

Review Article

A Literature Review on Gamification as an Interactive Approach in Mathematics Learning for Elementary School Students

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ABSTRACT

Students' interest and involvement in mathematics learning, particularly at the elementary school level, is often low due to the nature of the material that is considered difficult and less interesting. The gamification approach, which integrates elements of play into learning, emerges as a potential strategy to increase students' motivation and understanding of mathematical concepts. This study aims to analyze the effectiveness of gamification in increasing learning interest and understanding of mathematics in elementary school students. This literature review was carried out by collecting, filtering, and analyzing various relevant previous research, using keywords such as "gamification", "elementary school mathematics learning", "student motivation", "educational technology", and "student collaboration". The results of the study show that the application of gamification in mathematics learning has a significant positive impact on student motivation and engagement, improves understanding of mathematical concepts, and facilitates collaborative skills. The implication of these findings is that educators should consider integrating technology-based gamification in the math curriculum, in order to create a learning experience that is more adaptive and relevant to students' needs.

Keywords: Gamification; Elementary School Mathematics Learning; Student Motivation; Educational Technology; Student Collaboration

1. INTRODUCTION

Interest in learning mathematics among elementary school students often faces obstacles, mainly due to the perception that mathematics is a difficult and boring subject. This lack of interest can lead to low academic achievement, as well as minimal student involvement in the learning process. To overcome these challenges, various innovative approaches have been applied in mathematics learning, one of which is gamification. Gamification, which is the application of elements of play into non-play contexts such as education, is now increasingly popular as a strategy to increase student motivation and engagement in learning (Syuhada, 2023; Tyaningsih et al., 2022). With gamification, learning that usually seems serious can be transformed into a fun, interactive, and interesting experience, so that it can attract students' interest in mathematics.

Gamification has the potential to facilitate a more dynamic learning experience. Research shows that gamification allows students to engage in the learning process more actively, through the use of game elements such as challenges, levels, rewards, and competitions. This can create a more engaging and interactive learning environment, helping students feel comfortable and motivated to participate more actively (Hidayah et al., 2022; Wijayanti, 2021). In addition to increasing interest in learning, gamification also provides a more enjoyable learning experience and reduces the level of anxiety that often arises in mathematics learning, so that students focus more on understanding concepts (Rincón-Flores et al., 2023).

In the application of gamification, various studies have shown a positive impact on mathematics learning outcomes. For example, a study that applied the ADDIE model in the development of gamification-based learning tools showed satisfactory results, with a high level of student satisfaction and an increase in learning interest of up to 3.30% (Syuhada, 2023; Permata & Kristanto, 2020). In addition, gamification also allows students to learn in a more competitive and interactive method, which encourages their curiosity and passion for learning. The use of educational game media such as Sudoku or game-based applications is an example of how gamification elements can make students better understand complex mathematical concepts in a more fun and easy-to-digest way (Tyaningsih et al., 2022; Binsasi et al., 2019; Erdriani et al., 2022). However, the success of gamification is highly dependent on effective design and implementation. Teachers have an important role to play in ensuring that the gamification elements used are in accordance with the learning objectives and the level of students' abilities. Therefore, it is important for teachers to have the right strategies and get training to be able to utilize gamification optimally. Research shows that the role of trained teachers in using gamification can help

students feel a significant increase in learning interest and motivation (Sirait, 2016; Hamdani & Nurdin, 2020; Zainuddin, 2023). In today's digital education era, gamification is not only relevant in face-to-face learning, but can also be applied in distance learning, where an interactive approach is urgently needed to keep students engaged (Rincón-Flores & Santos-Guevara, 2021).

Overall, gamification offers great opportunities in supporting mathematics learning at the elementary school level, especially in an effort to increase students' interest in learning. By providing a more enjoyable and interaction-oriented learning experience, gamification can help students overcome the obstacles they often face in understanding mathematical concepts that are considered difficult. This approach has been proven to be able to change students' perception of mathematics, from a challenging subject to an interesting activity that triggers curiosity. In the broader context of learning, gamification serves not only as a tool that increases motivation, but also as a means to create a learning environment that supports students' active participation. Research shows that students who engage in gamification-based learning show increased conceptual understanding and better problem-solving skills compared to students who learn through traditional methods (Nurtanto et al., 2021; Es-Sajjade & Paas, 2020). Students who are motivated and more engaged usually show higher academic achievement, both in terms of grades and in their ability to absorb learning materials (Kim & Castelli, 2021). Meta-analysis research reveals that gamification can also extend students' learning time and increase their engagement, which overall has a positive impact on their academic outcomes (Lee et al., 2023).

Not only in face-to-face learning, gamification has also shown its effectiveness in distance learning, especially during the COVID-19 pandemic, where student interaction and engagement have become more difficult to maintain. Research by Rincón-Flores and Santos-Guevara (2021) shows that the use of gamification strategies in online learning successfully maintains students' motivation to stay actively participating in class and completing their assignments. In addition, the competitive element in gamification is also effective in reducing students' anxiety about mathematics, which is often the main obstacle in the learning process (Rincón-Flores et al., 2023). In order for gamification to reach its maximum potential, it is important for teachers to plan and design gamification elements that are in accordance with the learning goals and abilities of students. Game elements such as challenges, levels, and rewards need to be adjusted so that students feel challenged without feeling overwhelmed. Professional training and development for teachers is also very important, so that they can integrate gamification in learning effectively and consistently. With adequate training, teachers can design gamification-based learning experiences that are not only relevant and engaging, but also contribute to the development of students' conceptual understanding of mathematics (Kamalodeen et al., 2021; Sailer & Sailer, 2020).

With the various potentials offered, gamification in mathematics learning in elementary schools is expected to function more than just a temporary approach to attract interest in learning. Through continuous implementation, gamification has the potential to be a long-term strategy that supports improving the quality of mathematics education. This approach can help address the challenges students face in understanding mathematical concepts, while encouraging their active involvement in the learning process. Therefore, this study is designed to examine the extent of the effectiveness of gamification in increasing students' interest and understanding of mathematics in elementary schools. By analyzing the results of previous research, it is hoped that the factors that support the successful implementation of gamification in mathematics learning and its implications in significantly increasing student motivation and learning outcomes in the digital education era can be identified.

2. RESEARCH METHODS

The research method in this study consists of a series of systematic stages to identify, analyze, and synthesize relevant research results regarding gamification in mathematics learning in elementary schools (Masfufah et al., 2019). The first stage is the selection of literature sources carried out through the application of inclusion and exclusion criteria, where the included articles must be published in peer-reviewed journals in the last 10 years, and contain a special focus on the application of gamification in mathematics learning at the elementary school level. Articles that do not meet these criteria, such as those that focus on topics that are irrelevant or not published in scientific journals, will be excluded from the review.

Literature is searched through various academic databases such as Google Scholar, Scopus, IEEE Xplore, and SpringerLink with specific keywords such as "gamification", "elementary school mathematics learning", "student motivation", "game elements in education", and "effectiveness of gamification" (Supriyadi, 2023; Lee et al., 2023). Once the relevant articles have been collected, additional selection is carried out by checking the abstract and keywords to ensure the desired topic matches. The next stage is a descriptive analysis of the selected articles, including an evaluation of the research methods, the population studied, and the main findings of each study. Furthermore, data synthesis was carried out with a thematic approach, which grouped studies based on key themes, such as the impact of gamification on student engagement, understanding of mathematical concepts, and the influence of game elements such as challenges and rewards in increasing the learning motivation of elementary school students (Alsadoon et al., 2022; Es-Sajjade & Paas, 2020). The quality of the articles is evaluated based on the transparency of the methodology and the validity of the data to ensure that only quality articles receive attention in the final analysis.

The results of this synthesis will be interpreted by considering gaps in the current literature as well as the potential practical application of gamification in mathematics learning. In addition, this study includes a discussion of limitations, such as limited access to articles or bias in article selection, in order to provide a clear context for the results of the study obtained. The final results of this literature review are expected to provide a comprehensive understanding of the effectiveness of gamification in mathematics learning, as well as provide recommendations for further research and practical contributions to elementary school mathematics education (Kamalodeen et al., 2021; Sailer & Sailer, 2020).

3. RESULTS AND DISCUSSION

Based on the results of the selection of several relevant previous studies that have met the rules of inclusion and exclusion, it can be reviewed on 7 relevant articles in [Table 1](#).

Table 1. Selection Results for Relevant Articles

Author(s) and Years	Article Titles	Research Results
Cunha et al., 2018	Evaluating the use of gamification in mathematics learning in primary school children	Gamification increases student motivation and engagement by using game elements.
Liu, 2023	Gamification in Primary School Mathematics Teaching	Gamification helps increase students' interest and understanding of mathematical concepts in the classroom.
Hu & Shang, 2018	Application of Gamification to Blended Learning in Elementary Math Instructional Design	Blended learning with gamification helps students understand mathematical concepts through visual elements.
Sanabria et al., 2019	EDUMAT: gamified web tool for teaching elementary operations in primary school	Gamification-based web applications increase students' interest and skills in basic mathematical operations.
Jagušt et al., 2017	Gamified Digital Math Lessons for Lower Primary School Students	Digital math lessons with gamification increase students' motivation and interest in mathematics.
Firdaus et al., 2023	Promoting Collaborative Learning in Elementary Mathematics through the Use of Gamification Flipbooks: A Mixed-Methods Study	Gamified flipbooks support collaborative learning and are well received by students.
Play, 2021	Demonstration of Gamification in Education for Understanding Artificial Intelligence Principles at Elementary School Level	Gamification promotes student interaction and aids in understanding basic AI concepts through collaboration.

Based on the 7 articles selected above ([Table 1](#)), the discussion can be explained in the 3 sub-sections below:

1. Student Motivation and Engagement in Mathematics Learning

The application of gamification in mathematics learning has a significant impact on student motivation and engagement. Research by Cunha et al. (2018) found that students experienced increased motivation and engagement when game elements, such as level achievement and reward icons, were integrated into the math classroom. This approach transforms the classroom into a more collaborative and fun environment, where students interact with each other and experience the learning process as a meaningful experience. Gamification creates a "world of play" in the classroom, which motivates students to engage emotionally and cognitively in math learning. This research is in line with the findings of Liu (2023) who highlighted that student motivation can be drastically increased by implementing gamification in mathematics classrooms. Liu also noted that traditional methods often lack consideration of individual differentiation, so some students find it difficult to connect with the material. In this context, gamification acts as a catalyst that adds value to learning through a more adaptive approach to students' needs, which ultimately increases their motivation and participation in mathematics learning.

2. Improving Understanding of Mathematical Concepts

Improving the understanding of mathematical concepts is one of the main results of the application of gamification in education. Liu (2023) points out that gamification can help students understand mathematical concepts better, as this approach allows students to interact directly with abstract concepts through engaging game elements. Liu's findings reveal that students who learn using gamification methods tend to understand the material better than those who learn with conventional methods. This method gives students the opportunity to solve mathematical problems in the context of games, thus making learning feel more relevant and applicable in daily life. Another study that supports these findings is a study by Hu and Shang (2018), which designed math lessons using blended learning methods combined with gamification. In this study, Hu and Shang found that blended learning supported by gamification elements not only retained students' attention, but also allowed students to make connections between the rules of the game and the mathematical concepts being taught. In this way, gamification provides a visual and contextual structure that favors the understanding of abstract concepts, which in turn helps students to better understand and remember the material.

3. Use of Web-Based Learning Tools for Basic Mathematics Operations

The use of web-based tools designed with gamification elements has proven to be effective in supporting basic mathematics learning. Sanabria et al. (2019) developed a web-based application to teach basic mathematical operations, such as addition, subtraction, multiplication, and division. The app is designed with a gamification approach to create a more interactive learning environment and support student engagement in learning. The results of the study show that this gamification-based application has succeeded in improving students' performance and interest in learning mathematics. Through the use of interactive interfaces, students can test their skills and knowledge in a fun context, which makes them more enthusiastic about participating in learning activities. Another similar study by Jagušć et al. (2017) in Croatia also found that the use of digital-based math lessons with gamification elements, such as games on tablets, significantly increased student engagement and motivation. The students who participated in this gamification-based lesson showed a higher interest in mathematics learning compared to students who learned through conventional approaches. This study underscores the importance of using gamification-based digital technology as an effective way to increase students' interest in learning basic mathematics.

4. Collaborative Learning in Mathematics with Gamification Flipbooks

Gamification also has the potential to facilitate collaborative learning in the classroom. Firdaus et al. (2023) conducted a study on the use of gamified digital flipbooks in mathematics lessons in elementary schools. This flipbook is designed to increase students' acceptance of learning technologies and to encourage them to engage in collaborative learning. Using the Technology Acceptance Model (TAM), the study found that students felt utility, ease of use, and positive intentions towards the use of gamified digital flipbooks. In addition, the interaction between students during the learning session shows that this method is effective in encouraging students to cooperate and discuss in solving math problems. Research by Choi (2021) also supports the use of gamification-based learning media to create a collaborative learning environment. In a study on the use of board games to teach basic concepts of artificial intelligence (AI), Choi found that gamification encourages interaction between students and helps them to better understand concepts through discussion and cooperation. Although this research is not specific to the context of mathematics, the principles applied are similar and show that gamification can enhance collaborative learning in a variety of disciplines.

4. CONCLUSION

Based on the above description, overall, the literature shows that gamification offers a variety of benefits in mathematics learning in elementary schools, ranging from increased student motivation and engagement to conceptual understanding and collaborative skills. Through the support of technology and an interactive approach, gamification allows students to learn math in a more fun and relevant way. The application of gamification in mathematics learning strategies in elementary schools provides positive results and has great potential for wider adoption. Based on these findings, educators are advised to consider integrating gamification elements in the mathematics curriculum, utilizing digital technology so that learning is more adaptive and in accordance with the individual needs of students.

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AUTHOR'S CONTRIBUTIONS

The authors discussed the research results and contributed from the beginning to the finalization of the manuscript.

CONFLICT OF INTEREST

No conflicts of interest related to this article have been declared by the authors.

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