

The Effectiveness of Game-Based Learning in Improving Elementary School Students' Numeracy Skills

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Abstract: The low numeracy skills of elementary school students and the need for more engaging and effective learning strategies are important reasons for conducting this research. The purpose of this study is to analyze the effectiveness of game-based learning in improving elementary school students' numeracy skills, to identify the types of games used, and to analyze the factors that influence its success. This study uses the Systematic Literature Review (SLR) method referring to the PRISMA guidelines. Data sources were obtained through Scispace and Elicit, which access the Google Scholar, DOAJ, and Scopus databases. The articles analyzed met the inclusion criteria, namely, published during the period 2016–2026, available in full text, in Indonesian or English, and discussing game-based learning and numeracy skills of elementary school students. The synthesis results indicate that game-based learning, whether through traditional or digital games, has been proven effective in improving arithmetic skills, understanding of mathematical concepts, mathematical reasoning, problem-solving abilities, and numeracy literacy. In addition, this approach can also enhance students' motivation, interest in learning, active participation, and self-confidence. Therefore, game-based learning can be implemented as an innovative strategy to improve students' numeracy skills in elementary schools in a more effective, engaging, and technologically appropriate manner.

Keywords: Game-Based Learning, Numeracy Skills, Learning Effectiveness

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A. INTRODUCTION

Numeracy skills are one of the essential abilities that students must possess in the 21st century. Numeracy is not only about the ability to perform arithmetic but also includes the use of mathematical concepts, procedures, facts, and tools to solve various problems encountered in daily life (Miftahul Jannah & Miftahul Hayati, 2024). In primary education, numeracy serves as a foundation for understanding science, technology, as well as developing critical thinking and problem-solving skills. Strengthening numeracy abilities from the elementary school level has become one of the main focuses in various educational policies, in order to prepare a generation capable of facing increasingly complex global challenges (Arodani et al., 2025).

Although numeracy skills are highly crucial, various educational assessments indicate that students still face a number of challenges in this area. Many students experience difficulties in understanding mathematical concepts deeply, relating these concepts to real-life situations, and solving problems that require thinking skills. Low numeracy skills can be influenced by several factors, such as monotonous teaching methods, lack of motivation in learning, limited use of engaging learning tools, and a tendency to focus more on memorizing procedures rather than understanding concepts. This situation highlights the importance of innovative efforts to improve the quality of numeracy learning at the primary school level (Hariyono et al., 2025).

In an effort to improve numeracy skills, educators need to create learning experiences that can actively engage students. Learning methods that focus solely on teacher instruction often make students passive, quickly bored, and less enthusiastic about learning mathematics. Conversely, a learning approach that provides opportunities for students to explore, interact, and construct their own understanding can enhance their participation in the learning process. It is necessary to implement learning strategies that not only emphasize achieving academic results but also create an enjoyable and meaningful learning environment so that students can more easily understand basic numeracy concepts (Algifari et al., 2025).

One approach that is increasingly used in numeracy learning is game-based learning. This method utilizes game elements as a tool to achieve learning objectives (Mulyani, 2023). By using games, students can learn in a more relaxed, engaging, and interactive atmosphere without diminishing the core content being taught. In addition to enhancing learning motivation, games also serve to help students hone logical thinking skills, strategies for problem-solving, cooperation, communication, as well as decision-making abilities. In the context of learning numbers, games can provide real experiences that help students understand mathematical concepts more easily and enjoyably (Amreta et al., 2025).

Various studies have revealed that learning using games has great potential to improve students' mathematical abilities. Both traditional and digital-based games have been used to help students understand various concepts such as numbers, mathematical operations, measurements, patterns, and problem-solving. Some research indicates an increase in learning motivation, active engagement, self-confidence, as well as students' learning outcomes after participating in this learning method. Existing results still vary concerning the type of game chosen, student characteristics, research design, and the magnitude of the impact generated. These differences indicate the need for more in-depth research to gain a comprehensive understanding of the effectiveness of this approach (Yulaichah et al., 2024).

Although the number of studies on game-based learning is increasing, most research is still conducted in different contexts and scales, resulting in findings scattered across various publications (Syamsijulianto et al., 2025). This situation makes it difficult for researchers, educators, and policymakers to obtain a comprehensive picture of how effective game-based learning is in enhancing numeracy skills. There are still few reviews that systematically identify the types of games that are most successful, the factors influencing the successful implementation of games in education, and the emerging research trends in this field. A Systematic Literature Review approach is needed to collect, evaluate, and organize various research findings in an orderly and objective manner (Hidayat, 2025).

Based on the explanation above, this study aims to conduct a Systematic Literature Review (SLR) of various scholarly works that discuss the effectiveness of game-based learning methods in improving students' arithmetic abilities in elementary schools. This review aims to identify the characteristics of the research that has been conducted, the types of games applied in arithmetic learning, the impact on students' calculation abilities, as well as the elements that support the successful implementation. This study is expected to provide a comprehensive overview of the research developments in this field and at the same time serve as a reference for teachers, researchers, and policymakers in designing more effective, creative, and student-centered arithmetic learning strategies in the modern era.

B. METHOD

This study employs a Systematic Literature Review (SLR) approach to identify, analyze, and synthesize various research findings related to the effectiveness of game-based learning in enhancing students' numeracy skills at the elementary school level. The SLR method was chosen because it allows the process of literature search and synthesis to be conducted systematically, transparently, and comprehensively. This aims to provide a deeper understanding of the effectiveness of game-based learning in the context of numeracy education. Through this approach, the study aims to identify research trends, patterns of findings, as well as factors that influence the success of game-based learning in improving elementary school students' numeracy skills.

The research data sources were obtained through the literature search platforms Scispace and Elicit, which access several scientific databases, namely Google Scholar, DOAJ, and Scopus, with a publication range from 2016 to 2026. The selection of these databases was based on the consideration that these sources provide scientific publications relevant to the fields of primary education, mathematics learning, numeracy, and game-based learning. The literature search process was conducted using several keywords in both Indonesian and English, including game-based learning, educational games, play-based learning, numeracy skills, mathematics learning, pembelajaran berbasis permainan, and kemampuan numerasi. These keywords were combined using Boolean operators (AND and OR) to obtain articles that match the research focus. The flow of the research stages is presented in Figure 1.

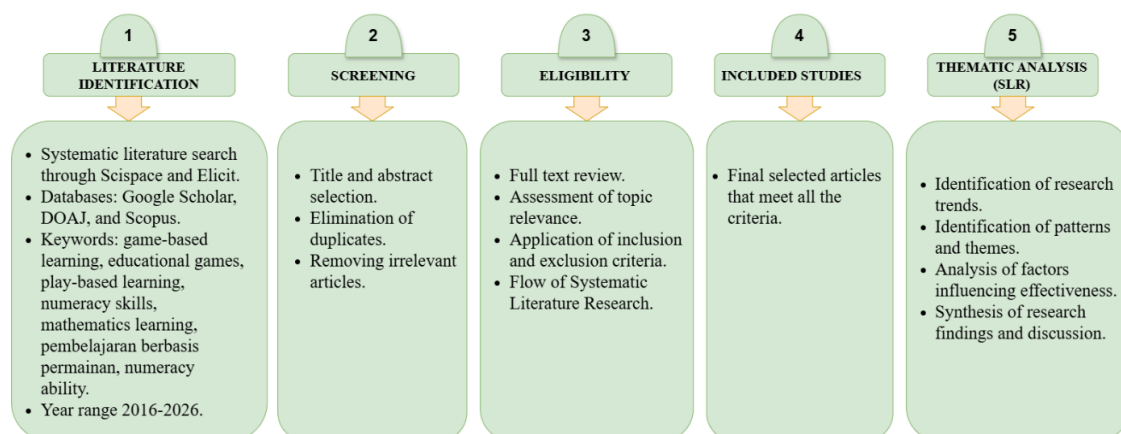


Figure 1. Research Flow of Systematic Literature Review (SLR)

Figure 1 illustrates the stages of the Systematic Literature Review (SLR) research, which include literature identification, screening, eligibility assessment, selection of included studies, and thematic analysis. The identification stage was conducted through searching for articles using Scispace and Elicit, which access the Google Scholar, DOAJ, and Scopus databases, with a publication range from 2016 to 2026. Subsequently, a screening process was carried out based on titles and abstracts to remove irrelevant and duplicate articles.

The inclusion criteria for this study include: (1) articles published during the period 2016–2026; (2) available in full text; (3) written in Indonesian or English; (4) published in national or international journals; and (5) discussing game-based learning and the numeracy skills of elementary school students. The exclusion criteria include articles published outside the research period, not available in full text, editorials, opinions, proceedings, or non-scientific documents, as well as articles that do not have a direct relevance to the research focus.

Literature selection was conducted through the stages of identification, screening, eligibility, and included studies, referring to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Articles that met all the criteria were then analyzed using thematic analysis techniques to identify research trends, patterns of findings, and factors influencing the effectiveness of game-based learning in improving elementary school students' numeracy skills. To maintain the validity and reliability of the research results, the entire selection and analysis process was carried out systematically based on predetermined criteria, ensuring that the research findings have a higher level of transparency and reproducibility.

C. RESULTS AND DISCUSSION

Based on the results of literature search and selection through the Systematic Literature Review (SLR) method, a number of articles were obtained that are relevant to the study of the effectiveness of game-based learning in improving the numeracy skills of elementary school students. These articles were subsequently analyzed and grouped according to similarities in field or research focus to support the process of systematic data synthesis. The classification results indicate six main research focuses for the period 2016–2026, namely: (1) the characteristics and forms of game-based learning; (2) the effectiveness of game-based learning in improving numeracy skills; (3) factors influencing the effectiveness of game-based learning; (4) the affective impact of game-based learning on students; (5) the role of teachers and student characteristics in game-based learning; and (6) the development and innovation of digital game-based learning. The grouping of these themes aims to identify research trends, analyze success factors, and explore opportunities for developing game-based learning to enhance elementary students' numeracy skills. The results of the literature synthesis that have been reviewed based on research focus, relevant authors, and main findings are presented in Table 1.

Table 1. Synthesis results from various studies based on research focus.

No	Field or focus	Names of authors in the same field	Insight or research variable
1	Characteristics of Game-Based Learning	Husein et al. (2015); Rosarian & Dirgantoro (2020)	Traditional and digital games create active, interactive, and enjoyable learning.
2	The Effectiveness of Game-Based Learning	Anggraeni et al. (2024); Nurhasanah (2025)	Enhancing numeracy skills, learning motivation, and student participation.
3	Factors Affecting Effectiveness	Priyani (2022); Noraffandy Yahaya & Nur Fazila i Salleh (2020)	Influenced by game design, teachers, media, and student characteristics.
4	Affective Impact of Game-Based Learning	Ali et al. (2025); Durisa et al. (2022); Latif et al. (2025)	Game-based learning enhances students' learning motivation, interest, self-confidence, and active participation during the learning process.
5	The Role of Teachers and the Characteristics of Students	Nurzannah (2022); Devi (2024); Ainiyah & Rohma (2025)	Teachers as facilitators determine the success of learning. Motivation, interest in learning, initial ability, and student involvement influence the improvement of numeracy skills.
6	Development and Innovation of Digital Game-Based Learning	Audia & Mastoah (2025); Tampubolon & Lubis (2025); Syamsijulianto et al. (2025)	The development of technology-based digital games, gamification, and interactive platforms provides a more adaptive, engaging, and relevant numeracy learning experience for students in the digital era.

Based on the results of the analysis of various reviewed studies, it was found that game-based learning in enhancing the numeracy skills of elementary school students can be grouped into three main aspects, namely the characteristics and types of games used, the effectiveness of game-based learning, and the factors influencing its success. In terms of characteristics, studies indicate that numeracy learning utilizes various types of games, such as traditional games, board games, educational cards, Android-based applications, and digital platforms like Wordwall, designed to create an interactive and enjoyable learning experience. Regarding effectiveness, most studies report that game-based learning is able to improve students' calculation skills, understanding of mathematical concepts, mathematical reasoning, problem-solving abilities, and numeracy literacy. The use of games has also been proven to enhance learning motivation, engagement, and active participation of students in the learning process. From the aspect of factors influencing effectiveness, research results indicate that the success of game-based learning is affected by the suitability of the type of game with the learning objectives, the teacher's ability to manage game activities, student characteristics, as well as the support of media and the learning environment. These findings suggest that game-based

learning is an effective strategy in improving the numeracy skills of elementary school students if it is designed and implemented appropriately according to the learning needs.

1. Characteristics and Forms of Game-Based Learning Used to Improve Elementary School Students' Numeracy Skills

Based on the synthesis of various studies, game-based learning used to enhance the numeracy skills of elementary school students takes diverse forms, ranging from traditional games, board games, educational cards, to technology-based digital games. Traditional games such as congklak are widely used because they help students understand number concepts, arithmetic operations, and place value concretely (Nur, 2025). In addition, math board games and educational cards are also frequently utilized to practice calculation skills and mathematical problem-solving through enjoyable and challenging activities (Ananda et al., 2024).

Along with technological developments, various studies have also shown an increase in the use of digital games in numeracy learning (Audia & Mastoah, 2025). Android-based educational game applications, the Wordwall platform, and various interactive digital media are used to create a more engaging learning experience that adapts to students' needs. Digital games are generally equipped with features such as immediate feedback, rewards, and challenges that can enhance students' engagement during the learning process. The main characteristics of all these forms of games are the presence of interaction, active participation, and opportunities for students to learn through direct experience (Rosarian & Dirgantoro, 2020).

The results of these studies indicate that there is a development in the form of game-based learning from the use of traditional games to more interactive and technology-based digital games. Traditional games are more often used to provide concrete learning experiences, whereas digital games emphasize interactivity, flexibility, and student engagement in the learning process. Nevertheless, various studies show that both forms of games share the same goal, which is to help students understand numeracy concepts more easily and enjoyably.

Based on these various findings, it can be concluded that game-based learning in numeracy education has diverse and flexible characteristics according to students' needs and technological developments. Both traditional and digital games share the same goal, which is to create an active, enjoyable, and meaningful learning experience, thereby helping students understand numeracy concepts more effectively compared to conventional learning.

2. The Effectiveness of Game-Based Learning in Improving the Numeracy Skills of Elementary School Students

The results of various studies indicate that game-based learning has a positive impact on improving the numeracy skills of elementary school students. The use of games in learning enables students to understand mathematical concepts more concretely through activities involving exploration, experimentation, and the completion of challenges related to numeracy (Nurhasanah, 2025). Various studies report improvements in counting

abilities, understanding of number concepts, and problem-solving skills after students participate in game-based learning (Anadia et al., 2025).

In addition to directly enhancing numeracy skills, game-based learning also affects students' affective aspects. Various studies indicate that the use of games can increase learning motivation, self-confidence, interest in mathematics, and active participation during the learning process (Ali et al., 2025). Students become more enthusiastic in participating in lessons because games create a non-monotonous learning environment and provide opportunities to learn while playing. This condition impacts the increased engagement of students in understanding the numeracy concepts being taught (Latif et al., 2025).

Research findings indicate a consensus that game-based learning consistently has a positive impact on the numeracy skills of elementary school students. However, there are differences in the focus of results obtained from each study. Some studies emphasize the improvement of cognitive abilities, such as counting skills, understanding of number concepts, and problem-solving skills, while other studies show that game-based learning also has a significant impact on students' affective aspects, such as learning motivation, interest in mathematics, self-confidence, and active engagement during the learning process. These differences indicate that the effectiveness of game-based learning is not only measured by the improvement in learning outcomes, but also by its ability to create an enjoyable, meaningful learning experience and to enhance overall student participation.

Based on the results of the research synthesis, it can be concluded that game-based learning is an effective strategy for improving the numeracy skills of elementary school students. This effectiveness is not only seen in the improvement of calculation abilities and understanding of mathematical concepts but also in the enhancement of learning motivation and student engagement in the learning process. Game-based learning can serve as a relevant alternative to support the development of numeracy skills in elementary schools.

3. Factors Affecting the Effectiveness of Game-Based Learning in Enhancing Elementary School Students' Numeracy Skills

Various studies indicate that the effectiveness of game-based learning is influenced by factors related to the design and selection of games. Games that align with learning objectives, students' developmental levels, and the numeracy material being taught tend to yield more optimal results (Priyani, 2022). The difficulty level of the game, clarity of the rules, and appropriateness of the media used also play a role in determining the success of learning. Games that are too easy or too difficult can reduce learning effectiveness because they fail to provide suitable challenges for students (Rohma, 2025)

Another equally important factor is the role of teachers and the characteristics of students in the learning process. Teachers act as facilitators who guide game

activities to remain focused on numeracy learning objectives. Teachers' ability to manage the classroom, provide instructions, and motivate students significantly influences the success of implementing game-based learning. Students' learning motivation, interest, initial abilities, and level of engagement during the games also become determining factors in the improvement of numeracy skills achieved (Devi, 2024).

Research results show that the effectiveness of game-based learning is determined not only by the type of games used but also influenced by various interrelated factors. Some studies emphasize that an engaging game design, an appropriate level of difficulty, and suitable media are key factors in enhancing students' numeracy skills. However, other studies indicate that the teacher's role as a facilitator, the teacher's ability to manage learning, as well as student characteristics such as motivation, learning interest, and active involvement, have an equally important impact on learning success. Therefore, the success of game-based learning is the result of a synergy between the quality of the games, teacher competence, and students' readiness to participate in the learning process.

Based on these various research findings, it can be concluded that the effectiveness of game-based learning is influenced by a combination of interrelated factors, both originating from the games themselves and from the teachers and students involved in the learning process. The suitability of game design, teacher competence in managing learning, as well as student motivation and active participation are the main factors determining the success of game-based learning in enhancing the numeracy skills of elementary school students. The synthesis of literature findings regarding the effectiveness of game-based learning in improving the numeracy skills of elementary school students is presented in Figure 2.

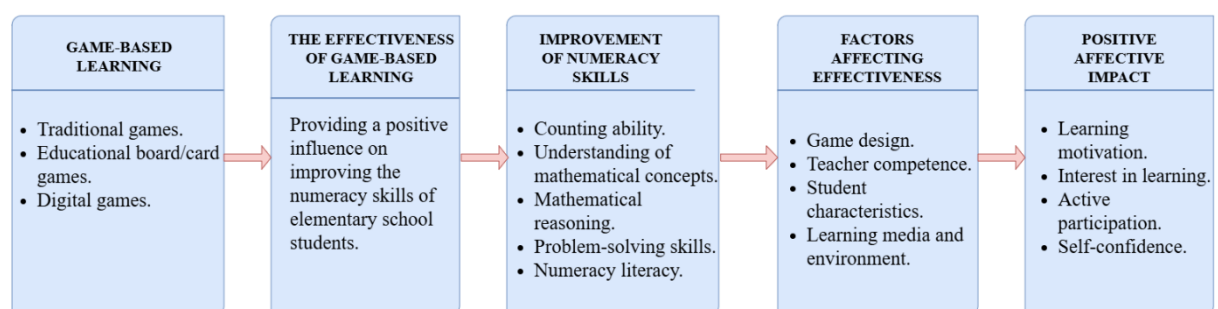


Figure 2. Framework of Game-Based Learning Effectiveness in Enhancing Elementary School Students' Numeracy Skills.

Figure 2 illustrates the relationship between game-based learning and the enhancement of numeracy skills in elementary school students. Game-based learning, which includes traditional games, educational board/card games, and digital games, has a

positive impact on the effectiveness of learning. This effectiveness contributes to the improvement of students' numeracy skills, such as counting ability, understanding of mathematical concepts, mathematical reasoning, problem-solving skills, and numeracy literacy. The success of learning is influenced by various factors, including game design, teacher competence, student characteristics, as well as learning media and environment. In addition, game-based learning also provides positive affective impacts in the form of increased learning motivation, interest in learning, active participation, and students' self-confidence.

D. CONCLUSIONS AND SUGGESTIONS

Based on the results of the literature review that has been conducted, game-based learning has been proven effective in improving the numeracy skills of elementary school students. Various forms of games, both traditional and digital, are capable of enhancing calculation abilities, understanding of mathematical concepts, mathematical reasoning, problem-solving skills, as well as students' numeracy literacy. Game-based learning also contributes positively to increasing learning motivation, interest in learning, active participation, and students' self-confidence during the learning process. The effectiveness of game-based learning is influenced by various factors, including the quality of game design, the teacher's competence in managing learning, student characteristics, as well as the support of media and the learning environment. The implementation of game-based learning needs to be systematically designed and adapted to the needs and characteristics of students in order to achieve optimal results. Future research should be directed towards the development of more adaptive digital game-based learning, the application of gamification in numeracy learning, as well as testing the long-term effectiveness of game-based learning to support the sustainable improvement of students' numeracy skills.

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