Enhancing Mathematical Strategy Through the Use of Board Games in Mathematics 10

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ABSTRACT

Innovative teaching strategies are essential to make mathematics more engaging and understandable, especially in complex topics like Statistics and Probability. This action research titled "Enhancing Mathematical Strategy Through the Use of Board Games in Mathematics 10" was conducted to improve the mathematical strategies of Grade 10 students in the topic of Statistics and Probability. The study utilized a quantitative research method, specifically a pre-test and post-test design, and involved 43 purposively selected students from a public secondary school. A researcher-made test served as the main instrument for data collection, focusing on measuring students' understanding and strategic thinking in solving probability-related problems. Before the implementation of the board game activity, the students' performance in the pre-test showed generally low levels of mastery. After participating in the board game sessions, students demonstrated notable improvements in their mathematical performance, as evidenced by higher post-test scores. Statistical analysis using a paired t-test revealed a significant difference between the pre-test and post-test results, with a p-value indicating statistical significance. The computed mean score increased from pre-test to post-test. Incorporating board games into mathematics instruction can promote active learning, critical thinking, and deeper conceptual understanding among learners. The use of board games made the learning process more interactive and enjoyable, helping students better grasp abstract mathematical concepts. The study concludes that board games are an effective and innovative teaching strategy for enhancing mathematical strategies and improving students' academic performance in mathematics. It is recommended that educators integrate board games into classroom instruction to foster active learning and improve mathematical performance. Schools are also encouraged to support teacher training on innovative instructional strategies and further explore the use of educational games across various topics and grade levels.

Keywords: Board Games, Mathematical Strategy, Student Engagement, Critical Thinking, Student Performance, Statistics and Probability, Problem-Solving Skills

INTRODUCTION

Mathematics stands as a fundamental subject, integral to both academic achievement and the development of essential critical thinking and problem-solving skills (Arisoy & Aybek, 2021). In secondary education, mathematics forms the core of the curriculum, with a focus on concepts such as algebra, geometry, and probability, which are pivotal for students' academic growth and real-world applications (Kumar et al., 2024). As students encounter more complex mathematical concepts, effective teaching strategies become increasingly important for fostering a deeper understanding and improving problem-solving abilities. However, using board games in mathematics education is a creative and engaging way to enhance students' problem-solving skills (Almeida et al., 2019). In Mathematics 10, where concepts such as algebra, geometry, and probability are crucial, board games can provide an interactive environment for students to apply and practice these mathematical strategies.

Despite growing recognition of the benefits of interactive, student-centered learning, many instructors still struggle to integrate these approaches into mathematics instruction. Traditional teaching methods, which primarily rely on lecturing and rote memorization, may not encourage students to engage in the more abstract aspects of mathematics, such as algebra, geometry, and probability. This leads to a lack of engagement and can

result in gaps in understanding, poor retention of key concepts, and limited application of mathematical strategies to real-world problems (Deng et al., 2020). Many educators lack the necessary resources, training, or institutional support to implement alternative teaching methods, such as game-based learning. As a result, they deny their students opportunities to apply their minds more dynamically and interactively in solving critical thinking and problem-solving problems. There is therefore a need for innovative teaching tools, such as board games, to provide students with more engaging, hands-on mathematics learning techniques (Bayeck, 2020).

Previous studies have explored the impact of game-based learning on mathematical skills across various age groups. Board games have demonstrated significant educational benefits, particularly in developing mathematical skills. For example, these games led to considerable improvements in mathematical abilities among children in prekindergarten and kindergarten, with a strong emphasis on numerical skills (Balladares et al., 2021). Similarly, they positively affected mathematical creativity among elementary students, particularly when used in a free-play setting that allowed students to explore and apply concepts (Park & Lee, 2021). Game-based learning approaches, including board games, have also been found to improve students' mathematical understanding, particularly in numbers and operations, through engaging and interactive methodologies (Erşen & Ergül, 2021). Despite these findings, there remains a gap in the literature regarding the application of board games in secondary education, particularly in enhancing strategic mathematical thinking and problem-solving skills among older students.

While creating a more engaging and effective learning environment is at the top of educators' wish lists, especially in mathematics education, it is vital to examine the specific issues that prevent educators from integrating interactive and game-based learning strategies into their daily teaching. While traditional teaching methods have long dominated mathematics classrooms, many students struggle with the abstract concepts of algebra, geometry, and probability. Understanding the challenges of adopting new teaching tools, such as board games, can help mitigate issues like low student engagement, limited use of strategies, and difficulty solving problems. The educator can then implement targeted interventions and incorporate board games into a curriculum framework to enhance student engagement, strategic thinking, and overall mathematics performance.

Many researchers have examined the impact of board games on students' mathematical development. For instance, board games are noted for significantly enhancing mathematical creativity by fostering flexibility and innovation in free play, while structured play guided by teachers strengthens problem-solving strategies (Park & Lee, 2021). Additionally, the increasing use of game-based methods in mathematics education, especially at the secondary level, has been highlighted in the literature. Reviews have shown that board games are effective in improving students' understanding of numbers, operations, and geometry (Erşen & Ergül, 2021). However, despite the growing body of research on the benefits of board games, there is still a lack of studies focusing specifically on their application in developing mathematical strategies and critical thinking among secondary school students. This gap highlights the need for further exploration into how these tools can be effectively utilized to support the mathematical growth of older students.

The researcher identified a knowledge gap in prior research regarding the application of board games designed to enhance mathematical strategy and critical thinking among secondary school students, particularly in Mathematics 10. While studies have explored the use of board games in education (e.g., Almeida et al., 2021; Lin & Cheng, 2021; Andini & Yunianta, 2021), much of the existing literature focuses on younger students or specific mathematical concepts such as algebra and prime factorization, without directly addressing the broader application of game-based learning for secondary students. In addition, prior research did not thoroughly examine the integration of game-based strategies as a tool for fostering strategic thinking across various mathematical topics in secondary education. This encompasses several unexplored dimensions that have recently attracted research attention in other fields, such as the use of board games to enhance spatial reasoning and mathematical knowledge (Almeida et al., 2021), technology-enhanced board games to improve student motivation and learning performance in primary education (Lin & Cheng, 2021), and the development of algebra-focused board games to train students' mathematical skills (Andini & Yunianta, 2021). The impact of these game-based strategies on secondary students' problem-solving skills, strategic thinking, and mathematical creativity should be further explored to better understand why such approaches have not been more widely implemented in traditional secondary mathematics classrooms (Miles, 2017).

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This study investigates the impact of board games on mathematical strategy and critical thinking skills in secondary school students, specifically within the Mathematics 10 curriculum. Exploring the possibility of board games as an educational tool can help us understand how this interactive method can be better used to engage students with the learning process in certain areas, such as algebra, geometry, and probability. The study will examine the organizational and contextual factors that influence the effectiveness of board games in the classroom, such as teacher preparation, classroom environment, and institutional support. The purpose of this research is to highlight the opportunities and challenges of using board games in mathematics education, and to offer actionable recommendations to educators and schools on how to better incorporate game-based learning into their teaching practices. Ultimately, the aim is to create a holistic framework that schools can use to foster a more dynamic and supportive environment for teaching and learning mathematics, leveraging board games to improve student engagement, problem-solving skills, and overall academic performance.

Strategy

Board games are a dynamic and engaging instructional approach that integrates elements of gameplay into educational activities to enhance student motivation and learning outcomes. This process has been shown to increase student engagement and effort in learning, resulting in improved academic performance (Hinebaugh, 2009). In the context of mathematics education, incorporating board games into the classroom can stimulate students' interest in complex concepts, making learning more enjoyable and effective. By using board games that blend fun and education, students are encouraged to apply mathematical strategies, solve problems, and think critically in a structured yet interactive environment.

The importance of using board games in the classroom is particularly evident in subjects like mathematics, where students often struggle with abstract concepts. The teacher's role is not only to introduce new mathematical concepts but also to encourage students' active engagement through hands-on activities that allow them to explore and internalize these concepts independently (Vale & Barbosa, 2023). One innovative method that has gained attention is the use of board games in mathematics instruction. Games such as "Mathopoly" and "The Adventure of Algebra" are designed to improve problem-solving, critical thinking, and mental calculation abilities (Farmonov & Karimova, 2023; Andini & Yunianta, 2021). These board games offer a more engaging and interactive way to learn, making the material less intimidating and more accessible to students.

In addition, studies have shown that using board games in secondary education can significantly boost students' motivation and enthusiasm for mathematics (Hanghøj & Karnøe, 2024). As students engage in math-related board games, they develop a deeper understanding of concepts such as prime factorization and algebra, which are often perceived as challenging. Board games offer students an opportunity to practice these skills in a fun and competitive environment, which can lead to better learning outcomes and a greater appreciation of the subject.

The researcher proposes implementing board game activities to enhance mathematical strategy among Mathematics 10 students. Innovation integrates elements like scoring, challenges, and competition into mathematical content to engage students and promote deeper learning. Using a board game format, students can interact with the content more hands-on, helping them develop their mathematical skills in a fun, collaborative environment. This approach aims not only to enhance students' mathematical abilities but also to foster critical thinking, problem-solving, and communication skills. The use of board games in Mathematics 10 could serve as a valuable tool to motivate students, improve their understanding of mathematical concepts, and ultimately enhance their academic performance in the subject.

Action Research Questions

This action research aims to enhance mathematical strategy through the use of board games in one of the secondary schools in Misamis Occidental during the S.Y. 2024- 2025. Specifically, this study seeks to answer the following questions:

1. What is the level of students' mathematical strategies in Mathematics 10 before the implementation of the board game activities?

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2. What is the level of students' mathematical strategies in Mathematics 10 after the implementation of the board game activities?

3. Is there a significant difference in students' mathematical strategies in Mathematics 10 before and after the implementation of the board game activities?

METHODOLOGY

A. Research Design

This study employed a quantitative pre-test and post-test design to examine the impact of board games on the mathematical strategies of a single section of Grade 10 students. The pre-test and post-test method will be used to assess changes in students' problem-solving approaches, engagement, and understanding after implementing board games in the classroom (Assapun & Thummaphan, 2023). This design allows for a systematic comparison of students' mathematical strategies before and after the intervention, providing insights into the effectiveness of board games in enhancing their learning experience. By focusing on a controlled group, the study aims to identify patterns in student performance and collaboration within a natural classroom setting.

B. Research Setting

The study was conducted at the junior high school level in Ozamiz City, Misamis Occidental, focusing on Grade 10 students. This school serves students from Grade 7 to Grade 12, offering subjects such as Mathematics, and accepts a diverse mix of students from various backgrounds and learning abilities. It offers a range of subjects aligned with the Department of Education's curriculum. It provides learning opportunities for students with diverse backgrounds to help them improve their skills and knowledge.

C. Respondents of the Study

The participants of this study were Grade 10 students from four sections taught by the researcher, selected through purposive sampling. This method allows the researcher to choose students based on specific criteria relevant to the study. The selection will be based on the following: (1) students enrolled in Grade 10 for the school year 2024–2025, (2) students who have been observed to have low performance in mathematics, and (3) students who are willing to participate in the study. The researcher will ensure that these criteria are met before conducting the research. However, students from other sections of the same grade level will not be included in the study.

D. Instruments

The research will use the following research instruments as a data gathering tool:

A.Measure of Position Test.

The instrument is a 40-item researcher-made questionnaire covering topics in Mathematics 10,Mathematics 10, specifically focusing on Statistics and Probability. These topics include key concepts such as quartiles, deciles, and percentiles, which are essential for understanding data distribution and interpretation. To ensure the test's validity, the researcher will have experts review it, including the research adviser, school head, principal, and cooperating teacher. A pilot test will be conducted with a separate group of students who are not part of the main study to refine the questionnaire. The instrument's reliability will be measured using Cronbach's Alpha, aiming for a value between 0.7 and 1.0. This questionnaire will be used for both the pre-test and post-test to assess students' understanding before and after the intervention.

B. Lesson Plan

The researcher will develop a lesson plan integrating board games to enhance students' mathematical strategies in Statistics and Probability. Before implementation, the lesson plan will be carefully reviewed by mathematics teachers and revised based on their feedback to ensure it aligns with the curriculum and students' learning needs.

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The lesson will be conducted with Grade 10 students at one of the secondary schools in Ozamiz City, Misamis Occidental, during the S.Y. 2024–2025.

C. Board Game Strategy.

The Board Game Approach will be used to help students develop their mathematical strategies in Statistics and Probability. This strategy incorporates board games designed to make learning measures of position more engaging and interactive while enhancing students' understanding of key concepts such as quartiles, deciles, and percentiles.

E. Data Collection

a) Pre-Implementation Phase. The researcher will request permission from the dean of the College of Education and once granted, approval from the Schools Division Superintendent, the school principal, and the cooperating teacher to conduct the study. Once the necessary approvals were obtained, students and their parents were asked to sign consent and assent forms. A pre-test was administered to assess the students' initial mathematical strategies and establish a baseline for comparison. Lesson plans, board games, and assessment tools were also prepared during this phase.
b) Implementation Phase. The strategy was conducted over a month, during which board games were integrated into regular mathematics lessons. Students were given detailed instructions on how to play board games and use them to solve mathematical problems. The games were played collaboratively in small groups to foster teamwork and enhance engagement. Observations were made throughout the intervention, and field notes, photos, and video recordings were collected.
c) Post-Implementation Phase. After the intervention, a post-test was administered to assess improvements in students' mathematical strategies. Data from the pre-test and post-test were analyzed and interpreted. The findings were compiled into a final report, along with recommendations for future research and practical applications in mathematics teaching. The study results were shared with relevant stakeholders to inform teaching practices and strategies.

Ethical Considerations

To maintain the ethical standards of this study, the researcher ensured that participation was voluntary for all respondents. As part of ethical practice, the researchers presented participants with a full briefing on the Data Privacy Act of 2012. The purpose of the study was clearly explained to them, and they were assured that their involvement would not cause harm. The researcher emphasized the importance of respecting the respondents' dignity throughout the process.

Additionally, privacy was maintained, and all collected data was kept confidential, with both students and teachers anonymized. The researcher ensured that the study's goals and objectives were presented honestly and accurately, disclosing no conflicts of interest or external funding sources. All communications related to the research were transparent, and no misleading information was shared. Lastly, the researcher obtained informed consent from all respondents as evidence of their voluntary participation.

Data Analysis

With the use of Minitab software, the researcher will utilize the following statistical tools:

Frequency and Percentage – These were used to assess students' mathematical strategies in Mathematics 10 before and after using board games.

Mean and Standard Deviation – These will be used to summarize students' performance levels before and after using board games, providing insights into the average scores and variability of their results.

Paired Sample T-Test – This statistical test will be used to compare students' performance before and after using board games, determining whether there is a significant improvement in their problem-solving and strategic thinking abilities.

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RESULTS AND DISCUSSION

A. Level of Students' Mathematical Strategy Before the Implementation of the Board Games

Table 1. Level of students' mathematical strategy before the implementation of board games.

Performance	Frequency	Percentage	M	SD
Satisfactory	1	2.33	28.000	*
Fairly Satisfactory	7	16.28	25.286	0.756
Did not Meet the Expectations	35	81.39	17.514	3.681
Overall Performance	43	100.00	19.023	4.626

Note: Performance Scale: 34-40(Outstanding); 31-33 (Very Satisfactory); 28-30(Satisfactory); 24-27 (Fairly Satisfactory); 1-23 (Did not Meet Expectation)

Table 1 shows that before the use of board games, most Grade 10 students (81.40% or 35 out of 43) were in the "Did Not Meet Expectations" level, with an average score of 17.51. Only 7 students (16.28%) reached the "Fairly Satisfactory" level, and just 1 student (2.33%) got a "Satisfactory" score. No student reached the higher levels, such as "Very Satisfactory" or "Outstanding." This means that many students had a hard time understanding and solving problems related to Statistics and Probability (Batanero & Borovcnik, 2016)

The results suggest that students struggled to use strategies like analyzing data, solving probability problems, and explaining their answers. Many may have memorized the steps without truly understanding the underlying ideas. Traditional teaching methods, such as lectures, often fail to help students develop critical thinking or practical problem-solving skills (Choi et al., 2014). Students learn better when they are involved in fun and meaningful activities that allow them to explore and work with others (Malone & Lepper, 2021).

Because of this, a different teaching approach is needed. The low pre-intervention scores indicate that students did not fully understand the topic. Board games offer a fun and interactive way to learn. They enable students to collaborate, think critically, and apply their knowledge in practical ways. These games can make lessons more engaging and help students grasp complex math concepts more effectively.

Based on the results, teachers are encouraged to use board games in their lessons to make learning more active and enjoyable. School leaders should also support teacher training to enable more teachers to create and use games that align with the learning goals. Using board games is not just for fun; it is a smart way to help students understand math better and become more confident in solving problems.

B. Level of Students' Mathematical Strategy After the Implementation of the Board Games

Table 2. Level of students' mathematical strategy after the implementation of board games.

Performance	Frequency	Percentage	M	SD
Outstanding	29	67.44	36.10	1.472
Very Satisfactory	10	23.26	32.50	0.707
Satisfactory	4	9.30	30.00	0.000
Overall Performance	43	100.00	34.69	2.484

Note: Performance Scale: 34-40(Outstanding); 31-33 (Very Satisfactory); 28-30(Satisfactory); 24-27 (Fairly Satisfactory); 1-23 (Did not Meet Expectation)

As shown in Table 2, students showed a significant improvement in their math strategy after using board games. Most of the students (29 out of 43, or 67.44%) scored in the "Outstanding" level, with an average score of 36.10. Ten students (23.26%) reached the "Very Satisfactory" level, and four students (9.30%) were in the "Satisfactory" range. No one remained in the lower performance categories.

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This significant change in scores shows that the board games had a strong positive effect on students' learning. The fun, interactive nature of the games helped students better understand Statistics and Probability. Working together while playing helped them explore and apply math concepts in ways that were both meaningful and enjoyable (Chen et al., 2022).

Interactive learning tools, such as board games, enhance students' understanding of lessons, retention of knowledge, and its application in real-life situations (Pope et al., 2021). This was clearly seen in the study, as many students moved from low to high performance levels after the intervention.

These results indicate that incorporating board games into math lessons enhances student learning. Teachers should consider incorporating these games into their teaching to make lessons more engaging and effective. The success of this approach also demonstrates that game-based learning can help close learning gaps, especially in topics students often find difficult, such as statistics and probability.

C. Significant Difference in Students' Mathematical Strategy Before and After the Implementation of Board Games

Table 3. Significant difference in students' mathematical strategy before and after the implementation of board games.

Variables	M	SD	*T* value	*P* value
mathematical strategy before the implementation of board games	19.02	4.626		
mathematical strategy after the implementation of board games	34.69	2.484	34.29	0.000

Note: *** p < .001 *(*Highly Significant);**p≤0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not significant)

Table 3 presents the results of a paired t-test that was conducted to determine whether there was a significant difference in students' mathematical strategy scores before and after using board games. The test included 43 Grade 10 students who took both a pre-test and a post-test to measure their understanding of Statistics and Probability.

The results showed a significant improvement in students' problem-solving skills after using board games. The average score before using the board games (pre-test) was 19.02 with a standard deviation (SD) of 4.63, indicating that students had lower and more varied levels of understanding. After the board games were introduced, the average score increased to 34.69, and the SD decreased to 2.48, indicating that students not only performed better but also demonstrated more consistent understanding. The statistical test yielded a t-value of 34.29 and a p-value of 0.000, indicating that the improvement was highly significant. This confirms that using board games helps students improve and better understand mathematical strategies.

The 95% confidence interval (CI) for this mean difference ranged from -16.60 to -14.75, indicating that the true average improvement lies within this range and is unlikely to be due to chance. The calculated t-value was 34.29, and the p-value was 0.000, much lower than the commonly accepted threshold of 0.05. This statistically significant result confirms that the observed difference in scores before and after the board game activity was not random but a direct effect of the intervention (Vita-Barrull et al., 2023).

These findings strongly support the idea that using board games can effectively enhance students' mathematical strategies in challenging topics. The interactive and fun nature of board games likely helped students engage more deeply with statistical concepts, allowing them to understand and apply ideas better than traditional lecture-based instruction alone (Lin & Cheng, 2022). This higher engagement and hands-on experience can improve retention and promote critical thinking skills.

Moreover, this study's results align well with other research in the field. For example, it found that hands-on learning tools and collaborative activities, such as games, encourage active participation and foster deeper learning in mathematics classrooms. These methods help students move beyond memorization to truly grasp and apply complex concepts (Karuru et al., 2023).

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In summary, the paired t-test results provide strong evidence that the board game intervention was highly effective in improving Grade 10 students' mathematical strategies in Statistics and Probability. Educators should consider incorporating similar game-based learning approaches to boost students' understanding, motivation, and overall academic performance in mathematics.

SUMMARY

The study was conducted to enhance Grade 10 students' mathematical strategies in Statistics and Probability through board games during the academic year 2024–2025 at a public secondary school in Ozamiz City. The research employed a classroom-based action research design and purposive sampling, selecting 43 students who demonstrated low academic performance and were willing to participate. A researcher-made test served as the primary instrument for data collection. Data analysis included descriptive statistics (mean and standard deviation) and a paired t-test to assess significant differences in performance. Specifically, the objectives of the study were to: (1) determine the students' level of mathematical strategy before the implementation of board games; (2) determine the students' level of mathematical strategy after the implementation of board games; and (3) identify whether there was a significant difference in students' mathematical strategy before and after the implementation of board games.

FINDINGS

The following were the key findings of the study:

1. Not all students met expectations in their mathematical strategies before the board games were implemented, with the majority scoring in the lower performance levels on the pre-test. This indicated that many students had difficulty applying strategies effectively in Statistics and Probability.
2. The mathematical strategies of the students significantly improved following the implementation of the board games. Most of the learners achieved higher performance levels in the post-test, reflecting better comprehension, engagement, and problem-solving ability.
3. The research showed that the difference in students' mathematical strategies before and after using board games was highly significant. The paired t-test results confirmed a statistically significant improvement in scores, indicating the effectiveness of board games in enhancing strategic thinking and mathematical understanding in Mathematics 10.

CONCLUSION

Based on the findings, the following conclusions are drawn:

1. Statistics and Probability remain a challenging area for many students, particularly in developing effective mathematical strategies needed for problem-solving and logical reasoning. These skills require improvement through interactive, engaging, and student-centered teaching approaches.
2. Using board games helps improve students' mathematical strategies and their understanding of concepts in Statistics and Probability. It also develops essential skills such as strategic thinking, collaboration, and increased participation in mathematical tasks.
3. Board games are an effective instructional strategy in Mathematics education. They promote deeper conceptual understanding, enhance student motivation, and create a more enjoyable and meaningful learning environment for students in Mathematics 10.

RECOMMENDATIONS

Based on the findings and conclusions, it is recommended that:

1. Teachers may incorporate game-based approaches, such as board games, into Statistics and Probability instruction to improve students' mathematical strategies and foster interest in solving real-life mathematical problems.

2. School administrators may support the implementation of innovative instructional methods by organizing professional development programs, training, and workshops that promote interactive and student-centered teaching practices.
3. Mathematics teachers may explore and adopt creative instructional strategies that promote higher-order thinking, collaboration, and active engagement to improve overall student performance.
4. Future researchers may consider conducting similar studies across different grade levels or mathematical strands to validate the effectiveness of board games and further examine their impact on other cognitive and problem-solving skills.

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