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Effectiveness of Using Ludo Game-Based Learning Media to Improve Understanding of Spatial Building Concepts in Elementary School Students: Literature Review

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ABSTRACT

Understanding the concept of spatial structures is a significant challenge in elementary school mathematics education due to its abstract nature. This study aims to evaluate the effectiveness of Ludo game-based learning media in enhancing students' understanding of spatial concepts. This research uses a literature review method to analyze various previous studies using game-based media to teach spatial concepts. The findings indicate that Ludo games significantly improve students' cognitive understanding by visualizing abstract concepts more concretely, fostering active and interactive learning, and reinforcing concepts through repetition. Additionally, this medium enhances students' learning motivation and spatial skills. However, its implementation faces challenges, such as diverse student abilities, limited classroom time, and the need for teacher training to integrate the games into the curriculum. These findings highlight the substantial potential of Ludo games in addressing difficulties in mathematics education, particularly in understanding spatial concepts. This study recommends integrating game-based media into teaching strategies to create a more engaging and effective learning environment.

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1. INTRODUCTION

Understanding building space is essential to primary education, especially in developing students' spatial abilities. Spatial skills, including understanding shapes, sizes, and relationships between objects in space, are crucial in improving students' logical and mathematical thinking skills. Research shows that a good understanding of building space can help students develop the critical and analytical thinking skills necessary to solve mathematical problems [1], [2].

In the context of learning, the use of a suitable learning model, such as the Dick and Carey model, can increase students' understanding of the concept of building space. This model emphasizes the achievement of specific learning objectives and evaluating learning outcomes so that teachers can design more effective learning [2]. In addition, the application of technology in learning, such as using Wingeom software, has also been proven to improve students' understanding of mathematical concepts, especially in geometry and space-building materials [1]. This shows that integrating technology into learning can strengthen students' understanding of complex mathematical concepts. Furthermore, the study also showed that spatial ability was closely related to students' mathematical communication skills. Students with good spatial abilities tend to relate mathematical concepts to real-life situations better, improving their problem-solving ability [3]. Therefore, educators must integrate space-building learning with encouraging students to think critically and creatively and connect mathematical concepts to everyday life [4], [5]. In order to achieve national education goals, the understanding of building space contributes to the mastery of mathematics material and the development of students' character, including curiosity, interest, and tenacity in learning [4]. Thus, primary education should specialize in teaching building space as an essential foundation for developing students' logical and mathematical thinking skills. One of them can be done through game-based learning.

Game-Based Learning (GBL) is an innovative educational approach that utilizes play elements to increase student engagement and understanding in various subject areas. GBL creates a fun learning atmosphere and encourages students to participate actively in the learning process. Research shows that GBL can increase students' intrinsic motivation, an essential factor in learning success [6].

A critical aspect of GBL is its ability to simplify complex materials. For example, in biology learning, collaboration between games and biology materials can help students understand complex concepts more interactively and engagingly [7]. In addition, GBL has also been shown to be effective in improving the understanding of mathematical concepts. A study shows that game-based learning media can significantly improve students' understanding of mathematical concepts, although its implementation has several challenges [8]. This shows that GBL can effectively overcome students' difficulties in understanding the subject matter.

In addition, GBL also contributes to the development of students' critical and creative thinking skills. In math learning, for example, students who engage in games designed to support the understanding of mathematical concepts significantly improve their ability to solve problems [9]. This approach improves academic understanding and prepares students to face real-world challenges better.

The importance of GBL is also seen in the context of online learning. During the COVID-19 pandemic, many schools switched to online learning, and the use of games in online learning has proven effective in keeping students interested and engaged [10]. Research shows that students who learn through digital game platforms better understand the material taught than traditional learning methods [11].

Conventional learning methods often face various challenges that make it difficult for students to understand the concept of building space. One of the main problems is an

overly teacher-centric approach, where students only receive information without active involvement in the learning process. This can cause students to feel bored and less interested in the material being taught, hindering their understanding of complex concepts such as waking up in a space Ayuningrum et al. [12]. In addition, the lack of supporting props or visual media is also a factor causing students' difficulties in imagining and understanding three-dimensional shapes [13].

Research shows that students often have difficulty mentally imagining the object of building space, which can result in errors in understanding the properties and formulas associated with building that space [14]. Conventional learning methods that rely on two-dimensional drawings in textbooks are not enough to help students develop a deep understanding of the shape and size of a space. Therefore, a more interactive and engaging approach is needed to improve students' understanding [14], [15]. One of the games that can be used in learning is the traditional game Ludo.

The Ludo game was chosen as a learning medium for several reasons that support its effectiveness in improving students' understanding, especially in learning the concept of building space. First, the simplicity of Ludo's game rules allows students to quickly understand how to play without taking a long time to learn. These simple rules can be easily modified for educational purposes, such as adding questions or challenges related to building a space during the game. This allows educators to adapt the game to the material being taught.

Second, as a board-based game, Ludo has interactive elements that can increase student engagement. Student engagement is essential in learning to ensure they listen and actively participate in the learning process. Research shows that games that involve social interaction, such as Ludo, can increase students' motivation and interest in learning. When students play Ludo, they learn about building space and practice social skills, such as cooperation and communication, which are very important in an educational context.

In addition, Ludo games can also be used to teach strategy and problem-solving. Students must think critically to determine the best moves in the game, which can be applied in the context of mathematical problem solving, including in understanding the building of space. Thus, Ludo not only serves as a tool to teach concepts but also as a means to develop higher-level thinking skills.

The primary purpose of this literature review is to explore the effectiveness of Ludo game-based learning media in improving the understanding of the concept of building space in elementary school students. Ludo, as a simple and interactive game, offers an exciting way to teach mathematical concepts that students often find difficult. By utilizing the element of play, it is hoped that students can be more actively involved in the learning process, which in turn can increase their motivation and understanding of the building materials of the space [16], [17].

In addition, the secondary objective of this review is to evaluate the extent to which game-based learning has been applied in the context of spatial concept education. Game-based learning, including Ludo, is efficacious in improving students' spatial skills, which is essential in understanding space building [16], [18]. This review aims to identify best practices and challenges in applying game-based learning media in educational settings by

evaluating various existing research. In this context, the literature review will also discuss how the Ludo game can be modified to meet specific learning needs, such as adding elements of questions or challenges related to building space. It is essential to point out that game-based learning media is not just a means of entertainment but can also effectively achieve educational goals [19].

The significance of this research lies in its contribution to the development of innovative learning methods, especially in the context of using Ludo games as a learning medium to improve the understanding of the concept of building space in elementary school students. The results of this literature review can provide a solid basis for further research by identifying the effectiveness of play in educational contexts and providing insights into how game elements can be integrated into the curriculum to achieve better learning goals.

By exploring the effectiveness of game-based learning media, this research can also guide educators in applying innovative learning methods in the classroom. Educators can use the findings from this review to design more interactive and engaging learning activities, improving students' understanding of the concept of building space and increasing their motivation and engagement in the learning process. For example, by modifying the Ludo game to include questions or challenges related to building space, educators can create a more contextual and relevant learning experience for students.

In addition, this review can also help evaluate the extent to which game-based learning has been applied in the context of spatial concept education. By identifying best practices and challenges faced in implementing game-based learning media, this research can provide valuable recommendations for developing curriculum and teaching strategies in the future. It is essential to ensure that the learning methods used are practical and follow the needs and characteristics of students.

2. METHOD

This study uses the literature review method to identify and analyze the effectiveness of game-based learning media, especially Ludo, in improving the understanding of the concept of building space in elementary school students. The literature review was chosen because this approach allows researchers to filter, assess, and integrate findings from various studies that have been conducted before [20].

Literature Selection Criteria

The literature selection process is carried out by considering several criteria. Inclusion criteria include research that focuses on:

1. Game-based learning in the context of primary education, especially those exploring games' role in improving understanding of spatial concepts.
2. The use of Ludo or board-based games in the learning process.
   a. A study examines spatial understanding and the concept of building space in elementary school students.
   b. Articles published in peer-reviewed journals and indexed in leading databases, such as Scopus, Sinta, and other academic sources.

The exclusion criteria include research irrelevant to spatial learning or focused on board-based games as a learning medium.

Data Source

Literature data was collected from several scientific journal databases, including Google Scholar, ScienceDirect, ProQuest, and JSTOR. The search was conducted using relevant keywords, such as "Ludo game-based learning," "teaching spatial concepts," and "elementary school education." Researchers also limited the period of article publication in the last ten years (2013-2023) to ensure that the literature used reflects the latest findings.

Data Collection Procedure

The literature search begins by identifying relevant articles through a systematic search process. Articles that meet the inclusion criteria are further filtered to ensure their suitability for the research topic. The search results include studies that focus on using games as learning aids, with particular attention to the use of Ludo in learning the concept of building space.

Data Analysis Process

Data analysis was carried out using a narrative synthesis approach, where the findings from various studies were analyzed thematically to identify patterns, general outcomes, and influential variables in the use of board-based game media for learning. The collected articles were analyzed to assess the effectiveness of games in improving students' spatial skills and the role of games in increasing motivation and understanding of the concept of building space.

Validity and Limitations

Only articles from indexed journals that have undergone a peer-review process are included in this review to maintain validity. However, the limitations of this review literature include the limited number of studies that specifically examine the use of Ludo in learning, so that some literature that uses similar games is also considered a comparative reference.

3. RESULTS AND DISCUSSION

Ludo game-based media affects students' cognitive understanding in learning spatial structures, depending on the problem formulation, research objectives, and results. Ludo games are a medium adjusted to the developmental stage of elementary school students entering the concrete operational stage. Teaching abstract concepts concretely makes it easier for today's children to understand them.

Mathematical concepts are inherently abstract, which can pose significant challenges for students in understanding and applying these concepts in real-world contexts. To facilitate this understanding, it is essential to utilize media that can help students translate abstract mathematical ideas into tangible, relatable experiences. Game-based learning, mainly through interactive games like Ludo, has shown promise in bridging this gap.

One of the key advantages of using games like Ludo in mathematics education is their ability to create an engaging and interactive learning environment. Games inherently motivate students by providing a fun and competitive atmosphere, which can enhance their willingness to participate in learning activities. For instance, research has indicated that educational games can improve learning outcomes by making abstract concepts more accessible and enjoyable [16]. The interactive nature of games allows students to experiment with mathematical ideas in a low-stakes setting, where they can make mistakes and learn from them without the pressure of traditional assessments.

Moreover, games can be designed to incorporate specific mathematical concepts, allowing for targeted learning experiences. For example, a modified version of Ludo can include questions or challenges related to geometric shapes and properties, enabling students to apply their knowledge in a practical context [16]. This approach not only reinforces their understanding of the material but also helps them see the relevance of mathematics in everyday life.

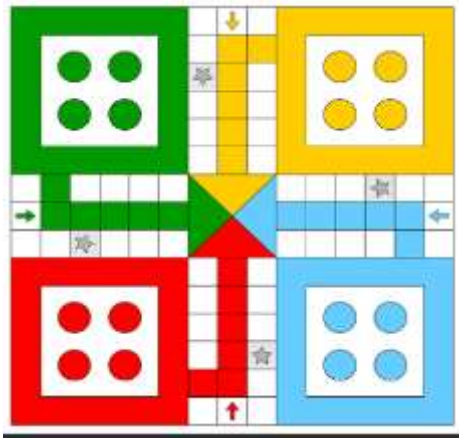

Figure 1. Ludo learning media based on spatial figures

Ludo media is a game-based media format for children. Therefore, it is inseparable from children's activities, such as games, and is suitable for learning. This follows the statement that games adapted from children's games have become learning media relevant to learning in schools and are one type of media that can be used as a container to involve students in learning.

The media developed by researchers have specific rules compared to Ludo, which was previously developed by Jannah and Wiyatmo [21]. The Ludo they developed, the ludo game can calculate the addition or subtraction in the dice roll against the game in progress, or students can find out what kind of spatial shape in the dice game they get, in the researchers did not explain the rules of the game in detail. They only use students who understand how to play Ludo to explain to their friends who do not know how to play Ludo so that the Ludo game will be effective in its game.

Ludo games were chosen as a learning media because of the researcher's interest. This is because previous research shows that Monopoly is more suitable for planar materials, while Snakes and Ladders are more suitable for use on materials with a number concept.

This game requires you to develop strategies you will not find in other games, such as Snakes and Ladders. Monopoly media was chosen because of the need for spatial material, allowing students to develop their imagination using Ludo media. The findings of previous research on the ludo game can be seen in Table 1.

Table 1. Research related to the Ludo game

Author and Year	Journal Name	Research result
Kamin et al. [22]	*Journal of Instructional Development Research*	Ludo games can improve mathematical skills in spatial geometry material.
Azizah & Fitrianawati [23]	WASIS: Scientific Journal of Education	The study showed that the Ludo game media effectively improved learning on simple fraction material.
Izzaty et al. [24]	Buana Pendidikan: Journal of the Faculty of Teacher Training and Education	The study results showed that the Ludo game media effectively improved learning on subtraction operations material.
Mawarni et al. [25]	*Indonesian Journal of Elementary Education (IJOEE)*	Ludo games can improve mathematical skills in geometry material.

Based on table 1 shows that the ludo game media is widely used to overcome learning problems in mathematics subjects. Ludo games can teach material through abstract concepts concretely [21], [22], [23], [24], [25]. The use of Ludo game-based media in learning spatial geometry among elementary school students significantly impacts their cognitive understanding. However, several limitations and challenges need to be considered to get a more comprehensive picture of the effectiveness of this media. The limitations in using Ludo include:

1. Learning Context: Ludo, while attractive, may not be suitable for all learning contexts. Students with different backgrounds in understanding mathematics may struggle with the adapted rules of the game. If students are unfamiliar with how to play or do not have adequate basic skills, they may not be able to get the most out of the medium.
2. Learning Focus: This medium can risk distracting students from the main learning objectives. Games can become too focused on the competitive aspect and de-emphasize the more profound understanding of mathematical concepts.
3. Time Constraints: In a time-constrained classroom setting, using games may require more time for preparation and implementation than conventional teaching methods. This can be challenging for teachers who must complete the curriculum within a specific time.

However, the Effectiveness of Using Ludo Game-Based Learning Media to Improve Understanding of the Concept of Spatial Building in Elementary School Students Has Challenges and Unexpected Results:

1. Diversity of Student Abilities: In a heterogeneous class, not all students may benefit equally from this learning medium. Students who are quicker to grasp concepts may dominate the game, while slower students may feel left out.
2. Lack of Teacher Knowledge: The success of implementing Ludo in learning depends on how well teachers understand how to use this media. If teachers are not well trained, learning outcomes can be suboptimal.
3. Evaluation and Feedback: While Ludo offers quick feedback, assessing students' conceptual understanding may not always be accurate. Assessments that rely too heavily on game outcomes may give a misleading picture of students' understanding.

Comparison with Similar Studies Previous studies have shown that Ludo effectively improves students' understanding of various aspects of mathematics, including spatial figures [22], [25]. However, comparison with similar studies shows that the results can vary. For example, in a study by Puspitasari et al. [26], students' engagement levels in other board-based games, such as Monopoly, showed more significant results in a geometric context despite increased understanding. Although Ludo has many advantages, no single medium can be considered universal for all students or contexts.

In this context, it is essential to conduct further research comparing the effectiveness of Ludo with other game-based learning media. Such research can provide deeper insights into when and how Ludo is most effectively used and how to adapt this media's use to the student's needs.

By considering the limitations and challenges and comparing the results with other studies, a better understanding of the effectiveness of using Ludo as a learning medium in geometric geometry is expected. This critical approach is essential for developing more effective and inclusive learning strategies.

By teaching abstract concepts concretely, children will find it easier to understand them. Mathematical concepts are abstract, so using mathematics in learning is easier to manage. Media is needed to help students change abstract concepts into tangible ideas. Because mathematics is abstract, students need resources such as learning media to help them understand abstract mathematical information.

Previous research results, as presented by Kamin et al. [22], Azizah and Fitrianawati [23], and Mawarni et al. [25], show that Ludo game media is efficacious in improving mathematical skills in geometry and simple fractions. These findings support our hypothesis that Ludo can be modified to explain the concept of spatial shapes, such as cubes, blocks, and other geometric shapes. This study continues and expands on existing understanding, showing how Ludo games can help students visualize and understand more complex concepts.

3.1. Geometry Learning Draft

The geometry of solid shapes is an essential branch of mathematics that studies the shape, size, and relative position of an object and the properties of space. In the context of primary and secondary education in Indonesia, learning about solid shapes is a crucial

component of the mathematics curriculum. According to Suwito et al. [27], learning geometric shapes aims to understand abstract concepts and develop students' visual-spatial abilities, which are necessary in various areas of life.

Basic concepts in studying geometric shapes include:

1. Introduction to geometric shapes such as cubes, cuboids, prisms, pyramids, cylinders, cones, and spheres.
2. Properties of geometric shapes include the number of sides, edges, and corner points.
3. Space builder network.
4. Surface area and volume of geometric shapes.
5. Relationship between spatial structures.

Maharani et al. [28] emphasized that a strong understanding of the geometric concepts of geometric shapes can help students solve more complex mathematical problems and apply them in everyday life. Therefore, educators need to design effective and meaningful learning.

In its implementation, learning spatial geometry in Indonesia often faces challenges. According to research conducted by Puspitasari et al. [29], One of the main difficulties students face in understanding the concept of spatial geometry is low visualization and abstraction skills. An innovative learning approach and appropriate learning media are needed to overcome this.

One approach that is considered adequate is problem-based learning (PBL). Widodo et al. [30] stated that applying PBL in learning spatial figures can improve students' problem-solving and mathematical reasoning abilities. In addition, the use of technology and interactive learning media is also considered to be able to help students visualize abstract concepts in geometric forms.

Integrating augmented reality (AR) in educational settings, particularly spatial geometry, has shown significant potential in enhancing students' conceptual understanding and interest in learning. AR bridges the physical and virtual worlds, allowing students to visualize complex geometric concepts more interactively and engagingly. For instance, AR applications can project three-dimensional models of geometric shapes, enabling learners to manipulate and explore these structures in real time, which fosters a more profound comprehension of spatial relationships and properties [31], [32]. This immersive experience not only aids in conceptual clarity but also stimulates students' curiosity and motivation to learn as they interact with the content dynamically [33], [34].

Moreover, the pedagogical advantages of AR extend beyond mere visualization; they also encompass the enhancement of learning engagement. Research indicates that AR can transform traditional learning environments into interactive spaces where students are more actively involved in their learning processes [32], [34]. This active participation is crucial for subjects like spatial geometry, where abstract concepts often lead to disengagement. By utilizing AR, educators can create a more stimulating learning atmosphere that captures students' interests and encourages exploration and experimentation with geometric concepts [35], [36]. Furthermore, studies have demonstrated that AR-based learning tools can improve academic performance, as students can grasp complex ideas more effectively through interactive learning experiences [33], [37].

3.2. The benefits of using spatial learning media using the Ludo game

Integrating spatial learning media, mainly through games like Ludo, offers numerous benefits in enhancing spatial skills among learners. Spatial learning media are designed to improve the ability to visualize and manipulate objects in space, which is crucial for various academic and real-world applications. Research indicates that game-based learning can significantly enhance spatial reasoning and cognitive skills. For instance, Merabet et al. emphasize the importance of contextual learning through gameplay, suggesting that such interactive experiences can facilitate the learning process by adapting to individual challenges and needs [38]. This adaptability is particularly beneficial in educational settings with diverse learning styles.

Moreover, the effectiveness of video games in improving spatial skills has been substantiated by meta-analyses, which highlight the malleability of these skills through targeted training. Uttal et al. found that playing action-oriented video games, often requiring spatial awareness and mental rotation, can significantly improve spatial abilities [39]. This finding aligns with the notion that games like Ludo, which involve strategic movement and planning, can similarly enhance spatial reasoning. The interactive nature of such games encourages players to visualize movements and outcomes, reinforcing their spatial understanding.

In addition to enhancing spatial skills, using games in educational contexts can also improve overall learning outcomes. Khairani et al. noted that instructional media, including games, can effectively boost students' spatial abilities in mathematics education [40]. This is particularly relevant for games like Ludo, which can be adapted to teach mathematical concepts such as counting, probability, and strategy. Incorporating educational content into gameplay makes learners more likely to engage with the material and retain information, thus improving their academic performance.

Furthermore, traditional games have been shown to facilitate understanding geometric concepts, as highlighted by Yumiati's research on the Baju Simi game [41]. This suggests that the principles underlying Ludo can similarly be applied to teach spatial concepts in a fun and engaging manner. The combination of play and learning enhances motivation and allows for the practical application of theoretical knowledge, making the learning experience more meaningful.

Finally, the role of spatial learning media in fostering motivation and engagement cannot be overlooked. Sari's study on 3D learning media indicates that interactive tools can significantly enhance spatial thinking abilities among students [42]. The enjoyment derived from playing games like Ludo can lead to increased participation and a positive attitude toward learning, which is essential for effective education. By creating an enjoyable learning environment, educators can harness the benefits of spatial learning media to cultivate essential skills in students.

7. CONCLUSION

The use of Ludo game-based learning media has been proven to have a positive impact on improving students' cognitive understanding, especially in spatial geometry material. Based on various studies, the Ludo game has succeeded in helping students

understand abstract concepts more concretely, thus encouraging their interest and motivation to learn. These findings indicate that an interactive and fun learning approach can overcome students' difficulties understanding complex geometric concepts. The main benefits of using Ludo media in learning include increasing interest and motivation, strengthening conceptual understanding, and developing spatial skills. Practical implications for teachers and education policymakers are the need to integrate game-based learning media into the curriculum, especially for elementary education. This can be done through training for teachers to design and implement innovative and interactive learning methods. In addition, policies that support the use of technology and exciting learning media are needed to create a conducive learning environment. For future research, several potential areas can be explored, including comparison of learning methods, use of modern technology, and differentiation of learning.

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