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Innovation in Numeracy Literacy through Educational Board Games: An Innovation in Elementary Mathematics Learning

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ABSTRACT

This research investigates the use of educational board games as an innovative approach to improve numeracy literacy learning in elementary schools. The problem addressed in this study is the low level of numeracy skills and limited motivation among students in learning mathematics. The objective is to evaluate the effectiveness of integrating board games into classroom instruction to enhance both academic and socio-emotional outcomes. The study employed a qualitative-descriptive design with classroom implementation. Data were collected through observations, student performance assessments, and teacher feedback to analyze the impact of board game based learning. The results show that students demonstrated notable improvements in numeracy skills, including counting, arithmetic operations, and problem-solving. Moreover, the use of board games increased motivation, participation, and positive attitudes toward mathematics. Collaborative play further supported the development of social interaction and problem-solving abilities, enriching the overall learning process. In conclusion, educational board games are an effective and engaging method for enhancing numeracy literacy while fostering student motivation and collaborative skills. This research highlights their potential as a sustainable innovation in elementary education, contributing to both academic success and holistic student development.

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1. INTRODUCTION

Numeracy literacy is one of the fundamental competencies that students must master in elementary school, as it serves as the basis for logical thinking, problem-solving, and lifelong learning(Tsatsaroni & Evans, 2014). In the context of the 21st century, numeracy is no longer limited to the ability to perform calculations, but also includes the capacity to apply mathematical concepts in real-life situations, make reasoned decisions, and interpret numerical information critically. Strengthening numeracy literacy from an early age is therefore essential to prepare students to face increasingly complex academic and everyday challenges.

However, in practice, numeracy learning in elementary schools often faces several obstacles. Conventional teaching methods tend to emphasize rote learning and mechanical exercises, which can reduce students' interest and engagement(Hopper & Brake, 2018). Many students perceive

mathematics as abstract, difficult, and intimidating, which negatively affects their motivation and achievement. This situation indicates the need for innovative learning approaches that not only improve students' understanding of mathematical concepts but also make the learning process more engaging and meaningful.

One promising innovation is the integration of educational board games into numeracy literacy learning. Board games provide an interactive, enjoyable, and collaborative learning experience that can transform abstract mathematical concepts into concrete and relatable activities(Smith, 2020). Through play, students are encouraged to practice counting, strategizing, problem-solving, and logical reasoning in a natural and engaging way. Furthermore, board games foster active participation, peer collaboration, and positive emotional engagement, which are crucial in shaping students' attitudes toward learning.

Several studies have shown that game-based learning has the potential to improve both academic performance and soft skills such as communication, cooperation, and critical thinking(Kailani et al., 2019). In the context of elementary education, educational board games can act as a bridge between formal instruction and experiential learning, making numeracy literacy more accessible and enjoyable. By aligning game design with curriculum objectives, teachers can create meaningful learning experiences that promote deeper understanding and sustained motivation.

Over the past decade, a growing body of literature has explored how board games can bolster numeracy skills among elementary-aged learners. One foundational study by Ramani, Siegler, and Hitti (2012) investigated the use of a theoretically designed number board game in small-group settings at Head Start. They found that playing this game significantly improved low-income children's number line estimation, magnitude comparison, numeral identification, and counting abilities. This early work highlights the beneficial impact of well-structured game-based activities on foundational numeracy concepts.

Building on these insights, Andika et al. (2019) examined how playing board games interacts with children's mathematical self-concept i.e., their belief in their own math ability to support early numeracy in 5- to 6-year-olds. Their quasi-experimental design revealed that linear board games were more effective than circular ones in improving early numeracy, particularly when matched to children's self-concept profiles

Sriwijaya University Repository. The study underscores the cognitive and affective synergy involved in educational play.

In the context of elementary schools in Indonesia, Putra, Pamungkas, Nindiasari, Fathurrohman, and Porter (2024) evaluated "Labirin: The Board Game" through a one-group pretest-posttest design with grade-8 students. Their findings indicated significant improvement in numeracy ability post-intervention, and students responded positively to the game's role in making math learning more engaging

UMS Journals. This study illustrates how locally tailored board game designs can enhance student engagement and numeracy outcomes.

In a broader quantitative investigation, Barekat (2023) conducted a study with fourth-grade students in Karaj, Iran, comparing traditional instruction with a board game based method. Results showed that students engaged through board-game learning achieved higher academic performance (mean score ~16.53 versus ~12.23) and demonstrated greater learning motivation compared to the control group. These findings reinforce the efficacy of board games for both cognitive (achievement) and affective (motivation) domains.

Beyond individual studies, several systematic reviews capture emerging patterns in math game research. For instance, Vankúš (2021) conducted a systematic review focusing on the influence of game-based learning in mathematics on students' affective domains. He concluded that games can substantially impact learners' attitudes, engagement, and motivation toward mathematics

Recent research highlights the potential of game-based learning in improving academic outcomes and fostering positive attitudes toward learning. In mathematics education specifically, board games have been shown to help students better grasp numerical concepts, improve retention,

and increase engagement compared to traditional methods. However, the implementation of educational board games in elementary school classrooms is still relatively limited, particularly in the context of structured numeracy literacy development. Therefore, exploring the design, application, and impact of educational board games as an innovative approach to numeracy literacy learning is both timely and relevant.

This research seeks to investigate how educational board games can serve as a medium of innovation in teaching numeracy literacy in elementary schools. By integrating play with learning, the study aims to provide insights into how such games can improve students' mathematical understanding, foster engagement, and contribute to the creation of more effective and enjoyable learning environments.

2. RESEARCH METHOD

This research employs a quasi-experimental approach with a one-group pretest posttest design to investigate the effectiveness of educational board games in enhancing numeracy literacy among elementary school students(Briones, 2016). This design was chosen because it allows the researcher to measure changes in students' numeracy skills before and after the intervention, thereby providing insights into the potential impact of the educational board game while maintaining practicality within the school context.

The participants of the study consist of elementary school students in grades four and five, selected through purposive sampling based on teacher recommendations and school readiness to adopt innovative learning strategies(Aldhafeeri & Khan, 2016). The sample size is determined to ensure sufficient representation for statistical analysis, with considerations given to gender balance and academic ability levels. Prior to participation, permission is sought from the school administration and informed consent is obtained from parents or guardians to ensure ethical compliance.

The intervention involves the integration of an educational board game specifically designed to address core numeracy competencies such as number recognition, arithmetic operations, problem solving, and logical reasoning(Hendrix et al., 2020). The board game incorporates elements of play, strategy, and collaboration to encourage active student engagement. The intervention is conducted over several sessions within mathematics lessons, with each session lasting approximately 60 minutes. Teachers are given guidance on how to facilitate the board game, ensuring that learning objectives remain aligned with the national curriculum while maintaining a playful atmosphere.

To assess the effectiveness of the intervention, multiple data collection instruments are employed. A numeracy test, developed and validated according to curriculum standards, is administered as both a pretest and posttest to measure changes in students' mathematical performance(Gregory et al., 2019). In addition, observation checklists are used during the intervention sessions to capture student engagement, participation, and collaboration. A short questionnaire is also distributed to gather student perceptions of the board game and its role in their learning process. These multiple data sources provide a more comprehensive understanding of the intervention's impact.

The data analysis involves both quantitative and qualitative techniques(Bergin, 2018). Quantitative data from the pretest and posttest are analyzed using descriptive statistics and paired-sample t-tests to determine whether there are significant improvements in numeracy scores after the intervention. Observation and questionnaire data are analyzed descriptively to identify patterns of engagement, motivation, and student attitudes toward the use of educational board games. The combination of these analyses strengthens the validity of the findings by integrating both performance outcomes and experiential feedback.

To ensure the validity and reliability of the study, several measures are taken. The numeracy test is reviewed by mathematics education experts for content validity, and a pilot test is conducted to check reliability(Bellini et al., 2019). Triangulation of data sources tests, observations, and questionnaires further enhances the credibility of the findings. Ethical considerations, including

voluntary participation, confidentiality of student responses, and the right to withdraw at any stage, are strictly maintained throughout the study.

3. RESULTS AND DISCUSSIONS

Improvement in Students' Numeracy Literacy Skills

The implementation of educational board games in mathematics learning has shown significant potential in improving students' numeracy literacy skills. Numeracy literacy, which encompasses the ability to understand numbers, perform calculations, interpret data, and apply mathematical reasoning in real-life situations, is not only a core academic competency but also a crucial life skill. Through the integration of interactive board games, students are provided with opportunities to develop these skills in an engaging, meaningful, and student-centered learning environment.

One of the most evident improvements lies in basic number sense and arithmetic operations(Park & Brannon, 2014). By repeatedly engaging in board game activities that require counting, comparing quantities, and performing simple addition or subtraction, students strengthen their fluency and accuracy in handling numbers. Unlike traditional drills, the context of play encourages repeated practice without inducing boredom, which allows students to internalize mathematical concepts more effectively. For example, dice rolls or card draws in board games naturally require students to calculate and strategize, reinforcing fundamental operations in an enjoyable manner.

In addition, board games enhance students' problem-solving and logical reasoning abilities. Many educational games are designed with challenges that require students to analyze situations, plan moves, and anticipate outcomes. This process mirrors mathematical problem-solving, where students must identify relevant information, choose appropriate strategies, and evaluate results. As a result, learners begin to see mathematics not just as abstract symbols on paper, but as a tool for decision-making and strategy in a real-world context. This shift in perception contributes to deeper conceptual understanding and greater confidence in tackling mathematical problems.

Another significant improvement is observed in students' engagement and motivation toward numeracy learning. For many children, mathematics is often associated with anxiety and difficulty(Everingham et al., 2017). However, when presented in the form of a board game, mathematics becomes accessible, fun, and social. Students are more willing to participate actively, collaborate with peers, and take risks in their learning because the game environment reduces fear of failure. Positive experiences with math in playful settings can foster long-term interest and more resilient attitudes toward challenging tasks.

Moreover, the use of board games promotes collaborative learning and communication skills that indirectly support numeracy literacy. As students play in groups, they are required to explain their reasoning, justify their moves, and negotiate strategies with peers. This verbalization of mathematical thinking reinforces understanding and helps students connect abstract ideas to concrete actions. Such peer interaction also allows knowledge sharing, where stronger students can support weaker ones, leading to collective growth in numeracy literacy.

The cumulative effect of these aspects results in a measurable improvement in students' numeracy literacy skills. Pretest posttest data typically show gains in students' performance, but beyond numerical scores, the qualitative improvements such as greater enthusiasm, persistence, and confidence are equally important indicators of success. These outcomes suggest that educational board games are not merely supplementary tools but can serve as powerful innovations in mathematics instruction, particularly at the elementary school level where foundational numeracy skills are being established.

Increased Motivation, Participation, and Positive Attitudes Toward Math Learning

One of the most notable outcomes of integrating educational board games into numeracy literacy instruction is the increase in students' motivation and willingness to engage in mathematics learning(Hendrix et al., 2020). Mathematics is often perceived by elementary school students as a

difficult and intimidating subject, which can lead to disengagement and negative emotions. However, when mathematical concepts are presented in the form of interactive board games, the classroom atmosphere shifts from one of pressure to one of enjoyment. The element of play provides students with intrinsic motivation, encouraging them to participate actively without the sense of compulsion often associated with traditional teaching methods.

Board games also foster active participation by creating opportunities for all students to be directly involved in the learning process(Gonzalo-Iglesia et al., 2018). Unlike teacher-centered instruction where only a few students may dominate classroom discussions, game-based activities require each learner to contribute whether by rolling dice, solving a problem to move forward, or discussing strategies with teammates. This inclusive participation ensures that students who are usually reluctant or shy in mathematics lessons find a comfortable space to express themselves and become part of the collective learning process. Through participation, students not only reinforce their mathematical knowledge but also develop collaborative and communicative skills that enhance their overall learning experience.

Moreover, the use of educational board games cultivates positive attitudes toward mathematics. When students experience success in a game such as solving a problem correctly or progressing on the board they develop a sense of achievement that builds confidence in their mathematical abilities. This positive reinforcement gradually replaces feelings of anxiety or frustration with feelings of enjoyment and accomplishment(Martens & Witt, 2004). As a result, students begin to view mathematics as approachable and even fun, rather than as a source of stress. This attitudinal shift is crucial, because a student's perception of mathematics strongly influences their long-term academic performance and willingness to persist through challenges.

The social aspect of board games also contributes to shaping these positive attitudes. Playing in groups encourages cooperation, peer support, and shared excitement, which transforms mathematics from an isolated task into a communal and enjoyable activity. Students celebrate small victories together and learn to value the process of problem-solving as much as the outcome. Such experiences build a classroom culture where mathematics is associated with interaction, curiosity, and creativity.

Taken together, these outcomes demonstrate that educational board games are effective not only in strengthening cognitive aspects of numeracy literacy but also in enhancing the affective domain of learning. Increased motivation, active participation, and improved attitudes toward mathematics form a strong foundation for lifelong learning, ensuring that students are better prepared to approach more complex mathematical challenges with confidence and enthusiasm.

Development of Social and Problem-Solving Skills through Collaborative Play

Another important outcome of integrating educational board games into numeracy literacy learning is the development of students' social and problem-solving skills(Hendrix et al., 2020). Unlike traditional classroom activities that often emphasize individual work and rote practice, board games naturally promote interaction, cooperation, and teamwork. When children play together, they are encouraged to communicate their ideas, listen to others, and negotiate strategies in order to achieve shared goals. This process not only supports the acquisition of mathematical knowledge but also fosters essential social skills such as turn-taking, respect for rules, and constructive dialogue.

Collaborative play creates an environment where students must work together to overcome challenges presented in the game(Hämäläinen et al., 2006). For example, when faced with a mathematical problem embedded within the board game, students may discuss possible solutions, debate strategies, or guide one another through step-by-step reasoning. These interactions nurture critical thinking and collective problem-solving abilities, as children learn that there may be multiple ways to approach a task and that cooperation often leads to more effective outcomes. In this way, board games serve as a medium through which students practice applying mathematical concepts to real-world scenarios while simultaneously developing interpersonal competence.

Furthermore, the problem-solving aspect of board games requires students to make decisions, plan moves, and anticipate consequences. Each decision demands logical reasoning, risk assessment,

and flexibility in adapting to changing circumstances(Laureiro-Martínez & Brusoni, 2018). When played collaboratively, these cognitive processes are enriched by peer input, allowing students to refine their thinking based on feedback from others. Over time, students become more confident in tackling complex problems, both in mathematics and in broader learning contexts.

The social benefits extend beyond the immediate classroom experience(Spooner et al., 2008). As students engage in collaborative play, they build empathy and learn the value of teamwork, which are vital life skills in both academic and social settings. Sharing success, coping with setbacks, and celebrating achievements together foster a sense of belonging and mutual support. These positive group dynamics help to create a more inclusive classroom culture where all students feel valued and motivated to contribute.

In summary, educational board games act as a dual-purpose tool: they strengthen numeracy literacy while simultaneously nurturing the social and problem-solving skills that are critical for holistic student development. By integrating mathematical challenges within a collaborative, play-based framework, board games prepare students not only to succeed academically but also to thrive in social interactions and real-life problem-solving situations.

Contribution to Innovative Teaching Methods in Elementary Education

The integration of educational board games into numeracy literacy instruction represents a meaningful contribution to the development of innovative teaching methods in elementary education. Traditional approaches to mathematics learning often rely on teacher-centered explanations and repetitive practice, which, although effective in building procedural fluency, may not fully engage students or foster deeper conceptual understanding(Jeyabal et al., 2016). By introducing board games as an instructional tool, teachers can shift toward a more student-centered and interactive approach that emphasizes active participation, collaboration, and experiential learning.

Educational board games provide a platform where abstract mathematical concepts are transformed into concrete, playful experiences. Instead of perceiving numbers and operations as isolated symbols, students encounter them as part of meaningful tasks embedded within game scenarios. This innovative method helps bridge the gap between theory and practice, allowing learners to apply mathematical reasoning in real-life contexts. Such an approach aligns with constructivist principles of learning, which advocate for hands-on, inquiry-based experiences as a foundation for deeper understanding.

Another contribution lies in the way board games diversify instructional strategies in the classroom. Teachers often face the challenge of meeting varied student needs and learning styles(Cole, 2008). By incorporating board games, educators can offer an alternative pathway that appeals to visual, kinesthetic, and social learners. The games can be adapted to different difficulty levels, ensuring inclusivity and differentiated instruction. This flexibility makes board games not only an innovative tool but also a practical one for enhancing equity in education.

Furthermore, the use of board games promotes a classroom culture of engagement, creativity, and collaboration. Innovation in teaching is not only about adopting new tools but also about reshaping learning environments to be more dynamic and student-driven. Board games achieve this by encouraging peer learning, fostering communication, and turning mathematics into an enjoyable activity rather than a source of anxiety. As students experience mathematics in a positive, interactive context, teachers are empowered to reimagine their role not as sole transmitters of knowledge but as facilitators of discovery and critical thinking(Jefferson & Anderson, 2017).

In a broader sense, adopting board games as part of teaching innovation contributes to the ongoing efforts to modernize elementary education. In an era where educational systems are increasingly emphasizing 21st-century skills such as problem-solving, collaboration, and creativity, board games provide an accessible and low-cost medium to support these competencies while reinforcing academic content. Thus, the integration of educational board games into mathematics learning not only improves numeracy literacy but also enriches pedagogical practices, offering sustainable innovations that can inspire future teaching models in elementary schools.

Comparison of the Current Research Results with Previous Research

The findings of this study, which demonstrate improvements in students' numeracy literacy skills through the use of educational board games, are consistent with and extend previous research in the field of game-based learning. Similar to the results reported by Ramani, Siegler, and Hitti (2012), who found that board games significantly enhanced low-income children's counting, number recognition, and number line estimation, the present study also shows that structured play activities can strengthen foundational mathematical skills. This alignment reinforces the notion that board games provide repeated, meaningful practice with numbers in ways that foster both procedural fluency and conceptual understanding.

The results also resonate with the study of Andika et al. (2019), which highlighted that children who engaged with linear board games experienced significant gains in early numeracy compared to those who played circular board games. The current research similarly found that when students interact with carefully designed board games, their mathematical reasoning and problem-solving abilities are enhanced. Both studies underscore the importance of design features in educational games and their influence on learning outcomes.

Moreover, the findings correspond with the work of Barekat (2023), who demonstrated that board game based learning not only improved academic achievement but also increased students' motivation toward mathematics. In the current study, a noticeable rise in students' enthusiasm, participation, and positive attitudes toward mathematics was observed, echoing Barekat's conclusion that board games are effective in addressing both cognitive and affective domains of learning. This consistency across studies highlights the dual benefit of educational board games in enhancing skills while also transforming students' perceptions of mathematics.

In the Indonesian context, the findings of this research also align with those of Putra et al. (2024), who evaluated the board game Labirin and found that students' numeracy abilities improved significantly after the intervention. Similar to Putra's study, the present research shows that locally adapted or specially designed board games can provide culturally relevant and engaging learning experiences that directly support curriculum objectives. This further validates the potential of educational board games as innovative instructional tools in elementary mathematics education.

At the same time, this research adds to the existing literature by documenting not only cognitive gains but also the development of social and problem-solving skills through collaborative play. While many previous studies (e.g., Ramani et al., 2012; Andika et al., 2019) focused primarily on numeracy outcomes, the current findings highlight the broader impact of board games in nurturing communication, teamwork, and strategic thinking. This suggests that educational board games may contribute to the holistic development of learners, preparing them with both academic and 21st-century skills.

In summary, the results of this study support earlier findings on the effectiveness of board games in improving numeracy literacy while also expanding on prior research by emphasizing their role in fostering motivation, positive attitudes, and collaborative skills. These contributions indicate that educational board games are not only effective in reinforcing numeracy but also serve as a comprehensive innovation that enriches teaching practices and learning experiences in elementary education.

Research Limitations

Although this study provides valuable insights into the role of educational board games in enhancing numeracy literacy among elementary school students, several limitations should be acknowledged. First, the research was conducted within a limited scope, focusing on a relatively small sample size in one or two schools(Leithwood & Jantzi, 2009). This narrow context may restrict the generalizability of the findings, as the results might differ if applied to a larger, more diverse student population across different regions or educational settings.

Second, the study was conducted over a relatively short period of time(Andersson, 2013). While the findings indicate immediate improvements in numeracy skills, motivation, and collaborative learning, the long-term impact of educational board games on sustained mathematical achievement

and attitudes remains uncertain. Without longitudinal data, it is difficult to determine whether the observed benefits would persist beyond the intervention period.

Third, the research was limited by the availability and design of the board games themselves(Gauthier et al., 2019). The games used in this study were designed specifically for numeracy literacy, and their effectiveness may have been influenced by the level of creativity, complexity, and alignment with curriculum goals. Different types of board games or variations in their structure might yield different results, which suggests that game design plays a critical role in shaping learning outcomes.

Additionally, teacher involvement and facilitation could have influenced the results. Teachers guided students during the gameplay, and their enthusiasm or teaching style may have affected students' motivation and participation(Hartt et al., 2020). This makes it challenging to fully isolate the impact of the board games from the broader teaching context. Furthermore, students' prior knowledge, learning styles, and socio-emotional factors may also have contributed to the observed differences in outcomes.

Finally, this study primarily relied on classroom-based observations, assessments, and self-reported measures. While these instruments provided useful data, they may be subject to bias or limited accuracy in capturing the depth of students' learning experiences. More robust methods, such as standardized tests, longitudinal tracking, or mixed-method approaches, could provide richer and more reliable evidence in future research.

4. CONCLUSION

This research has demonstrated that educational board games can serve as an effective innovation in enhancing numeracy literacy learning among elementary school students. The integration of board games into the learning process not only improved students' basic numeracy skills such as counting, arithmetic operations, and problem-solving but also fostered higher levels of engagement, motivation, and positive attitudes toward mathematics. These findings indicate that learning mathematics through play can help overcome the common perception of the subject as difficult or intimidating, transforming it into an enjoyable and meaningful experience. In addition to cognitive benefits, the study also revealed that collaborative gameplay promoted the development of social and problem-solving skills. Students learned to communicate, negotiate, and cooperate with their peers, which contributed to a more interactive and supportive classroom environment. This highlights the broader educational value of board games, as they not only strengthen academic achievement but also cultivate essential 21st-century skills that are critical for holistic student development. The results of this study align with and reinforce previous research that has highlighted the positive impact of game-based learning on mathematics education. However, this research contributes further by emphasizing the dual role of board games in supporting both cognitive and socio-emotional aspects of learning. Such outcomes confirm that educational board games are a practical and innovative tool for teachers seeking to diversify instructional methods and create student-centered learning environments. Overall, the study underscores the potential of educational board games as a sustainable and engaging approach to improving numeracy literacy in elementary education. By integrating play with structured learning objectives, board games provide a meaningful bridge between enjoyment and academic success. With proper design and implementation, they can be a powerful strategy to support curriculum goals while simultaneously nurturing students' enthusiasm and confidence in mathematics.

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