GAMES IN MATHEMATICS IN THE TEACHING OF INTEGERS FOR GRADE 6 LEARNERS

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Abstract : This study explores the effectiveness of game-based learning in enhancing the understanding of integer operations among Grade 6 students. Using a quasi-experimental design, the research involves two primary phases: a pre-test and a post-test, with a game-based instructional intervention implemented in between. At the onset of the third academic quarter, a 30-item teacher-made pre-test and post-test were administered to determine students' knowledge of integers, including addition, subtraction, multiplication, and division. Item analysis revealed common areas of difficulty, which informed the structure of the intervention. The intervention utilized four educational games specifically selected to target key integer concepts. Integer Number Line Race (by Math Geek Mama) promoted kinesthetic learning through physical engagement with number lines. Integer War (by Teachers Pay Teachers) used modified playing cards to help students compare and compute integers. Integer Bingo (by Math Resources) focused on repeated practice of integer addition and subtraction, while Integer Jeopardy (by Jeopardy Labs) served as a review tool, incorporating various integer skills in a collaborative quiz-show format. These games were integrated into the classroom over several sessions to reinforce procedural fluency and conceptual understanding. The study recommends broader integration of interactive games into mathematics curricula and suggests further research into their long-term impact on student achievement.

IndexTerms - Game-based Learning, Integers, Pre-test, Post-Test

I.INTRODUCTION

1.1 Rationale

In contemporary education, teaching integers in Grade 6 is a pivotal component of the mathematics curriculum, introducing students to the concepts of positive and negative numbers. This foundational knowledge is essential for progressing to more advanced mathematical areas such as algebra and number theory. However, many students encounter difficulties grasping integers due to their abstract nature. Traditional instructional methods often emphasize rote memorization and abstract reasoning, which may not effectively engage all learners. Consequently, students may become disengaged, leading to diminished motivation and a superficial understanding of the subject matter.

The Programme for International Student Assessment (PISA) evaluates the competencies of 15-year-old students worldwide in reading, mathematics, and science. In the 2022 assessment, Filipino students had an average mathematics score of 355, significantly below the OECD average of 472. Only 16% of students in the Philippines achieved at least Level 2 proficiency in mathematics, indicating the ability to interpret and recognize how a simple situation can be represented mathematically. This is markedly lower than the OECD average of 69%. Furthermore, 84% of Filipino students scored below Level 2, highlighting a substantial deficiency in basic mathematical skills compared to international peers.

Research indicates that various factors contribute to these performance gaps, including differences in learning environments, resource availability, and student motivation. To address these challenges, the Philippine Department of Education has emphasized four key strategies: curriculum review and enhancement, improvement of learning environments, teacher upskilling and reskilling, and active stakeholder engagement. Nonetheless, there is a pressing need to explore innovative teaching methodologies that transcend traditional approaches and cater to the diverse learning needs of students.

In recent years, educational games have emerged as effective tools for teaching various subjects, including mathematics. Games provide interactive and dynamic learning experiences that actively involve students, making learning more engaging and enjoyable (Lasala, 2024). By incorporating games into mathematics instruction, educators can help students visualize abstract concepts, enhance problem-solving skills, and build confidence in their mathematical abilities.

Scholars and educators have advocated the integration of games into mathematics education for their potential to deepen understanding, particularly in abstract areas like integers. John Horton Conway, a distinguished British mathematician, exemplified this by discovering surreal numbers through the analysis of games. He once remarked, "You get surreal numbers by playing games. I used to feel guilty in Cambridge that I spent all day playing games, while I was supposed to be doing mathematics. Then, when I discovered surreal numbers, I realized that playing games is mathematics." Conway's approach underscores the profound connection between gameplay and mathematical discovery, illustrating how engaging with games can lead to significant insights into numerical concepts.

Similarly, German philosopher Kuno Lorenz, along with Paul Lorenzen, developed a framework where logic and arithmetic are viewed as dialogue games. In this model, mathematical reasoning is conceptualized as an interactive game between a proponent and an opponent, reflecting the dynamic nature of learning and understanding. This perspective aligns with the idea that engaging in mathematical "games" can deepen comprehension, particularly in foundational areas like integer arithmetic.

Historically, games have been employed as educational tools to teach mathematical concepts. Rithmomachia, also known as the "Philosophers' Game," is a medieval mathematical board game used to teach arithmetic and number theory. The game involves pieces with numerical values and emphasizes the relationships between numbers, making it a practical method for exploring integer concepts. Prominent scholars like Roger Bacon recommended Rithmomachia for its educational value in understanding numerical harmony and proportion.

This study explores using mathematics games as a pedagogical approach to teaching integers in Grade 6. The primary goal is to assess whether integrating games into mathematics instruction can enhance students' understanding of integers, improve their attitudes toward learning mathematics, and promote greater engagement with the subject matter. Through the use of interactive learning environments, this study aims to highlight the benefits of mathematics games as an effective method for teaching complex mathematical concepts in an enjoyable and meaningful way.

1.2 Theoretical Framework

This study is grounded in several key educational theories and concepts that support the integration of games into teaching mathematics, particularly in the context of learning integers in Grade 6. These theories include Cognitive Load Theory, Constructivism, Game-Based Learning, Self-Determination Theory, and Social Learning Theory

John Sweller's Cognitive Load Theory (CLT) suggests that learners have a limited amount of working memory, and instructional methods should aim to reduce unnecessary cognitive load to maximize learning. Mathematics games help manage the cognitive load by breaking down complex concepts into manageable, engaging tasks. Through gamified learning experiences, students are better able to process information without feeling overwhelmed. For instance, visual representations of integers through games can help students understand operations like the addition and subtraction of negative numbers without overloading their cognitive capacities.

Constructivism, primarily associated with the works of Jean Piaget and Lev Vygotsky, posits that learners actively construct their own understanding of concepts through interaction with their environment. In this view, knowledge is not simply transmitted from teacher to student but is built through active exploration and discovery. When students engage with mathematics games, they are provided with opportunities to experiment, hypothesize, and test their understanding of integers in a supportive, low-risk environment. In the context of teaching integers, constructivist principles suggest that students benefit from concrete, hands-on activities that allow them to manipulate and visualize numbers, particularly the abstract concept of negative and positive values. Games can serve as an effective medium for this by providing visual and interactive tools that allow students to make sense of integers tangibly. Moreover, constructivism emphasizes the importance of problem-solving and critical thinking, both of which are essential components of many mathematics games.

Game-Based Learning (GBL) is an instructional approach that uses games to enhance the learning process. GBL draws on the motivational and engagement aspects of games to improve learning outcomes by making the learning experience more enjoyable and interactive. James Paul Gee, a prominent scholar in GBL, emphasizes that games can serve as powerful learning tools because they encourage active problem-solving, immediate feedback, and sustained engagement with challenging tasks. Mathematics games, when applied to the teaching of integers, can provide real-time feedback, which helps students correct errors, adjust their strategies, and learn from their mistakes in a supportive environment. GBL also incorporates elements of rewards, progress tracking, and achievement, which can boost student motivation and make the learning of challenging mathematical concepts more accessible and fun.

Self-determination theory, developed by Deci and Ryan, posits that students are more motivated to learn when they experience autonomy, competence, and relatedness. Games naturally align with these motivational factors by allowing students to have a sense of control (autonomy) over their learning process, providing challenges that match their skill level (competence), and fostering social interaction (relatedness) through collaborative or competitive gameplay. This theory suggests that students will be more engaged and motivated to learn integers through games than through traditional methods.

Albert Bandura's Social Learning Theory emphasizes the role of social interaction and modeling in learning. According to this theory, students learn not only from direct instruction but also through observing others, imitating behaviors, and receiving feedback from peers. Mathematics games often involve collaboration and competition, where students work in pairs or groups, observe strategies used by others, and adapt their own approaches based on feedback and peer interaction. Incorporating games into the teaching of integers aligns with the principles of social learning because it encourages cooperative learning, where students can share ideas, discuss strategies, and learn from each other's successes and mistakes. This interaction fosters a deeper understanding of mathematical concepts and promotes a sense of community within the classroom. In this context, mathematics games provide a social learning experience that enhances both individual and collective learning.

Together, these theories provide a robust framework for understanding the potential benefits of using games to teach integers to Grade 6 students. Constructivism and Social Learning Theory emphasize the active, collaborative nature of learning, while Game-Based Learning and Cognitive Load Theory highlight the specific advantages that games offer in terms of engagement, motivation, and the effective management of cognitive resources. Finally, Self-Determination Theory underscores the motivational benefits of games, which can foster a more positive and self-driven learning experience.

This study examined the integration of games in teaching integers through these theoretical lenses to assess how games can improve conceptual understanding, promote collaboration, and increase student motivation and engagement.

1.3 Conceptual Framework

A visual and theoretical model to explain the relationship between mathematics games and the teaching of integers to Grade 6 students. It outlines the key variables and concepts that underpin the research, showing how games can impact students' understanding, motivation, and engagement. The framework draws on the ideas of Cognitive Load Theory, Constructivism, Game-Based Learning (GBL), and Social Learning Theory, highlighting their interconnected roles in the learning process.

Mathematics games are interactive, educational activities designed to help students learn mathematical concepts through play. These games may be digital or physical, and they provide students with opportunities to apply and explore mathematical concepts in an engaging, fun, and interactive way. In this study, mathematics games are the core instructional tool being tested. Their use is expected to influence several outcomes related to learning and engagement.

Teaching integers involves helping students understand positive and negative whole numbers, their representation on a number line, and operations such as addition, subtraction, multiplication, and division of integers. The study examines how the use of mathematics games improves the effectiveness of teaching integers, specifically in terms of students' conceptual understanding, problem-solving skills, and ability to apply integer operations.

Conceptual Understanding refers to a deep comprehension of the principles and relationships underlying the concept of integers, beyond simple memorization or procedural knowledge. This includes understanding how negative and positive numbers interact, their real-world applications, and the ability to perform operations with integers. Games are expected to enhance conceptual understanding by allowing students to explore integer concepts through visualization, interaction, and problem-solving.

Engagement refers to the level of interest, attention, and active participation students exhibit during the learning process. Motivation refers to the student's willingness and drive to participate in and succeed at learning tasks. Mathematics games are designed to be interactive and enjoyable, making the learning process more engaging for students. The framework posits that higher engagement and motivation will lead to better retention and understanding of integers.

Cognitive load refers to the mental effort required to process information. By reducing unnecessary cognitive demands, students can better focus on core concepts. Mathematics games provide visual aids, immediate feedback, and simplified representations that help reduce cognitive load, allowing students to better focus on understanding the rules and operations of integers.

Collaborative learning involves students working together to solve problems or complete tasks, while social interaction refers to the communication and exchange of ideas that occur during the learning process. Social learning theory suggests that students learn more effectively through interaction with peers. The use of games in teaching integers often involves teamwork, competition, and discussion, which foster collaboration and enhance learning outcomes.

Students' attitudes toward mathematics refer to their feelings, beliefs, and perceptions about the subject, including their level of confidence and enjoyment. The use of mathematics games is expected to improve students' attitudes toward learning mathematics by making the subject more enjoyable and less intimidating. A positive attitude can lead to sustained interest and better long-term outcomes in mathematics education.

The use of mathematics games as the central instructional tool impacts both student engagement and understanding of integers. Through the reduction of cognitive load and promotion of collaboration, games lead to more meaningful, positive, and effective learning experiences (Phunsa and Pawala, 2024).

This study follows quantitative methods to explore how mathematics games can enhance the teaching and learning of integers for Grade 6 students. Pragmatism, as a research paradigm, emphasizes practical outcomes and solutions to real-world problems, allowing flexibility in the methods used to gather data and answer research questions. In this study, the focus is on understanding the effectiveness of game-based learning in teaching integers by examining measurable learning outcomes (quantitative).

Ultimately, this approach aims to enhance student learning outcomes and foster a positive disposition toward mathematics, which can have long-term benefits for students' mathematical development.

1.4 Research Paradigm

Figure 1 illustrates the conceptual framework of the study, which investigates the effectiveness of using mathematics games as an instructional strategy to enhance students' understanding of integers. The process begins with the administration of a pre-test to evaluate the students' prior knowledge of integers. This establishes a baseline for comparison. Following this, students engage in a mathematics game, which serves as the primary intervention aimed at reinforcing key concepts related to integers interactively and engagingly. After participating in the game, students take a post-test to assess any improvement in their understanding and skills. The results from the pre- and post-tests are then analyzed to determine the level of performance, providing insight into the educational value of the mathematics game.

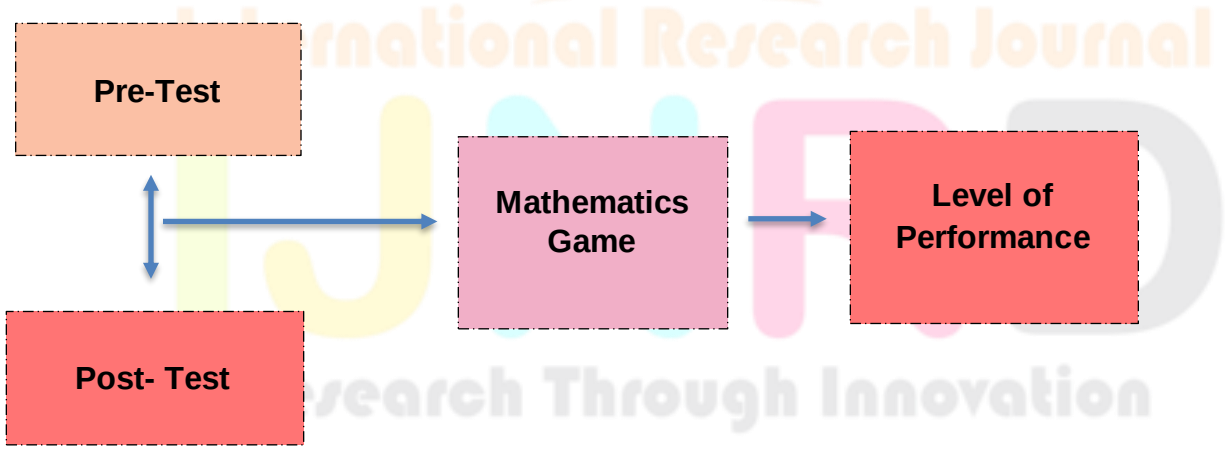

Figure 1: Research Paradigm

1.5 Statement of the Problem

This study aimed to assess the level of performance in Mathematics of Grade 6 learners in the teaching of Integers during the 3rd quarter teacher-made test of the school year 2024-2025.

Specifically, it sought to answer the following sub-problems:

1. What is the level of performance in Mathematics of the Grade 6 learners in the teaching of integers in the pre-test during the 3rd quarter, teacher-made test?
2. What Mathematics games can be used to determine the level of performance of the Grade 6 learners?
3. What is the level of performance in Mathematics of the Grade 6 learners in the teaching of integers in the post-test during the 3rd quarter, teacher-made test?
4. Is there a significant difference in the performance of the Grade 6 learners between the pre-test and the post-test results?
5. What games can be recommended to improve the performance of the Grade 6 learners?

1.6 Hypotheses of the Study

The hypothesis was tested at the .05 level of significance.

There is no significant difference in the performance of the Grade 6 learners between the pre-test and post-test results.

1.7 Scope and Limitations of the Study

The scope of this study focuses on Grade 6 students in a formal educational setting, specifically examining the teaching and learning of integers. The study aimed to evaluate the effectiveness of game-based learning in helping students understand positive and negative numbers, including basic operations such as addition, subtraction, multiplication, and division of integers. The primary intervention is the use of mathematics games, either digital or physical, which would be compared to traditional teaching methods like lectures and textbooks. Data would be collected through quantitative measures (pre-test and post-test results). However, the study has several limitations.

The sample size, determined by the available students within a specific school or district, may limit the generalizability of the results. The duration of the intervention could also affect the study's ability to capture the long-term impact of game-based learning. Teacher influence, access to resources, individual student differences, and the quality of the games used may further affect the findings. Additionally, since the study is focused solely on integers, the results may not apply to other areas of mathematics or other subjects. Recognizing these limitations ensures that the findings are interpreted within the specific context of the research.

1.8 Significance of the Study

This study on the use of mathematics games in teaching integers to Grade 6 students has several important contributions and implications for different stakeholders, including educators, students, curriculum developers, and educational researchers. The study aims to improve both the effectiveness of mathematics instruction and student learning experiences, addressing a key challenge in teaching abstract mathematical concepts.

Teachers. Innovative teaching strategies that provide teachers with practical insights into how mathematics games can be used as an instructional tool to improve student engagement, motivation, and understanding of integers. By demonstrating the potential benefits of game-based learning, the study may encourage teachers to adopt more interactive, student-centered teaching methods. Enhanced Classroom Experience, Teachers will gain knowledge on how to integrate games effectively into their lessons, creating a more dynamic and enjoyable learning environment. This can help reduce the monotony of traditional lectures and worksheets, fostering a more positive classroom culture.

Students. Improved understanding of Integers directly benefits students by exploring a teaching strategy that could make the complex concept of integers more accessible and easier to understand. Through game-based learning, students may develop a deeper conceptual understanding of integers and their operations, leading to improved performance in mathematics. Increased Engagement and Motivation, mathematics games are designed to be engaging, providing students with a fun and interactive way to learn. This can help increase their interest in the subject, potentially reducing math anxiety and fostering a more positive attitude toward mathematics. Engaged students are more likely to retain information and enjoy the learning process. Beyond the understanding of integers, students may develop essential skills such as problem-solving, critical thinking, and collaboration through the use of games, which often involve teamwork and strategic thinking.

School Administrators. The results of this study can provide valuable data to curriculum developers and school administrators when designing or updating mathematics curricula. If mathematics games are shown to be effective, schools may consider incorporating them into the standard curriculum as a supplementary or alternative teaching method. Understanding the potential benefits of game-based learning can help school administrators make informed decisions about investing in educational resources, such as mathematics games, technology, and teacher training. By supporting innovative teaching methods, schools can improve overall student performance and engagement in mathematics.

Future Researchers. The growing body of research on game-based learning and its application in mathematics education. It offers empirical evidence on how games can influence student understanding, engagement, and attitudes, particularly in relation to abstract mathematical concepts like integers. The study opens new avenues for further research into the effectiveness of games in teaching other mathematical concepts or in different educational contexts. It may also inspire future studies on long-term impacts, variations in game design, or comparisons with other innovative teaching strategies.

Policy Makers. They can use the findings to promote the inclusion of interactive learning tools, like mathematics games, in national or regional educational policies. The study provides evidence that supports the integration of technology and innovative teaching strategies into the classroom, contributing to broader efforts to modernize education systems.

Parents. The study highlights the potential of mathematics games as a tool that parents can use to support their children's learning at home. Understanding the benefits of these games may encourage parents to engage with their children in mathematical activities, contributing to the development of a positive learning environment both inside and outside the classroom.

1.9 Definition of Terms

To ensure clarity and consistency throughout this study, the following key terms are defined as they are used within the context of this research. These definitions aim to provide a common understanding of the concepts central to the investigation of using mathematics games as a pedagogical tool for teaching integers to Grade 6 students. By establishing clear operational definitions, this section supports accurate interpretation of the findings and ensures that readers and future researchers can follow the study with a shared understanding of the terminology.

Game-Based Learning. The use of educational games or simulations to teach students specific skills or concepts. In this study, game-based learning involves the use of mathematics games to teach integers, with the goal of increasing student engagement, improving conceptual understanding, and making learning more enjoyable.

Integers. Integers are a set of numbers that include whole numbers and their negatives, such as ..., -3, -2, -1, 0, 1, 2, 3, ... In mathematics, integers are used for various operations, including addition, subtraction, multiplication, and division. This study

focuses on helping Grade 6 students understand integer concepts, particularly positive and negative numbers, and perform operations with integers.

Mathematics Games. Refers to educational games specifically designed to teach mathematical concepts in an interactive and engaging way. In this study, mathematics games focus on enhancing students' understanding of integers through activities, puzzles, or digital tools that involve mathematical problem-solving. These games can be either digital (e.g., apps, online platforms) or physical (e.g., board games or card games) and are used as a teaching strategy.

Performance. It pertains to the achievement of the Grade 6 students in the pre-test and post-test results based on the third quarter test.

Post-test. A post-test is an assessment administered after the instructional intervention has taken place. In this study, it is used to measure the students' learning and understanding of integers following the use of mathematics games. The results of the post-test are compared with those of the pre-test to determine any improvement in performance and the effectiveness of the teaching strategy

Pre-test. A pre-test is an assessment administered to students before the implementation of an instructional intervention, such as the use of mathematics games. It is designed to evaluate the students' prior knowledge and skills related to a specific topic-in this study, integers. The results of the pre-test serve as a baseline for measuring the effectiveness of the intervention by comparing them with post-test outcomes.

2. METHODOLOGY

This chapter presents the research design, data sources, instrumentation, data collection, data analysis tools, and ethical considerations.

2.1 Research Design

The study utilized a quasi-experimental quantitative design involving a pre-test and post-test. Respondents were randomly assigned to groups selected based on classroom availability and teacher consent.

The implementation plan for the study involved the Grade 6 learners. At the start of the 3rd quarter, the learners took a 30-item pre-test to assess their initial understanding of integers. Following the pre-test, respondents received the intervention using Integer Number Line Race, Integer War (Game card), Integer Bingo, and Integer Jeopardy Mathematics Games. At the end of the quarter, the researcher administered a 30-item post-test to evaluate their skills in integers and measure any changes in learning outcomes.

2.2 Sources of Data

In this study examining the use of mathematics games in teaching integers to Grade 6 students, data was collected from multiple sources to ensure a comprehensive understanding of the impact of the intervention. The sources of data were categorized into quantitative data.

2.3 Locale of the Study

The respondents of this research are the Grade 6 students in a private school in Dagupan City. A total of 22 students participated in the study.

2.4 Population Sampling

This study focused on Grade 6 students in private schools using random sampling methods. The aim is to create a representative sample that allows for effective comparison between the pretest and post-test of the Grade 6 students while addressing ethical considerations and ensuring a manageable sample size. This approach enabled the researcher to yield meaningful insights into the effectiveness of mathematics games in teaching integer concepts within the specific educational context.

2.5 Instrumentation and Data Collection

The researcher employed a teacher-made third-quarter test for both pre-test and post-test assessments. The pre-test was administered before the implementation of the intervention to establish a baseline measurement of student performance. Following the intervention, a post-test was conducted to evaluate any changes or improvements in performance.

To ensure the content validity of the test items, the researcher developed a Table of Specifications (TOS) that aligns with the Most Essential Learning Competencies (MELCs) for various grade levels, specifically focusing on the third quarter. The construction of the test items was guided by Bloom's Taxonomy, ensuring that a diverse range of cognitive skills is assessed. The test questions were drawn from a validated test bank, which has received approval from both the master teacher and the head teacher to guarantee accuracy and relevance.

Permission to conduct the study and collect the necessary data were obtained from the principals of the private schools. The study took place during the third quarter, with the experimental group receiving instruction through Game-Based learning. The intervention was delivered by a qualified teacher holding a Bachelor of Elementary Education (BEED) degree, with at least two years of experience in private schools.

The conduct of research lasted for six weeks, with 50-minute teaching sessions scheduled each day. After this study period, the post-test was administered, and the data were collected and analyzed to assess any changes or improvements in performance.

2.6 Tools for Data Analysis

The respondents' performance in Mathematics focused on their understanding of integers and aims to identify areas for improvement. First, the pre-test results were analyzed to determine the learners' initial level of performance, using descriptive statistics to highlight general trends. This provided a baseline for their grasp of mathematical concepts. Next, an item analysis of the pre-test identified specific weaknesses, pinpointing which questions or topics the learners struggled with most. Based on these results, targeted educational games were used to address these weak areas, offering a more engaging and interactive way to reinforce learning. After implementing the intervention, the post-test results were analyzed similarly to the pre-test, allowing for a comparison of performance. A paired t-test was used to determine if there is a significant difference between the pre- and post-test scores. If the

results show a significant improvement, it would indicate that the mathematics games and other interventions were effective in enhancing the learners' understanding of integers. Excel data analysis was utilized in this study to check for and ensure accurate and unbiased results.

2.7 Ethical Considerations

This study would prioritize ethical considerations throughout the research process, ensuring that the rights and well-being of all participants are protected. By adhering to ethical guidelines related to informed consent, confidentiality, voluntary participation, and risk assessment, the research aimed to conduct a responsible and respectful investigation into the use of mathematics games in teaching integers to Grade 6 students.

Confidentiality and Anonymity. All data collected from participants would be treated confidentially. Identifiable information would be removed, and data would be stored securely to protect students' privacy. Results would be reported in aggregate form, and individual student responses would not be identifiable in any reports or publications. Pseudonyms may be used in qualitative data reporting to further protect anonymity.

Data Integrity. Researchers would ensure the integrity of the data collection and analysis process, reporting findings honestly and transparently. Any potential conflicts of interest would be disclosed, and the research would adhere to academic standards.

Debriefing. After the study concludes, participants would be debriefed to explain the findings and purpose of the research. This debriefing would provide an opportunity for students to ask questions and discuss their experiences.

Ethical Approval. Before conducting the study, ethical approval would be obtained from the relevant School Principal. This ensures that the research design meets ethical standards and protects participant welfare.

Informed consent would be obtained from the parents or guardians of all participating students. A clear explanation of the study's purpose, procedures, potential risks, and benefits would be provided in written form. Students would also be asked to provide verbal or written assent to participate in the study, ensuring they understand their involvement and can choose to participate willingly.

Professional Conduct. All interactions with students, parents, and teachers would be conducted respectfully and professionally, fostering a positive research environment.

Risk Assessment. The study would be designed to minimize any potential physical, emotional, or psychological risks to participants. Careful attention would be given to ensure that all activities are safe and appropriate for Grade 6 students. Researchers would monitor participants during the study for any signs of distress or discomfort and would have protocols in place to address any concerns that arise.

Voluntary Participation in the study would be completely voluntary, and students would have the right to withdraw at any time without any negative consequences. This ensures that students feel comfortable and are not coerced into participating.

3. RESULTS AND DISCUSSION

This chapter presents the analysis and interpretation of the data gathered relative to the different sub-problems raised in the study.

Level of Performance

Grade 6 learners are at the final stage of their elementary education, typically aged between 11 and 12 years old. Their academic background is shaped by their foundational knowledge in Mathematics, including basic operations, fractions, decimals, and early algebraic concepts. The performance of these learners in Mathematics is influenced by their previous learning experiences, cognitive abilities, and exposure to interactive learning methods. Challenges often arise in transitioning to more complex topics like integers, as misconceptions and gaps in fundamental arithmetic skills may hinder their progress. This study assessed their academic strengths and weaknesses to develop effective intervention strategies.

Table 1
Score Range for Level of Performance

Score Range	Interpretation
26-30	Excellent
21-25	Very Good
16-20	Good
6-10	Needs Improvement
1-5	Poor

Table 1 presents the score range used to evaluate the level of performance of students in the study. The scores are categorized into five levels to interpret the students' mastery of the topic. A score of 26 to 30 is classified as Excellent , indicating outstanding performance and a high level of conceptual understanding. Scores between 21 and 25 fall under the *Very Good* category, suggesting a strong grasp of the material with only minor areas for improvement. The *Good* category, ranging from 16 to 20, reflects an acceptable level of performance, though there is still room for growth. Scores from 6 to 10 are interpreted as *Needs Improvement*, indicating that the student is below the expected proficiency level and requires additional support. Finally, scores between 1 and 5 are categorized as *Poor*, signifying minimal understanding and a lack of basic comprehension of the subject matter. This interpretation is crucial in assessing the effectiveness of the intervention, specifically, the use of mathematics games in teaching integers, and helps determine how much students improved from the pre-test to the post-test.

Level of Implementation

Table 2
Pre-Test Performance

Score Range	Interpretation	Frequency	Percentage
26–30	Excellent	0	0.00%
21–25	Very Good	2	9.09%
16–20	Good	18	81.82%
6–10	Needs Improvement	2	9.09%
1–5	Poor	0	0.00%
Total		22	100%

Pre-Test Performance

In Table 2, the pre-test conducted with a 30-point teacher-made test on the topic of integers, most Grade 6 learners (81.82%) scored within the good range (16–20 points). Only 9.09% reached the Very Good level (21–25 points), while another 9.09% fell into the Needs Improvement range (6–10 points). No students were categorized as Excellent or Poor. The mean score of 17.50 out of 30 suggests a moderate level of understanding prior to the lesson, and the SD of 1.87 shows relatively consistent performance among the group.

Table 3
Post-Test-Performance

Score Range	Interpretation	Frequency	Percentage
26–30	Excellent	2	9.09%
21–25	Very Good	18	81.82%
16–20	Good	2	9.09%
6–10	Needs Improvement	0	0.00%
1–5	Poor	0	0.00%
Total		22	100%

Post-Test Performance

In Table 3, a majority (81.82%) of learners scored within the Very Good range, with 9.09% advancing to the Excellent level. Only 9.09% remained in the Good category, and no students fell below this level. The mean score rose to 23.05 out of 30, with a slightly lower SD of 1.53, indicating stronger and more consistent achievement across the class.

Difference between Pre-test and Post-Test Performance

The paired samples t-test was conducted to determine whether there was a significant difference in the mathematics performance of Grade 6 learners before and after the instruction on integers. The test yielded a mean difference of -5.95 points (post-test scores were higher), with a standard deviation of 2.26. The t-value of -12.376 and the associated p-value of .000 ($p < 0.05$) indicate a statistically significant difference between the pre-test and post-test scores. The 95% confidence interval for the mean difference ranges from -6.96 to -4.95, further supporting that the post-test scores were significantly higher than the pre-test scores. There is a significant improvement in the performance of Grade 6 learners in Mathematics after the teaching intervention on integers.

Table 4
Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
pre-post	-5.95455	2.25678	.48115	-6.95515	-4.95394	-12.376	21	.000

Framework

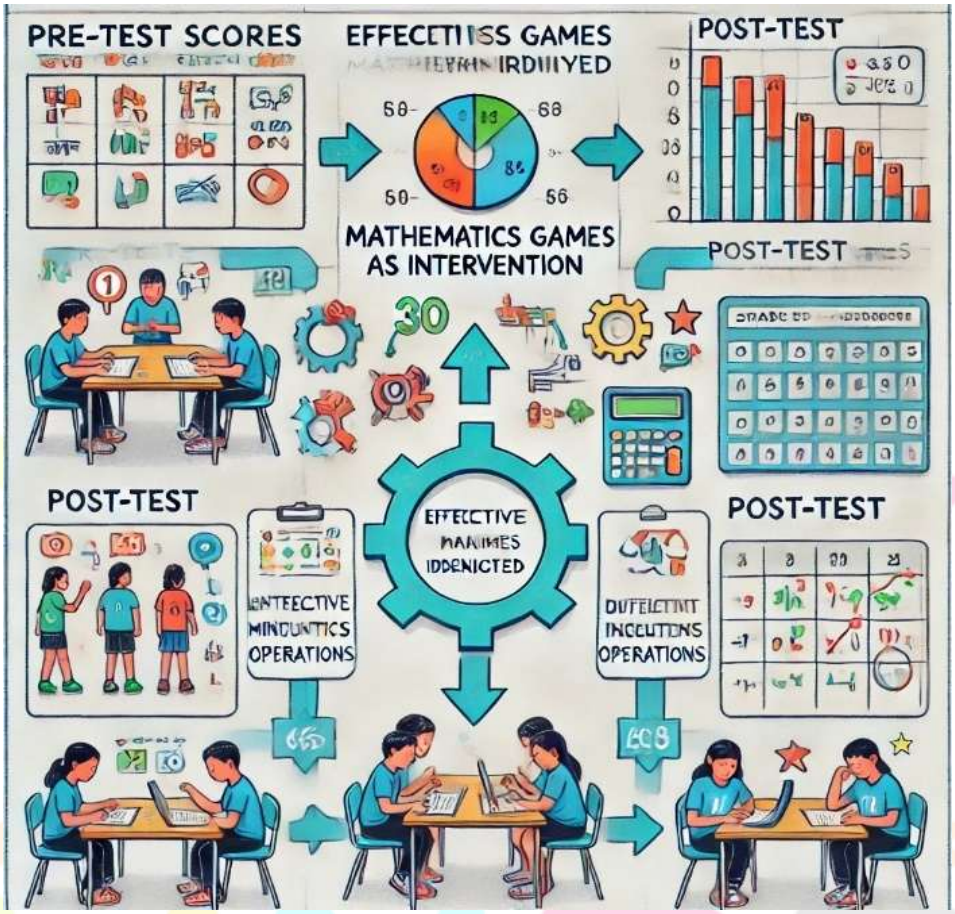

Figure 2 Framework

This study adopts a quasi-experimental design, incorporating two primary phases: a pre-test and a post-test. Between these phases, the intervention involves the use of game-based instructional strategies aimed at improving students' conceptual and procedural understanding of integers. At the beginning of the third quarter, students are administered a 30-item pre-test to establish baseline knowledge of integer operations. Following item analysis, a series of targeted mathematical games is implemented to support learning and engagement.

The intervention features four main educational games.

Integer Number Line Race (*By Math Geek Mama*) is designed to reinforce students' ability to order, compare, and locate integers, especially through addition. A large number line, displayed on the classroom floor or board and spanning both negative and positive values, serves as the primary visual aid. Students are divided into teams and compete by placing markers on the number line in response to questions or word problems involving integer addition (e.g., "What is the sum of -3 and 5?"). Points are awarded for both accuracy and speed, encouraging active participation and mental computation.

Integer War (*By TPT*) is a card-based game that focuses on comparing integers. A standard deck of cards is modified so that red cards represent negative integers and black cards represent positive integers. Face cards are either removed or assigned numerical values (e.g., Jack = 11). Players draw and compare single cards or draw two cards and perform operations such as addition or subtraction before comparing totals. This format promotes critical thinking and deepens understanding of integer operations through friendly competition.

Integer Bingo (*By Math Resources*) aims to enhance skills in adding and subtracting integers. Students receive bingo cards filled with various integers. The teacher announces problems involving integer operations (e.g., "What is –3 + 5?"), and students solve the problems before marking their cards if the correct answer is present. The first student to complete a full row, column, or diagonal is declared the winner. This format provides repeated practice and reduces math anxiety through a familiar, game-based structure.

Integer Jeopardy (*By Jeopardy Labs*) is used to review and assess multiple integer skills, including addition, subtraction, multiplication, and division. The game board is organized by category (e.g., Word Problems, Absolute Value, Integer Comparisons),

with questions increasing in difficulty and point value. Students take turns selecting and answering questions, earning points for their individual or team performance. This game promotes engagement, collaboration, and mastery of content in a dynamic classroom environment.

Following the intervention, a 30-item post-test is administered to evaluate students' progress. The post-test is parallel in structure and content to the pre-test, allowing for direct comparison. Statistical analysis is conducted using a paired-samples *t*-test to determine whether the difference in scores before and after the intervention is statistically significant, thereby evaluating the effectiveness of the game-based learning approach in improving students' understanding of integers.

4. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of the research work undertaken, the conclusions drawn, and the recommendations made for the development of this study.

4.1 Summary

Grade 6 students initially faced challenges in adding and subtracting negative numbers and applying these concepts in word problems. To address these difficulties, interactive games such as Integer Number Line Race, Integer War (Card Game), Integer Bingo, and Integer Jeopardy were introduced. These activities promoted active learning and increased student engagement.

Findings

Following these interventions, the 3rd Quarter teacher-made post-test results showed significant improvement. A majority of students (81.82%) achieved "Very Good" scores, with 9.09% reaching the "Excellent" category. No students scored in the "Needs Improvement" or "Poor" ranges. The class average rose to 23.05 out of 30, and the standard deviation decreased to 1.53, indicating more consistent performance. A paired samples t-test comparing pre-test and post-test scores revealed a mean increase of 5.95 points, with a t-value of -12.376 and a p-value of .000. This statistically significant result confirms that the instructional intervention on integers effectively enhanced students' mathematical understanding.

4.2 Conclusions

Based on the results, this study concludes that Grade 6 learners initially faced significant challenges in mastering integer operations, as reflected in their low pre-test scores. However, the implementation of Mathematics games as an intervention tool proved to be highly effective in enhancing student learning, leading to notable improvements in post-test results. These games not only reinforced mathematical concepts but also fostered engagement and motivation, making abstract topics more accessible and enjoyable for learners. Furthermore, statistical analysis confirmed a significant difference between pre-test and post-test scores, validating the effectiveness of game-based learning as a strategy for improving Mathematics performance.

4.3 Recommendations

Integrate Mathematics games into daily instruction to improve student comprehension and engagement. Use interactive and digital-based learning tools to supplement traditional teaching methods. Provide additional practice exercises using game-based activities to reinforce integer concepts. Actively participate in Mathematics games to develop a better understanding of integer operations. Work collaboratively with classmates to solve game-based problems and improve critical thinking skills.

Support the integration of game-based learning by providing training for teachers on innovative teaching strategies. Allocate resources for interactive Mathematics tools in classrooms. Encourage teachers to incorporate modern educational technologies to enhance Mathematics instruction. Conduct further studies on the long-term effects of Mathematics games on students' overall academic performance. Explore the impact of game-based learning on other Mathematics topics such as fractions, algebra, and geometry. Investigate how digital Mathematics games affect students' learning outcomes.

This study highlights the importance of game-based learning in improving student performance in Mathematics. The significant increase in post-test scores demonstrates that Mathematics games are an effective teaching strategy. Schools should consider incorporating interactive learning methods to create a more engaging and productive educational environment for learners

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