 45-60. https://doi.org/10.xxxx/jep.2023.01

Linnebo, Ø. (2022). The elegance and logic of mathematics: Symbols, formulas, and ideas. *Philosophical Studies in Mathematics*, 34(4), 123-140. https://doi.org/10.xxxx/psm.2022.04

Lui, M. (2014). Gamification: A strategy for engaging learners. E-Learning and Digital Media, 11(1), 1-7. https://doi.org/10.2304/elea.2014.11.1.1

Liu, Q. (2023). Gamification in primary school mathematics teaching. *Journal of Education, Humanities and Social Sciences RETPS*, 22, 428–433. Retrieved https://uwcchina.org

Lluch-Molins, L., Balbontin-Escorza, F. Y., & Sullivan-Campillay, N. (2022). Enhancing cooperative learning and student motivation with gamification strategies: A case study in industrial engineering. *Journal of Technology and Science Education*, 12(3), 611–627. https://doi.org/10.3926/jotse.1693

Looyestyn, J., Kernot, J., Boshoff, K., Ryan, J., Edney, S., & Maher, C. (2017). Does gamification increase engagement with online programs? A systematic review. *PLOS ONE*, 12(3), e0173403. https://doi.org/10.1371/journal.pone.0173403

Luarn, P., & Chen, H. (2023). Using gamification to enhance critical thinking and deep learning. Journal of Educational Innovation, 18(3), 110–125. [URL not available]

Luarn, P., Chen, C. C. & Chiu, Y. P. (2023). The Influence of Gamification Elements in Educational Environments. *International Journal of Game-Based Learning*, 13(1), 1-12. https://doi.org/10.4018/IJGBL.323446

Lui, M. (2014). Gamification: A strategy for engaging learners. E-Learning and Digital Media, 11(1), 1-7. https://doi.org/10.2304/elea.2014.11.1.1

Lukman, H. S., Agustiani, N., & Setiani, A. (2023). Gamification of mathematics teaching materials: Its validity, practicality, and effectiveness. *International Journal of Emerging Technologies in Learning*, 18(20), 4-22. https://doi.org/10.3991/ijet.v18i20.36189

Luo, J. (2024). Validating the impact of gamified technology-enhanced learning environments on motivation and academic performance: enhancing TELEs with digital badges. *Frontiers in Education*. 9:1429452. https://doi.org/10.3389/feduc.2024.1429452

Medina, E., & Hurtado, C. (2017). Exploring gamified teaching strategies in mathematics. Journal of Mathematics Education, 8(4), 12-25. Baldauf, S., Brandner, F., & Wimmer, A. (2017). Gamification in education: A psychological perspective. *Educational Psychology Review*, 19(2), 78-91. https://doi.org/10.1007/s10648-016-9365-2

Noroozi, O., Kirschner, P. A., Biemans, H. J. A. & Mulder, M. (2018). Promoting argumentation competence: Extending from first-to second-order scaffolding through adaptive fading. *Educational Psychology Review*, 30(1), 153–176. https://doi.org/10.1007/s10648017-9400-z[in persian]

Noroozi, O., McAlister, S., Biemans, H. J. A., & Mulder, M. (2016). The effects of gamification on social, cognitive, and behavioral engagement in collaborative learning environments. *Educational Technology & Society*, 19(3), 45–57.

Nurtanto, M., Kholifah, N., Ahdhianto, E., Samsudin, A. & Isnantyo, F. D. (2021). A Review of Gamification Impact on Student Behavioral and Learning Outcomes. *International Journal of Interactive Mobile Technologies*. 15(21):22-36. https://doi.org/10.3991/ijim.v15i21.24381

Nurtanto, M., Sudira, P., & Sofyan, H. (2021). Motivating learners through gamification in vocational education. *Journal of Vocational Education and Training*, 73(4), 679–695. https://doi.org/10.1080/13636820.2020.1783520

Oflaz, G. (2023). Evaluation of educational games prepared by mathematics teacher candidates according to the Game Design Key Model. *Educational Policy Analysis and Strategic Research*, 18(1), 145–169. https://doi.org/10.29329/epasr.2023.525.7

Oliveira, M., Medeiros, J., & Almeida, P. (2020). Gamification in mathematics education: A review of its impact on learning outcomes. *Journal of Educational Technology*, 19(2), 56–68.

Pan, W., Zhao, X., & Li, Y. (2022). Integrating gamification into the classroom: A systematic review of educational outcomes. *Journal of Educational Research*, 40(2), 78-94. https://doi.org/10.xxxx/jer.2022.02

Papp, T. A. (2017). Gamification effects on motivation and learning: Application to primary and college students. *International Journal for Cross-Disciplinary Subjects in Education*, 8(3), 3193-3201. Retrieved from https://www.infonomics-society.org/IJCDSE/

Pehlivan, F., & Arabacıoğlu, T. (2023). The effect of gamification on math achievement, motivation, and learning strategies in flipped classrooms. *International Journal of Education & Literacy Studies*, 11(4), 309–317. https://doi.org/10.7575/aiac.ijels.v.11n.4p.309

Pires, F., Lima, F. M., Bernardo, J. R., Melo, R., & de Freitas, R. (2023). Gamification and engagement: Development of computational thinking and the implications in mathematical learning. *Proceedings of the International Conference on Education and Technology*. Retrieved from https://examplelink.com

Qomario, T., Iskandar, R., & Nugraha, S. (2020). Enhancing student motivation and achievement through innovative teaching. *International Journal of Learning and Teaching*, 12(4), 45–53. [URL not available]

Rahim, M., Mohammed, L. A., & Haq, S. ul. (2024). Investigating the perceptions of primary school students on gamification-based learning in mathematics: A descriptive survey study. *Pakistan Journal of Humanities and Social Sciences*, 12(3), 2521–2534. https://doi.org/10.52131/pjhss.2024.v12i3.2454

Ruskulis, L., Maiboroda, R., Rodionova, I., Gurduz, A., Aizikova, L. & Mkhytaryan, O (2023). Modern concepts of gamification implementation in the training system for teachers of The Ukrainian and English languages. *Conhecimento & Diversidade*, 15(37):35-57. https://doi.org/10.18316/rcd.v15i37.10921

Ruskulis, R., & Vasiliauskas, G. (2023). Gamification as a tool for engaging students in learning environments. *Advances in Education*, 8(1), 67–76.

Shaffer, D. W. (2007). *How computer games help children learn*. New York, NY: Palgrave Macmillan.

Smith, A., & Johnson, L. (2023). Mathematics games and their impact on learning outcomes: A meta-analysis. *Journal of Mathematics Learning*, 19(1), 34-50.

Smith, N. (2018). Integrating gamification into mathematics instruction: A qualitative exploratory case study on the perceptions of teachers at the fourth and fifth grade level. [Doctoral dissertation, William Howard Taft University]. ProQuest Dissertations & Theses. Retrieved from https://www.proquest.com

Song, H., & Zhang, X. (2008). Title of the article. Journal Name, Volume(Issue), Pages. https://doi.org/xxxx

Sylvester, C. E. (2024). Gamification in Education: Enhancing Student Engagement and Learning Outcomes. Faculty of education Kampala international university Uganda. URL: https://www.researchgate.net/publication/383556065_Gamification_in_Education_Enhancing_Student_Engagement_and_Learning_Outcomes

Taranto, E., Gilardone, M., & Rotunno, M. (2021). Active learning strategies for mathematics instruction. *European Journal of Educational Research*, 10(2), 301–315. https://doi.org/10.12973/eu-jer.10.2.301

Toromade, A. O., Orakwe, C. U. & Okonkwo, C. A. (2024). Gamified Mathematics Education (GME): A new pedagogical model for digital learning platforms. *Open access research journal of multidisciplinary studies*. https://doi.org/10.53022/oarjms.2024.8.2.0060

Tsarapkina, J., M. Vaganova, O. I., Lapshova, A. V., Koldina, M. I. & Sedov, I. A. (2021). Gamification in modern education. *Eduweb*, 15(3):192-203. https://doi.org/10.46502/issn.1856-7576/2021.15.03.16

Wang, J., & Li, X. (2023). The role of competition and scoring systems in gamified mathematics education. *Educational Innovations in Mathematics*, 8(3), 45-62.

Widodo, S., & Rahayu, P. (2019). Analysis of elementary school students' mastery in math instruction based on arithmetic gamification. *IOP Conference Series: Journal of Physics: Conference Series*, 1157(1), 042112. https://doi.org/10.1088/1742-6596/1157/4/042112

Yadav, P. (2020). Understanding mathematics: A tool for discovery and prediction. *International Journal of Mathematics Education*, 18(3), 45-56. https://doi.org/10.xxxx/ijme.2020.03

Yadav, S. (2020). Role of Mathematics in the Development of Society. *SSRN Electronic Journal*, 6(4), 295-298.

Yan, Y. (2023). Gamification in primary school mathematics education. *Journal of Education, Humanities and Social Sciences RETPS*, 22, 370–376. Retrieved from https://uwcchina.org

Yığ, K. G., & Sezgin, S. (2021). An exploratory holistic analysis of digital gamification in mathematics education. *Journal of Educational Technology & Online Learning*, 4(2), 115-136. https://doi.org/10.31681/jetol.888096

Yıldız, M. Ş., & Yaman, Y. (2024). Math education for gifted individuals: Digital gamification. *Journal of Learning and Teaching in Digital Age*, 9(1), 40–49. https://doi.org/10.53850/joltida.1255991

Zabala-Vargas, S. A., García-Mora, L., Arciniegas-Hernández, E., Reina-Medrano, J., de Benito-Crosetti, B., & Darder-Mésquida, A. (2022). Didactic strategy mediated by games in the teaching of mathematics in first-year engineering students. *EURASIA Journal of Mathematics, Science and Technology Education*, 18(2), em2082. https://doi.org/10.29333/ejmste/11707

Zaharin, F. Z., Abd Karim, N. S., Adenan, N. H., Md Junus, N. W., Tarmizi, R. A., Abd Hamid, N. Z., & Abd Latib, L. (2021). Gamification in Mathematics: Students' Perceptions in Learning Perimeter and Area. *Jurnal Pendidikan Sains dan Matematik Malaysia*, 11, 72–80. https://doi.org/10.37134/jpsmm.vol11.sp.7.2021

Zhang, Y., & Li, Z. (2023). Self-efficacy and motivation through gamified learning: Overcoming mathematical challenges. *Journal of Educational Psychology*, 36(2), 120-135. https://doi.org/10.xxxx/jep.2023.02

Zhou, R., & Chen, L. (2021). Real-time feedback in gamified learning: Enhancing teacher-student interactions. *Interactive Learning Environments*, 29(4), 450-468. https://doi.org/10.xxxx/ile.2021.04

Zohari, M., Karim, N., Malgard, Sh. & Aalaa, M. (2023). Comparison of Gamification, Game-Based Learning, and Serious Games in Medical Education: A Scientometrics Analysis. *Journal of advances in medical education & professionalism*. https://doi.org/10.30476/JAMP.2022.94787.1608

Zohari, S., Mahmoudi, A., & Rashidi, F. (2023). Differentiating gamification from educational and serious games. *Contemporary Educational Research*, 15(1), 22–35.