Improving Mathematics Performance Through Educational Technology: A Game-Based Learning Approach among Grade 5 Pupils in Agusan del Sur Pilot Laboratory School

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ABSTRACT
Mathematics achievement among Filipino students continues to lag behind international standards, often due to traditional teaching methods that emphasize route memorization over meaningful engagement. This research proposal investigates the effectiveness of the Game-Based Learning Strategy (GBLS) as an instructional intervention to improve the mathematics performance of Grade 5 pupils at Agusan del Sur Pilot Laboratory School. Anchored on constructivist and experiential learning theories, the study employs a one-group pre-test and posttest experimental design to measure changes in student achievement. The intervention involves integrating interactive curriculum-aligned digital games and problem-solving tasks into mathematics instruction. A researcher made 30 item achievement tests will serve as the primary instrument for data collection, with baseline performance established through a pre-test and improvement measure via a post-test. Data will be analyzed using a paired sample t-test to determine if a statistically significant difference exists between the mean scores before and after the intervention. By providing empirical evidence on the effectiveness of GBLS in a local context, this study aims to offer insights for curriculum development, teacher training, and policy decisions aimed at fostering 21st century skills and improving mathematics education in the Philippines.

The abstract serves as a concise roadmap for a study designed to address a critical gap in the Philippine education system: the persistent underperformance of students in mathematics. According to the Trends in International Mathematics and Science Study (TIMSS) 2023, only a small fraction of Filipino students meets high benchmarks in mathematics, often struggling to apply conceptual knowledge to multi-step problems. This study justifies its focus on Game-Based Learning (GBL) as a necessary shift from traditional, rote-heavy instruction toward an interactive, technology-driven approach that aligns with the needs of 21st-century learners. This research is anchored in Constructivist and Experiential Learning Theories, which by using games, learners engage in a "low stakes" environment that reduces math anxiety while providing immediate feedback. This is further supported by Flow Theory which explains how games maintain deep engagement by balancing challenge and skill, and the TPACK Framework, which ensures that technology is used pedagogically to support curriculum-aligned content. The study is particularly significant for the Agusan del Sur Pilot Laboratory School, as it tests these innovative strategies in a local public-school context. By demonstrating the effectiveness of GBLS, the research provides a replicable model for other educators and offers data-driven insights for DepEd policymakers regarding the integration of Information and Communication Technology (ICT) in foundational mathematics instruction. Ultimately, the study justifies the transition to gamifies instructions as a vital tool for improving student achievement, motivation, and retention in a technology-driven world.

Keyword Game-Based Learning Strategy: *Mathematics Performance, Educational Technology, Interactive Learning, Grade 5 pupils*, *Constructivist, Experiential Learning*

1. CHAPTER 1

1.1 INTRODUCTION

The world today is undergoing rapid technological transformation, reshaping many aspects of human life, including education. Digital innovation has become a defining feature of the 21st century, influencing how people communicate, work, and learn. As societies adapt to these changes, schools face the challenge of preparing learners with the skills necessary to thrive in a technology-driven environment. Education is no longer confined to traditional textbooks and chalkboards; instead, it increasingly incorporates digital tools, interactive platforms, and innovative strategies that reflect the realities of modern life. Among the disciplines most affected by these changes is mathematics, a subject central to logical reasoning, scientific advancement, and technological innovation. Mathematics remains a cornerstone of education, providing learners with mental discipline, problem-solving skills, and the ability to connect concepts across science, technology, social studies, and even the arts. In the technological age, mathematics is not only a tool for knowledge but also a foundation for innovation, making it essential for teachers to adopt modern strategies that resonate with today's learners. The ability to understand and apply mathematical concepts is critical for success in fields such as engineering, computer science, economics, and data analytics, all of which drive global progress. Despite its importance, mathematics achievement among Filipino students continues to lag behind international standards. The Trends in International Mathematics and Science Study (TIMSS) 2023 revealed that only a small proportion of Filipino fourth-grade students reached the high benchmark in mathematics, indicating limited ability to apply conceptual understanding to solve multi-step problems. This persistent gap reflects broader challenges in the Philippine education system, including limited access to resources, reliance on traditional teaching methods, and difficulties in sustaining learner motivation. The results highlight the urgent need for innovative teaching approaches that can enhance engagement, reduce math anxiety, and improve performance in mathematics. One promising strategy is Game-Based Learning (GBL), which integrates educational technology with interactive play to foster deeper understanding of mathematical concepts. GBL is grounded in constructivist and experiential learning theories, emphasizing active participation, exploration, and problem-solving. Recent studies highlight GBL's effectiveness in improving student achievement, motivation, and confidence. For example, Debrenti (2024) found that digital game-based learning environments support varied representations of mathematical concepts, helping students build and reinforce connections. Similarly, Hidayat et al. (2024) emphasized that online GBL is particularly effective for Generation Z learners, who are naturally inclined toward digital interaction. In the Philippine context, Cayang and Ursabia (2024) demonstrated significant improvement in mathematics performance among elementary pupils after GBL interventions, showing its potential to transform traditional instruction. GBL's strength lies in its ability to make learning both engaging and meaningful. By setting clear objectives aligned with curriculum standards, teachers can implement student centered activities that encourage exploration and problem-solving. Research shows that GBL promotes implicit learning, where students acquire mathematical skills without realizing they are practicing formal concepts, thereby reducing anxiety and fostering creativity. Moreover, the interactive nature of games provides immediate feedback, allowing learners to correct mistakes in a safe environment and build confidence in their abilities. Unlike traditional drills, GBL situates learning in contexts that are enjoyable and relatable, making mathematics less intimidating and more accessible to diverse learners. In addition, GBL aligns with the Department of Education's (DepEd) thrust toward integrating Information and Communication Technology (ICT) in classroom instruction. The Philippine education system has emphasized the importance of digital literacy and 21st-century skills, recognizing that learners must be equipped not only with academic knowledge but also with technological competencies. By incorporating GBL into mathematics instruction, schools can bridge the gap between traditional pedagogy and modern digital practices, ensuring that pupils are prepared for future academic and professional challenges. Given these benefits, this study proposes the use of educational technology through game-based learning to improve the mathematics performance of Grade 5 pupils at Agusan del Sur Pilot Laboratory School. This approach is flexible enough to be implemented in both face to-face and online settings, ensuring continuity of learning even in times of disruption such as lockdowns. By leveraging technology-enhanced strategies, the research aims to contribute to more effective mathematics instruction and to address the persistent challenges in student achievement. Ultimately, the study seeks to provide empirical evidence on the effectiveness of GBL in the local context, offering insights that may inform curriculum development, teacher training, and policy decisions in Philippine basic education.

1.2 THEORETICAL FRAMEWORK

This study is anchored on the idea that educational technology, specifically game-based learning (GBL), can significantly improve mathematics performance among Grade 5 pupils. Mathematics has long been recognized as a

fundamental discipline that develops logical reasoning, problem-solving, and analytical skills, yet many learners continue to struggle with its abstract nature. By integrating GBL into instruction, teachers can provide pupils with interactive, engaging, and meaningful experiences that make mathematical concepts more accessible and enjoyable. The theoretical foundation of this study draws from several established perspectives in education and psychology, each of which explains how GBL can enhance learning outcomes.

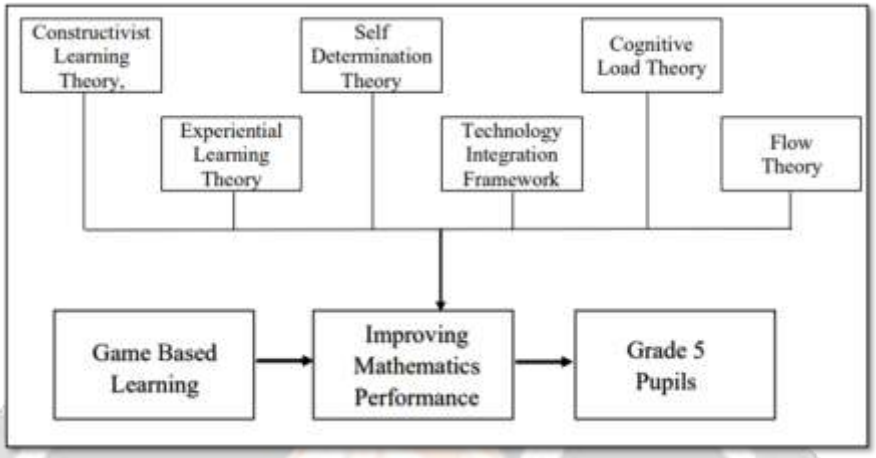


Chart -1: Theoretical Framework (Font-10)

Constructivist Learning Theory, advanced by Piaget and Vygotsky, emphasizes that learners actively construct knowledge through interaction and experience. In the context of GBL, pupils are not passive recipients of information but active participants who explore mathematical concepts, test strategies, and receive immediate feedback. This aligns with Kolb's Experiential Learning Theory, which highlights the importance of learning through cycles of experience, reflection, and application. Games provide concrete experiences that allow pupils to reflect on their actions, conceptualize mathematical principles, and apply them in new problem-solving situations. Together, these theories suggest that GBL can transform mathematics instruction into a dynamic process of discovery and application. Motivation also plays a crucial role in learning, and Self-Determination Theory by Deci and Ryan explains how autonomy, competence, and relatedness drive intrinsic motivation. GBL fosters these elements by allowing pupils to make choices, progress through levels that demonstrate competence, and collaborate with peers in shared tasks. When learners feel motivated, they are more likely to persist in solving mathematical problems and to develop confidence in their abilities. This motivational aspect is further supported by Csikszentmihalyi's Flow Theory, which describes deep engagement as occurring when challenge and skill are balanced. Games naturally adjust difficulty levels, keeping pupils in a state of flow where learning feels enjoyable and rewarding, thereby sustaining their interest in mathematics. Equally important is the integration of technology into pedagogy, as explained by the Technological Pedagogical Content Knowledge (TPACK) framework of Mishra and Koehler. Effective teaching requires the alignment of content knowledge, pedagogical strategies, and technological tools. In this study, GBL represents the technological component, mathematics provides the content, and constructivist and experiential approaches guide pedagogy. This integration ensures that GBL is not only entertaining but also curriculum-aligned and pedagogically sound. Cognitive Load Theory further strengthens this foundation by emphasizing that learning is optimized when instructional design reduces unnecessary cognitive demands. Well-designed games scaffold mathematical concepts into manageable tasks, allowing pupils to focus on essential problem-solving skills without being overwhelmed. Taken together, these theories provide a strong foundation for the present study. They explain how GBL can enhance mathematics performance by engaging pupils in active learning, fostering motivation, integrating technology effectively, and sustaining deep engagement. By applying these theoretical perspectives to the local context of Agusan del Sur Pilot Laboratory School, this research seeks to demonstrate that educational technology, when thoughtfully implemented, can transform mathematics instruction into an interactive, motivating, and effective approach that improves performance among Grade 5 pupils.

1.3 CONCEPTUAL FRAMEWORK

This conceptual framework illustrates the cause-and-effect relationship between the use of Game-Based Learning Strategy (GBLS) and the mathematics performance of Grade 5 pupils. GBLS serves as the independent variable, representing the instructional intervention designed to enhance learning through interactive, technology-supported games. The central hypothesis of the study is that the implementation of GBLS will lead to improved mathematics performance, which is the dependent variable. The framework also identifies several moderating and mediating variables that influence the strength and direction of this relationship. Learner engagement and technology accessibility are considered moderating variables, as they can either enhance or limit the effectiveness of GBLS. Pupils who are more engaged and have access to reliable digital tools are expected to benefit more from the strategy. Teacher facilitation is treated as a mediating variable, since the teacher's ability to align game-based activities with curriculum goals and guide learners through the process plays a critical role in translating the strategy into measurable learning outcomes. Additionally, pupil characteristics such as prior knowledge, learning styles, and attitudes toward mathematics may further influence how learners respond to GBLS. The framework assumes that when GBLS is implemented effectively—supported by high engagement, accessible technology, and skilled facilitation—it will result in significant improvement in pupils' mathematics performance. This structure guides the study's investigation into how educational technology can be leveraged to create more engaging, motivating, and effective mathematics instruction in the context of Agusan del Sur Pilot Laboratory School.

1.4 STATEMENT OF THE PROBLEM

Mathematics is a core subject in the Philippine basic education curriculum, essential for developing logical reasoning, problem-solving skills, and analytical thinking. However, many Grade 5 pupils continue to struggle with mathematics performance, as reflected in classroom assessments and national indicators. Traditional teaching methods often emphasize rote memorization and repetitive drills, which may fail to engage learners meaningfully and contribute to low achievement and math anxiety. This persistent challenge highlights the need for innovative instructional approaches that can make mathematics more interactive, motivating, and effective. Educational technology offers promising solutions, and one emerging approach is the Game-Based Learning Strategy (GBLS). International studies have shown that GBL can improve learner engagement, motivation, and achievement by providing interactive, feedback rich environments. Yet, despite its potential, the application of GBLS in Philippine public schools remains limited and underexplored. There is a lack of empirical evidence on whether GBLS can significantly improve mathematics performance among Filipino pupils, particularly in the local context of Agusan del Sur Pilot Laboratory School. This study seeks to address this gap by evaluating the effects of GBLS on the mathematics performance of Grade 5 pupils. Specifically, it aims to determine the mean scores of pupils before and after the use of GBLS, to establish whether there is a significant difference in their performance, and to identify the implications of the findings for improving mathematics instruction. By investigating these questions, the study intends to provide evidence-based insights into the effectiveness of game-based learning as an educational technology strategy, thereby contributing to the development of more engaging and effective mathematics teaching practices in Philippine basic education. There is no statistically significant difference in the mean mathematics performance scores of Grade 5 pupils before and after the implementation of the Game-Based Learning Strategy.

1.5 SCOPE AND LIMITATION OF THE STUDY

This study focuses on examining the effectiveness of the Game-Based Learning Strategy (GBLS) in improving the mathematics performance of Grade 5 pupils. The investigation will be conducted at Agusan del Sur Pilot Laboratory School and will specifically involve pupils currently enrolled in Grade 5 during the Fourth Quarter of the school year. The scope of the study is confined to evaluating mathematics achievement through the administration of a researcher-made questionnaire, which will serve as the primary instrument for data collection. Performance will be measured using pre-test and post-test scores to determine the level of improvement after the intervention. The study is limited to the selected Grade 5 pupils of Agusan del Sur Pilot Laboratory School and does not extend to other grade levels or subject areas. The effectiveness of GBLS will be assessed only in terms of its impact on mathematics performance, without considering other possible influences such as socio-economic background, prior academic achievement, or external learning support. Furthermore, the statistical treatment of data will be restricted to the use of the t-test, which will determine whether there is a significant difference between the mean scores before and after the implementation of GBLS. These delimitations ensure that the study remains focused, manageable, and achievable within the given timeframe and resources.

1.6 SIGNIFICANCE OF THE STUDY

Mathematics is a foundational subject in the Philippine basic education curriculum, essential for developing logical reasoning, problem-solving skills, and analytical thinking. Yet, many pupils continue to struggle with mathematics performance, often due to traditional teaching methods that emphasize rote memorization rather than meaningful engagement. This persistent challenge has prompted educators and researchers to explore innovative strategies that integrate educational technology into classroom instruction. One promising approach is the Game-Based Learning Strategy (GBLS), which combines interactive digital tools with curriculum-aligned content to create engaging and student-centered learning experiences. While international studies have demonstrated the effectiveness of GBLS in enhancing motivation and academic achievement, its application in Philippine public schools remains limited and underexplored. There is a clear research gap in understanding whether GBLS can significantly improve mathematics performance among Filipino pupils, particularly in the local context of Agusan del Sur Pilot Laboratory School. Addressing this gap is crucial, as it provides empirical evidence on the potential of technology-enhanced strategies to transform mathematics instruction in Philippine classrooms. This study contributes to the academic community by grounding its investigation in established theories such as constructivism, experiential learning, self-determination, and flow theory, thereby offering a strong theoretical foundation for the use of GBLS. Methodologically, it introduces the use of pre-test and post-test measures with statistical analysis to evaluate the effectiveness of the intervention, providing a replicable model for future research. Practically, the findings of this study will benefit teachers by offering insights into how GBLS can be integrated into mathematics instruction to increase learner engagement and achievement. School administrators and policymakers may also use the results to inform decisions about adopting educational technology strategies that align with curriculum goals and improve learning outcomes. Beyond its immediate context, the study has broader relevance to ongoing efforts in Philippine education to promote 21st-century skills, digital literacy, and inclusive learning environments. By demonstrating the effectiveness of GBLS in mathematics, the research underscores the importance of integrating technology into teaching practices to make learning more interactive, motivating, and effective. Ultimately, this study contributes to the national goal of improving mathematics performance and preparing pupils for future academic and professional challenges in a technology-driven world.

1.7 DEFINITION OF TERMS

The following terms were defined operationally for better understanding:

• Game-Based Learning Strategy (GBLS) – In this study, GBLS refers to the use of interactive digital games designed by the researcher to teach Grade 5 mathematics lessons. It is the instructional intervention applied to improve pupils' performance.

• Educational Technology – In this study, educational technology refers to the integration of digital tools and strategies, specifically GBLS, to enhance mathematics instruction.

• Mathematics Performance – This refers to the Grade 5 pupils' achievement in mathematics as measured by their scores in the researcher-made pre-test and posttest.

• Independent Variable – In this study, the independent variable is the use of GBLS, which is introduced as the instructional strategy.

• Dependent Variable – The dependent variable is the mathematics performance of Grade 5 pupils, measured through test scores before and after the intervention.

• Learner Engagement – This refers to the level of motivation, interest, and active participation of pupils during the implementation of GBLS, observed through their involvement in game-based activities.

• Technology Accessibility – In this study, this refers to the availability and usability of digital tools (computers, tablets, or projectors) necessary for implementing GBLS in the classroom.

• Teacher Facilitation – This refers to the teacher's role in guiding pupils during GBLS activities, ensuring that the games are aligned with curriculum objectives and that pupils understand the mathematical concepts embedded in the games.

• Pre-test – The assessment administered before the implementation of GBLS to establish the baseline mathematics performance of Grade 5 pupils.

• Post-test – The assessment administered after the implementation of GBLS to measure improvement in mathematics performance.

• T-Test – The statistical method used in this study to determine whether there is a significant difference between the mean scores of the pre-test and post-test.
• Grade 5 Pupils – The participants of this study, specifically those enrolled in Grade 5 at Agusan del Sur Pilot Laboratory School during the Fourth Quarter of the school year.

2. CHAPTER 2 REVIEW OF RELATED LITERATURE AND STUDIES

I. Conceptual Literature Mathematics is considered a cornerstone of education, essential for developing mental discipline, logical reasoning, and problem-solving skills necessary for innovation in a technological age. Despite its critical role, achievement levels among Filipino learners continue to lag behind international standards. For instance, results from the Trends in International Mathematics and Science Study (TIMSS) 2023 indicated that only a marginal proportion of Filipino fifth-grade students reached high benchmarks in mathematics, demonstrating limited ability to apply conceptual understanding to complex problems. Traditional teaching methods, which often prioritize rote memorization and repetitive drills, are frequently cited as factors contributing to low student engagement and performance. Game-Based Learning Strategy (GBLS) is defined as an instructional approach that integrates educational technology with interactive play to achieve specific learning objectives. Unlike traditional instruction, GBL leverages the mechanics of games such as goals, rules, and immediate feedback to create an immersive environment where learning happens implicitly. A key characteristic of GBL is its ability to reduce "math anxiety" by providing a low stakes environment where learners can experiment and learn from mistakes without the fear of immediate academic penalty.

II. Theoretical Framework The effectiveness of GBL is grounded in several established educational theories:
- Constructivist Theory: Grounded in the work of Piaget and Vygotsky, this theory posits that learners active construct their own knowledge through experience. GBL facilitates this by allowing Grade 5 pupils to interact with mathematical concepts in dynamic, digital, or physical environments.
- Self-Determination Theory (SDT): Proposed by Deci and Ryan, SDT emphasizes that intrinsic motivation is fostered when students feel autonomous, competent, and related to others. GBL satisfies these needs by offering choices (autonomy) and clear progression levels (competence).
- Flow Theory: Developed by Csikszentmihalyi, this theory suggests that deep engagement occurs when a task's challenge matches the learner's skill level. Educational games are designed to maintain this "flow" state through scaffolded difficulty.
- TPACK Framework: The Technological Pedagogical Content Knowledge framework ensures that the use of GBL is not just for entertainment but is strategically aligned with specific mathematical content and sound pedagogy.

2.1 FOREIGN STUDIES

2.1.1 Impact on Student Achievement and Motivation Global research from the last five years consistently demonstrates that GBL is a multi-dimensional intervention that addresses both what students learn (cognitive) and how they feel about learning (affective). A systematic review by Mahmud et al. (2023) analyzed the influence of GBL in mathematics, concluding that it positively impacts five key affective domains: achievement, attitude, motivation, interest, and engagement [1]. The study highlighted that GBL not only quickens the pace of learning but also helps students develop self-esteem by providing a sense of accomplishment through game levels. Similarly, Nadeem et al. (2023) examined digital GBL platforms popular at the elementary level, such as Prodigy and Boddle [2]. Their findings indicated that these immersive environments significantly improve academic performance by fostering active participation. Unlike traditional lectures, these games allow pupils to "learn by doing," which is particularly effective for Grade 5 learners who are transitioning from concrete to more abstract mathematical operations.
2.1.2 Cognitive Benefits: Problem-Solving and Conceptual Understanding One of the most significant advantages of GBL is its ability to bridge the gap between concrete and abstract understanding. Acquah and Katz (2020) found that educational digital games specifically designed for mathematics improve problem-solving skills by requiring

students to apply logic to progress within the game world [3]. This "procedural" way of learning helps students formulate mathematical situations into models, a core competency required in modern curricula. Further research by Debrenti (2024) reinforces this, stating that digital game environments facilitate "varied representations" of mathematical concepts [4]. This allows students to build stronger mental connections between abstract symbols (like fractions or decimals) and their practical applications. By maintaining the student's attention and working memory through exciting visuals, GBL helps speed up visual information processing during complex tasks.

2.1.3 Retention and Long-Term Effects The effectiveness of GBL extends beyond immediate test scores. A study by Al-Hassan (2024) involving 120 elementary students revealed that those taught with GBL significantly outperformed a control group in both immediate and delayed post-tests [5]. This suggests that GBL is not merely a short-term "fun" activity but a robust pedagogical tool that strengthens the retention of mathematical concepts over time. The study also noted that the "low-stakes" environment of games reduces "math phobia," making students more likely to engage with the subject in the future.

2.1.4 Comparative Effectiveness: GBL vs. Traditional Instruction Comparative studies have increasingly favored GBL over conventional "chalk-and-talk" methods. A meta-analysis of 26 studies published between 2012 and 2021 by Muhaimin et al. (2025) concluded that GBL proved to be a "highly effective learning strategy" across numerous disciplines [6]. Specifically, in mathematics, students reported higher levels of concentration and retention when using GBL compared to traditional strategies. In a randomized controlled trial, Partovi and Razavi (2019) found that students using online learning games achieved better academic results in math than peers who practiced concepts through traditional worksheets [7]. They argued that the "low-risk competition" and "immediate feedback" inherent in games provide a more effective learning environment than delayed grading in traditional classrooms.

2.1.5 GBL and the Generation Z Learner Understanding the demographic of the learner is crucial. Hidayat et al. (2024) emphasizes that Online GBL is uniquely suited for Generation Z (and the subsequent Generation Alpha) because these learners are "digital natives" [8]. They are naturally inclined toward interactive decision-making and rapid feedback. International studies suggest that for this age group, technology is not just a tool but a primary mode of interaction, making GBL a necessary evolution in mathematics instruction to maintain relevance and effectiveness in the 21st century.

2.2 LOCAL STUDIES

2.2.1 Effectiveness in Grade 5 Mathematics in the Philippine primary education system, Game-Based Learning (GBL) has emerged as a key intervention for addressing numeracy gaps. Munda et al. (2024) explored the effectiveness of GBL in improving the fundamental operations skills of Grade 5 learners [9]. Their study revealed that integrating game-based materials resulted in a significant shift from "poor" pre-test performance to "very satisfactory" post-test levels, with computed t-values exceeding critical values at a 0.05 level of significance. This aligns with the findings of Cayang and Ursabia (2024), whose experimental study in North Cotabato demonstrated that fourth and fifth-grade pupils in GBL environments scored significantly higher than those taught through conventional methods, proving that the strategy is particularly effective for foundational concepts like fractions and basic arithmetic [10].

2.2.2 Localization and Traditional Game Integration A growing trend in Philippine research is the use of localized games to make mathematics more culturally relevant. Maghanoy (2023), through a study published in DepEd's E-Saliksik, investigated the use of Larong Pinoy (traditional Filipino games) like Patintero and Langit-Lupa to teach Grade 5 mathematics [11]. The research found that these culturally familiar activities not only improved academic performance but also reduced "math anxiety" by creating a joyful and social learning environment. By connecting abstract concepts to physical movements and local traditions, the study demonstrated that GBL does not always require high-end technology to be effective in a local setting.

2.2.3 Impact on Engagement and Performance under the MATATAG Curriculum With the implementation of the MATATAG Curriculum, recent studies have focused on how GBL supports active and enjoyable learning. Sulpico et al. (2025) conducted action research in a laboratory school context (similar to Agusan del Sur Pilot Laboratory School) and found that both digital and non-digital GBL strategies led to a "robust and statistically significant" association between student engagement and mathematical success [12]. Their results indicated a mean gain score of over 50%, suggesting that GBL is a vital tool for bridging performance gaps in the current Philippine basic education framework.

2.2.4 Challenges and Moderating Variables in Local Implementation While local studies overwhelmingly support GBL, they also highlight contextual challenges. Research by Marcaida et al. (2024) noted that the extent of GBL integration in Philippine schools is often moderated by the "digital divide" [13]. Factors such as limited internet

connectivity in remote communities and the varying computer literacy levels of teachers can affect the consistency of GBL's impact. However, even with these hurdles, a positive correlation remains between gamified instruction and academic performance, reinforcing the need for schools especially pilot laboratory schools to lead in the development of sustainable GBL models.

3. CHAPTER 3

3.1 RESEARCH DESIGN

The objective of this study is to determine the effectiveness of the Game-Based Learning Strategy (GBLS) in improving the mathematics performance of Grade 5 pupils, particularly in mastering basic operations. To achieve this objective, the study will employ a one-group pre-test–post-test experimental design. This design is appropriate because it allows the researchers to measure the performance of the same group of pupils before and after the intervention, thereby identifying any significant changes attributable to the use of GBLS. In this design, the Grade 5 pupils of Agusan del Sur Pilot Laboratory School will serve as the participants. A researcher-made mathematics achievement test will be administered as the pre-test to establish baseline performance. Following this, the pupils will be exposed to a series of game-based learning activities carefully designed to align with the Grade 5 mathematics curriculum. These activities will incorporate interactive digital games and problem-solving tasks intended to foster engagement, reduce anxiety, and enhance conceptual understanding. After the intervention period, the same achievement test will be administered as the post-test to measure improvement in performance. The results of the pre-test and post-test will then be compared using appropriate statistical methods, specifically the paired sample t-test, to determine whether there is a statistically significant difference in the pupils' mean scores. This research design ensures that the study remains focused on evaluating the direct impact of GBLS on mathematics performance. By using a single group measured at two points in time, the design provides a clear basis for determining the effectiveness of the intervention while controlling for individual differences among learners.

3.2 RESEARCH LOCALE

This study will be conducted at Agusan del Sur Pilot Laboratory School, located in Barangay 4, Municipality of San Francisco, Province of Agusan del Sur, within the Division of Agusan del Sur in the Caraga Region, Mindanao. Agusan del Sur Pilot Laboratory School is a public institution that caters to elementary-level learners and serves as one of the key educational centers in the municipality. The school provides a conducive learning environment for pupils, with classrooms equipped for both traditional and technology-enhanced instruction. It is strategically situated within the community, making it accessible to learners from diverse socio-economic backgrounds. The institution follows the Department of Education's (DepEd) K–12 curriculum, with mathematics as one of its core subjects. The locale was chosen because it represents a typical public elementary school setting in the region, where challenges in mathematics performance are evident among pupils. Conducting the study in this school allows the researchers to evaluate the effectiveness of the Game-Based Learning Strategy (GBLS) in a real classroom context, providing insights that are relevant and applicable to similar schools in Agusan del Sur and across the Caraga Region.

3.3 RESEARCH RESPONDENTS

The respondents of this study will be the Grade V pupils of Agusan del Sur Pilot Laboratory School enrolled during the Fourth Quarter of the school year 2025–2026. These learners were chosen as participants because they represent the target population for which the effectiveness of the Game-Based Learning Strategy (GBLS) in mathematics instruction is to be evaluated. Grade V pupils are at a critical stage in developing foundational skills in basic operations, problem-solving, and logical reasoning, making them suitable subjects for the intervention. The selection of respondents will be limited to those officially enrolled in Grade V at Agusan del Sur Pilot Laboratory School during the specified period. All participants will be given equal opportunity to take part in the study, subject to the approval of the school administration and the informed consent of their parents or guardians. The total number of respondents will depend on the actual enrollment of Grade V pupils, ensuring that the study reflectsthe authentic classroom context of the school. By focusing on this group, the study aims to generate reliable data on the impact of GBLS on mathematics performance, providing insights that may be applied to similar learner populations in other public elementary schools within the Division of Agusan del Sur.

3.4 RESEARCH INSTRUMENTS

To gather the necessary data for this study, the researchers will utilize a pre-test and post-test design. A researcher-made mathematics achievement test will serve as the primary instrument, consisting of 30 multiple-choice items specifically designed for Grade V pupils. The test items will cover basic mathematical operations and problem-solving skills aligned with the Department of Education's Grade V mathematics curriculum. The instrument will undergo content validation by mathematics teachers and subject experts to ensure that the questions are appropriate, reliable, and reflective of the competencies expected at the Grade V level. A pilot test may also be conducted to further refine the items and establish clarity and consistency. The pre-test will be administered at the beginning of the intervention period to establish baseline performance. Following this, pupils will participate in mathematics lessons integrated with the Game-Based Learning Strategy (GBLS), which will involve interactive digital games and structured activities designed to enhance engagement and conceptual understanding. After the completion of the intervention, the post-test will be administered to measure improvement in performance. The results of the pre-test and post-test will provide the basis for determining the effectiveness of GBLS in improving mathematics performance. Scores will be tabulated, analyzed, and compared using appropriate statistical methods, specifically the paired sample t test, to identify whether there is a significant difference between the pupils' mean scores before and after the intervention. Additionally, the researchers will prepare GBLS-based worksheets and activity guides to support the intervention. These materials will be aligned with the lessons covered during the instructional period and will serve as supplementary tools to reinforce learning through interactive practice.

3.5 DATA GATHERING PROCEDURE

Prior to the conduct of the study, the researchers will formally seek approval from the school head of Agusan del Sur Pilot Laboratory School to implement the research on improving mathematics performance among Grade 5 pupils through the use of the Game-Based Learning Strategy (GBLS). In compliance with ethical standards, informed consent forms will be distributed to the participating Grade 5 pupils and their parents or guardians, ensuring voluntary participation and confidentiality of responses. The data collection will employ a pre-test–post-test experimental design. A researcher made mathematics achievement test will be administered asthe pre-test to establish the baseline performance of the pupils before the intervention. Following this, the researchers will implement GBLS in mathematics classes over a defined instructional period, integrating interactive, curriculum-aligned games into the lessons. After the full administration of the intervention, the same achievement test will be administered as the post-test to measure changes in performance. The scores obtained from the pre-test and post-test will be tabulated and analyzed using appropriate statistical methods. Specifically, the paired sample t-test will be employed to determine whether there is a statistically significant difference between the mean scores before and after the intervention. This procedure ensures that the effectiveness of GBLS in improving mathematics performance is objectively measured and validated.

3.6 ETHICAL CONSIDERATION

In the conduct of this study, the researchers were guided by the following ethical principles:
Vulnerability. The respondents of this study are Grade 5 pupils, who are considered minors and therefore a vulnerable group. To protect their rights and welfare, informed consent was obtained from their parents or guardians, while assent was secured from the pupils themselves. Participation in the study was voluntary, and pupils were free to withdraw at any time without penalty or negative consequences to their academic standing.
Conflict of Interest. The researchers clarified to all participants and stakeholders that there was no conflict of interest in the conduct of thisstudy. The research was undertaken solely for academic purposes and professional advancement, with no financial or personal gain involved. The researchers had no affiliations or relationships that could influence the results or compromise the integrity of the study.

Informed Consent Process. Prior to data collection, the objectives, procedures, and scope of the study were explained to both pupils and their parents or guardians. Consent forms were distributed and signed to confirm voluntary participation. Pupils were assured that they could decline to answer questions or withdraw from the study at any time without prejudice.

Review of Risks and Measures to Mitigate. The study posed minimal risks to participants, limited to possible mild stress during the administration of pre-tests and post-tests. To mitigate this, the researchers ensured that the test items were clear, age-appropriate, and aligned with the Grade 5 mathematics curriculum. Adequate time was provided for pupils to complete the assessments, and the learning activities were designed to be engaging and supportive.

Compensation. No monetary or material incentives were provided to the participants. While pupils did not receive direct benefits from the study, they gained indirect benefits through exposure to innovative teaching strategies that may enhance their mathematics learning experience. Teachers and the school community may also benefit from the insights generated by the research.

Right to Self-Determination. Pupils and their parents or guardians were given the freedom to decide whether to participate in the study. They could decline to provide information, withdraw at any stage, or ask questions about the research. The researchers respected these rights and ensured that participation was based on informed choice.

Anonymity and Confidentiality. To protect the identity of participants, code numbers were assigned instead of names in all research notes and documents. Test papers and consent forms were stored securely and accessible only to the researchers. Data were saved in password-protected files, and all identifying information was removed during analysis. Results were reported in aggregate form to ensure that no individual pupil could be identified.

Privacy. The study did not collect personal information beyond what was necessary for research purposes. Questionnaires and test instruments did not include pupils' names, and only their assigned codes and grade level were recorded. This ensured that their privacy was maintained throughout the study.

Justice and Fairness. All participants were treated equally and fairly, without discrimination or prejudice. Each pupil was given the same opportunity to participate in the intervention and assessments. The principle of justice was upheld to ensure the integrity of the research process.

Community Considerations. The findings of this study will be shared with the school community, particularly teachers and administrators, to inform instructional practices and curriculum development. The results may serve as a basis for integrating game-based learning strategies into mathematics instruction, thereby benefiting future cohorts of pupils.

Benefits from the Study. While pupils may indirectly benefit from improved learning experiences, the broader benefit lies in providing empirical evidence on the effectiveness of GBLS in mathematics instruction. Teachers may gain insights into innovative strategies for engaging learners, and administrators may use the findings to support decisions about integrating educational technology into classroom practice. Ultimately, the study contributes to the improvement of mathematics education in Philippine basic education.

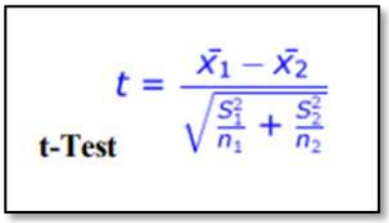
3.6 DATA ANALYSIS

This research employed a pre-test and post-test design to determine the mathematics performance of Grade 5 pupils, specifically in relation to their skills in basic operations. The pre-test was administered prior to the implementation of the Game-Based Learning Strategy (GBLS) to establish baseline performance, while the post-test was conducted after the intervention to measure improvement. The scores obtained from both tests were systematically tabulated, computed, and analyzed. To determine whether the observed differences in performance were statistically significant, the researchers utilized the paired sample t-test, a statistical tool appropriate for comparing the mean scores of the same group before and after an intervention. This analysis provided evidence of whether GBLS contributed to measurable progress in pupils' mathematics performance. By comparing the results of the pre-test and post-test, the study sought to establish not only the level of improvement but also the effectiveness of GBLS as an instructional strategy in enhancing mathematics achievement among Grade 5 pupils.

3.7 STATISTICAL TREATMENT OF DATA

The purpose of collecting data is to determine if Game-based learning is an effective tool in improving Mathematics performance among Grade 5 pupils before and after engaging the said learning. The purpose of the test is to determine whether there is statistical evidence that the mean difference between paired observations is significantly

different from zero (Kent State University, 2022). The statistical treatment of data used in the study were: Mean M= ∑M N Where: M = mean of the pupils' score ∑M =sum of pupils' score N =total number of pupils



$$t = \frac{\bar{x_1} - \bar{x_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Fig-1: Formula (Font-10)

Where, x1¯x1¯ = Mean of first set of values x2¯x2¯ = Mean of second set of values
S1 = Standard deviation of first set of values
S2 = Standard deviation of second set of values
n1 = Total number of values in first set
n2 = Total number of values in second set

4. CONCLUSIONS

This research proposal concludes that integrating educational technology through the Game-Based Learning Strategy (GBLS) is a vital intervention for addressing the persistent challenges in mathematics achievement among Filipino learners. Grounded in constructivist and experiential learning theories, the study posits that GBLS transforms mathematics from an abstract, often intimidating subject into an interactive and engaging experience that resonates with 21st century "digital native" learners. By replacing traditional rote memorization with immersive play, the strategy aims to reduce math anxiety and foster intrinsic motivation through immediate feedback and scaffolded challenges. Ultimately, the researchers expect that this approach will yield a statistically significant improvement in the mathematics performance of Grade 5 pupils at Agusan del Sur Pilot Laboratory School, providing a replicable, evidence-based model for modernizing instructional practices in the Philippine basic education system.

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