

Gamification In Mathematics Education: Improving EGNA Scores of Key Stage 2 Learners in Numbers and Algebra

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Abstract

This study determined the effectiveness of Game-Based Learning Activities (GBLA) in enhancing the results of the Early Grade Numeracy Assessment (EGNA) among Key Stage 2 learners of Carmelo Elementary School, Cebu Province Division, during School Year 2025–2026. Specifically, it examined the demographic profiles of the teacher and learner respondents, the extent of implementation of GBLA in terms of the types of games utilized and teaching and learning competencies, the mathematics performance of learners after the intervention, and the significant relationship between the implementation of GBLA and learners' mathematics performance. The study employed a descriptive-correlational quantitative research design involving 60 respondents, composed of 10 teachers and 50 Key Stage 3 learners, selected through purposive sampling. Data were gathered using a researcher-made questionnaire to assess the implementation of Game-Based Learning Activities and the Early Grade Numeracy Assessment (EGNA) to measure learners' numeracy performance. Descriptive statistics, including frequency, percentage, weighted mean, and Pearson Product-Moment Correlation Coefficient, were utilized to analyze the data. Findings revealed that the implementation of Game-Based Learning Activities was Very Highly Implemented in terms of both the types of games utilized and teaching and learning competencies. The posttest results indicated a significant improvement in learners' mathematics performance compared to their pretest results. Moreover, Pearson correlation analysis revealed a significant positive relationship between the implementation of Game-Based Learning Activities and learners' mathematics performance, leading to the rejection of the null hypothesis. The study concluded that Game-Based Learning Activities effectively enhance learners' numeracy skills, motivation, engagement, and overall mathematics achievement. Based on the findings, a Game Learning Exercises in Mathematics package was developed to provide teachers with a supplementary instructional material that supports engaging, learner-centered, and competency-based mathematics instruction.

Keywords: Game-Based Learning Activities, Early Grade Numeracy Assessment (EGNA), mathematics performance, numeracy skills, Key Stage 2 learners, descriptive-correlational research, learning exercises in mathematics.

1. Introduction

THE PROBLEM AND ITS SCOPE

Rationale of the Study

Mathematics education continues to be a worldwide concern as numerous learners still encounter challenges in understanding essential concepts, especially in areas like Numbers and Algebra. Conventional instructional methods have frequently been linked to low student engagement and unsatisfactory academic performance. Recent research indicates that innovative approaches such as game-based learning (GBL) effectively enhance learners' achievement, motivation, and participation in mathematics. Evidence suggests that incorporating game elements into lessons establishes interactive settings that encourage critical thinking, problem-solving, and deeper conceptual comprehension, resulting in higher academic performance compared to traditional teaching approaches. Moreover, game-based strategies facilitate the development of 21st-century competencies, including collaboration, creativity, and communication, which are vital in contemporary education.

In the Philippine setting, mathematics remains among the most difficult subjects for elementary learners, as evidenced by various national and school-level evaluations. The Department of Education has implemented initiatives such as the Early Grade Numeracy Assessment aligned with the Most Essential Learning Competencies (MELCs) to assess learners' basic numeracy abilities. Nevertheless, many students continue to exhibit low levels of proficiency, particularly in computation and problem-solving skills. Studies conducted in Philippine schools show that learners exposed to game-based learning interventions demonstrate notable gains in mathematics achievement, motivation, and engagement compared to those instructed through conventional approaches. These results highlight the necessity for innovative, learner-centered methods that address learning gaps and maintain students' interest in mathematics.

According to the 2022 report of Programme for International Student Assessment, over the most recent period (2018 to 2022), the disparity between top-performing students (10% with the highest scores) and low-performing students (10% with the lowest scores) decreased in mathematics, while remaining relatively unchanged in reading and science. In mathematics, lower-performing students showed improvement, whereas high-performing students' results remained relatively stable. Mathematics instruction has traditionally relied on lecture-based teaching and textbook use. However, educators have increasingly adopted innovative strategies such as game-based learning to improve learners' academic performance and enthusiasm for mathematics.

At the local level, similar issues continue to affect the teaching and learning of mathematics among Key Stage 2 learners. Classroom observations and assessment findings reveal that many students experience difficulty with fundamental numeracy skills in Numbers and Algebra, which directly influences their performance in assessments such as the RMA. Factors including limited student engagement, the abstract nature of mathematical ideas, and the absence of contextualized instructional materials contribute to these challenges. Consequently, there is an increasing need to implement interactive and contextualized teaching approaches that address the diverse learning needs of students.

Game-based learning activities present a viable solution by transforming traditional instruction into engaging and meaningful learning experiences. Through the integration of structured games aligned with MELCs, learners are given opportunities to practice mathematical skills in an enjoyable, motivating, and less intimidating setting. These activities not only improve computational and problem-solving abilities but also promote positive attitudes toward mathematics.

Therefore, this study is undertaken to address the identified gaps in learners' performance in the Early Grade Numeracy Assessment (EGNA) by implementing game-based learning activities focused on Numbers and Algebra among Key Stage 3 learners. The results of this study are expected to contribute to enhanced instructional practices, improved learner achievement, and the development of effective intervention strategies in mathematics education, particularly within the local context of Cebu.

Theoretical Background

This chapter presents the theoretical foundation supporting the study, which examines the effects of Game-Based Learning (GBL) on the mathematical performance of Key Stage 2 learners, as measured through the Early Grade Numeracy Assessment (EGNA). The incorporation of game-based approaches into mathematics instruction has gained recognition as an effective pedagogical method, especially for learners at the primary level. As traditional teaching practices face growing criticism due to their limited capacity to engage diverse learners, Game-Based Interventions (GBIs) provide a dynamic alternative aligned with modern educational perspectives. This framework is anchored in contemporary theories that reflect a transition toward inclusive, engaging, and cognitively enriching learning environments.

The Constructivist Theory, commonly associated with Jean Piaget and Lev Vygotsky, asserts that learners actively construct knowledge through experience and social interaction rather than passively receiving information. Learners develop new understanding by linking prior knowledge with new experiences through processes such as assimilation and accommodation. In mathematics education, this theory supports the use of interactive and experiential strategies like game-based learning, where learners participate in meaningful problem-solving activities.

Complementing constructivism is the Behaviorist Theory, linked to B.F. Skinner, which focuses on observable behavioral changes resulting from stimulus-response interactions. Within game-based learning environments, reinforcement mechanisms such as rewards, points, and feedback strengthen correct responses and encourage mastery of mathematical skills. This approach aligns with the structured and repetitive nature of mathematics practice, particularly in developing computational abilities.

The Information Processing Theory describes how learners receive, process, store, and retrieve information, emphasizing the roles of attention, memory, and cognitive load in learning. Game-based learning supports this theory by simplifying complex mathematical concepts into manageable tasks, offering immediate feedback, and enabling repeated practice, thereby improving retention and comprehension.

The Game-Based Learning Theory integrates motivation, engagement, and experiential learning. Global studies indicate that game-based environments enhance learner autonomy, problem-solving, and iterative learning through feedback and progression systems. Learners are encouraged to explore, make

decisions, and learn from errors—essential processes in mastering mathematical concepts such as Numbers and Algebra. Additionally, game-based learning fosters an interactive environment that supports both cognitive and affective domains of learning.

One of the most relevant modern theories supporting this study is Meylani's (2025) Gamification and SDG 4 Framework, which connects game-based learning to the United Nations Sustainable Development Goal 4 advocating inclusive and equitable quality education. Meylani emphasizes that gamification, through structured elements such as points, badges, levels, and feedback systems, can democratize learning and minimize achievement gaps, particularly in mathematics. In this framework, GBIs function not merely as entertainment tools but as strategic interventions that enhance motivation, persistence, and engagement among learners. For Key Stage 2 learners, who are at a crucial stage of cognitive and emotional growth, gamified environments provide a sense of autonomy and achievement often lacking in traditional methods. By aligning GBIs with SDG 4, this theory positions game-based learning as a socially responsive and pedagogically sound approach to improving mathematics education.

Paglomutan's (2024) Game-Based Cognitive Engagement Theory provides a strong explanation of how GBIs enhance mathematical learning through cognitive activation. This theory suggests that game-based strategies stimulate key mental processes such as recall, pattern recognition, and problem-solving. Empirical findings reveal that learners exposed to mathematics through games demonstrate significant improvements in retention and performance compared to those taught using conventional approaches. The theory highlights the importance of repeated exposure and active engagement, suggesting that games create meaningful learning experiences beyond rote memorization. In this study, GBIs are designed to challenge learners at appropriate levels of difficulty, encouraging the application of mathematical reasoning in dynamic and interactive contexts. This cognitive stimulation is expected to be reflected in improved RMA results, confirming the effectiveness of game-based learning in enhancing mathematical proficiency.

In the Philippines, the implementation of learner-centered and competency-based education is mandated by Republic Act No. 10533, also known as the Enhanced Basic Education Act of 2013, which institutionalizes the K to 12 curriculum. This curriculum promotes constructivist, inquiry-based, and contextualized learning approaches aimed at developing lifelong learners equipped with 21st-century skills.

Aligned with this, the Department of Education Order No. 42, s. 2014 encourages the use of varied teaching strategies, including learner-centered and interactive approaches such as games, to ensure meaningful learning experiences. It promotes lesson designs that actively involve learners and address diverse learning needs.

Furthermore, DepEd Order No. 8, s. 2015 emphasizes the role of formative and summative assessments in monitoring learner progress. Tools such as the Early Grade Numeracy Assessment support this policy by providing timely data on learners' numeracy skills, while game-based learning activities serve as effective formative interventions that can improve assessment outcomes.

The application of Developmentally Appropriate Practices (DAP) further supports this study by emphasizing that instructional strategies must align with learners' developmental levels, interests, and learning styles. Game-based activities naturally support DAP by offering engaging, age-appropriate, and meaningful learning experiences for Key Stage 3 learners.

At the local level, many Key Stage 2 learners encounter difficulties in mastering basic mathematical competencies, particularly in Numbers and Algebra, as reflected in low performance in assessments such as the RMA. Traditional teaching methods often fail to address diverse learner needs, resulting in limited engagement and shallow conceptual understanding.

Integrating game-based learning activities provides a contextualized and interactive approach aligned with global educational trends and national policies. Through structured and competency-based games, learners are enabled to actively construct knowledge (constructivism), receive reinforcement (behaviorism), process information efficiently (information processing theory), and remain motivated and engaged (game-based learning theory).

Thus, the integration of these theoretical perspectives and policy frameworks supports the implementation of game-based learning as an effective intervention to enhance the mathematical performance of Key Stage 2 learners, particularly in improving their EGNA results.

The social dimension of game-based learning is reflected in the Collaborative Game Learning Model by Adipat et al. (2021), which highlights the importance of peer interaction and teamwork in educational games. Collaboration fosters deeper understanding and sustained interest in learning. Games that involve cooperative problem-solving, communication, and shared decision-making contribute not only to academic achievement but also to the development of interpersonal skills and lifelong learning habits. For Key Stage 2 learners, collaborative games provide an effective platform for exploring mathematical concepts in a supportive environment, enhancing confidence and motivation that positively influence RMA performance.

The theoretical framework concludes with a conceptual model illustrating the relationship between GBL and mathematical performance, proposing that game-based learning activates motivation, cognition, and collaboration. These domains interact to create enriched learning experiences that lead to improved mathematical outcomes. This model serves as the foundation for the study's research design, guiding the analysis of how GBL influences learners' RMA scores and reinforcing the role of Game-Based Interventions in mathematics education.

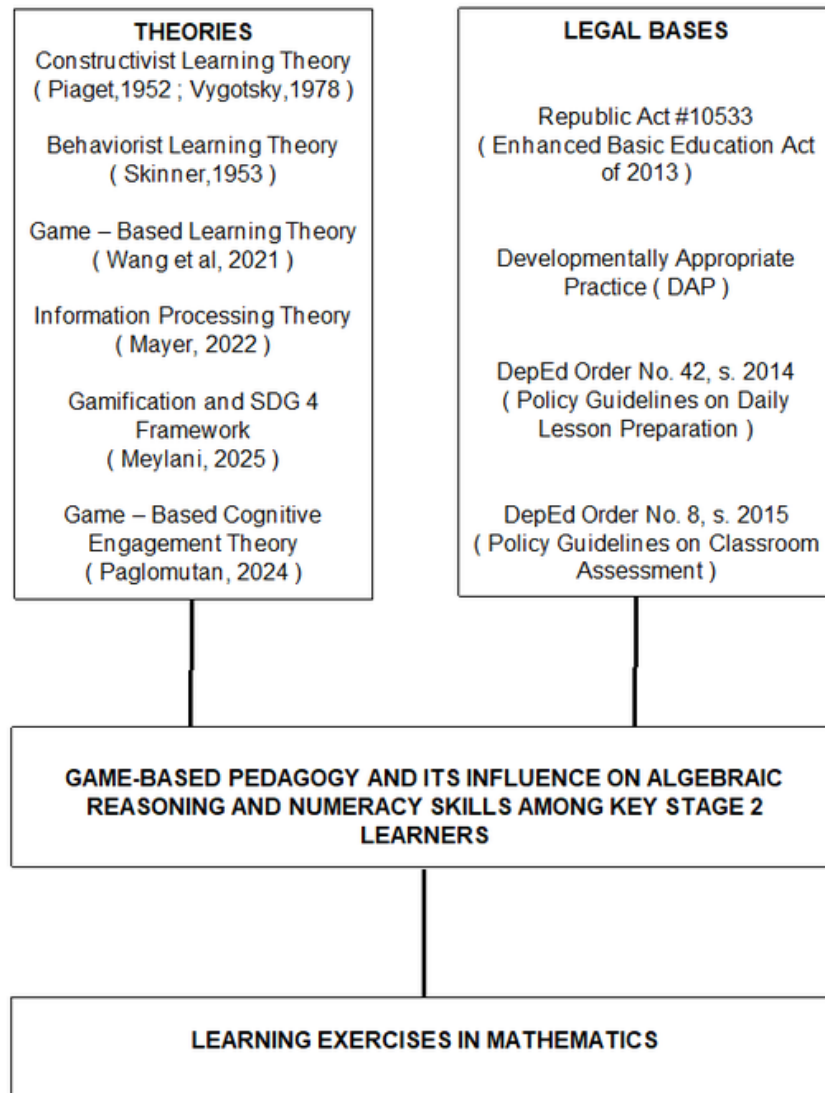


Figure 1.
Theoretical Conceptual Framework
THE PROBLEM

Statement of the Problem

This study aims to determine the effectiveness of game learning activities in enhancing the results of the Early Grade Numeracy Assessment (EGNA) among Key Stage 2 learners of Carmelo Elementary School in Cebu Province Division Year 2025 – 2026 as basis for learning exercises in mathematics.

This study specifically sought to answer the following questions:

1. What is the profile of the teachers in terms of:
 - 1.1 age;
 - 1.2 gender;
 - 1.3 highest educational attainment;
 - 1.4 number of years in service; and
 - 1.5 relevant trainings, seminars and workshops attended?

2. What is the profile of the learners in terms of:
 - 2.1. age;
 - 2.2. gender; and
 - 2.3. EGNA Pretest Scores?
3. What is the extent of the implementation of the Game – Based Learning Activities as to:
 - 3.1 Types of Games Utilized; and
 - 3.2 Teaching and Learning Competencies?
- 4 After using the Game – Based Learning Activities, what is the performance of the identified competencies in mathematics?
- 5 Is there a significant relationship in employing game-based learning activities and the performance of the learners in mathematics?
6. Based on findings, what game learning exercises in mathematics can be crafted?

2. SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents the summary, findings, conclusions, and recommendations of the study. The research aimed to determine the effectiveness of Game-Based Learning Activities (GBLA) in enhancing the results of the Early Grade Numeracy Assessment (EGNA) among Key Stage 2 learners of Carmelo Elementary School, Cebu Province Division, School Year 2025–2026. Specifically, the study examined the demographic profiles of the teacher and learner respondents, the extent of implementation of Game-Based Learning Activities, the mathematics performance of learners after the intervention, and the significant relationship between the implementation of Game-Based Learning Activities and learners' mathematics performance. The findings served as the basis for developing Game Learning Exercises in Mathematics to strengthen learners' numeracy competencies.

Summary

The study employed a descriptive-correlational research design using a quantitative approach. A total of 60 respondents, composed of 10 teachers and 50 Key Stage 2 learners of Carmelo Elementary School, participated in the study through purposive sampling. Data were gathered using a researcher-made questionnaire for the implementation of Game-Based Learning Activities and the Early Grade Numeracy Assessment (EGNA) to determine learners' mathematics performance.

The study evaluated the implementation of Game-Based Learning Activities in terms of the types of games utilized and teaching and learning competencies. Likewise, learners' mathematics performance was assessed through the EGNA before and after the implementation of the intervention. Pearson Product-Moment Correlation was used to determine the significant relationship between Game-Based Learning Activities and learners' mathematics performance.

Based on the findings, a Game Learning Exercises in Mathematics package was developed to address the numeracy competencies that require further enhancement among Key Stage 2 learners.

To provide a concise overview of the study, the summary table below presents the major findings.

Table 14
Summary of Results

Major Area	Key Findings (Quantitative)	Overall Result	Interpretation
Teacher Profile	Majority were 31–40 years old, female, Bachelor's degree holders, with 6–15 years of teaching experience.	—	Teachers possessed sufficient professional experience to implement innovative instructional strategies.
Learner Profile	Majority were 9 years old; learners initially obtained low EGNA pretest scores.	—	Learners required numeracy intervention to improve mathematics performance.
Implementation of Game-Based Learning Activities	Overall Mean = 4.65	Very Highly Implemented	Teachers consistently integrated educational games into mathematics instruction.
Mathematics Performance	Majority of learners achieved Very Satisfactory and Satisfactory ratings after the intervention.	Improved	Learners' numeracy performance increased after the implementation of GBLA.
Relationship between GBLA and Mathematics Performance	$r = 0.734$; $p = 0.000$	Significant Positive Relationship	Increased implementation of GBLA was associated with higher mathematics performance.
Proposed Output	Development of Game Learning Exercises in Mathematics	Completed	Supplementary instructional material was crafted based on the findings.

Findings

The findings revealed that the teacher-respondents were predominantly female, aged between 31 and 40 years, Bachelor's degree holders, with six to fifteen years of teaching experience, and had attended various mathematics-related seminars and training programs. Meanwhile, the learner-respondents were mostly nine years old, with nearly equal representation of male and female learners. The results of the Early Grade Numeracy Assessment (EGNA) pretest indicated that many learners did not initially meet the expected numeracy proficiency, highlighting the need for instructional interventions.

The implementation of Game-Based Learning Activities was assessed as Very Highly Implemented in terms of both the types of games utilized and the teaching and learning competencies. Teachers consistently incorporated educational games such as number games, puzzles, board games, card games, and interactive learning activities into mathematics instruction. These instructional strategies effectively promoted learner engagement, collaboration, critical thinking, and enjoyment during mathematics lessons.

The study further found that learners' mathematics performance significantly improved after the implementation of Game-Based Learning Activities. The posttest results demonstrated a marked increase in the number of learners who achieved Very Satisfactory and Outstanding performance levels, while the number of learners who did not meet expectations substantially decreased. Pearson Product-Moment Correlation analysis revealed a strong positive and statistically significant relationship ($r = 0.734$, $p = 0.000$) between the implementation of Game-Based Learning Activities and learners' mathematics performance. These findings indicate that Game-Based Learning Activities effectively enhanced learners' numeracy skills and overall mathematics achievement.

Conclusions

Based on the findings of the study, it is concluded that Game-Based Learning Activities are highly effective instructional strategies for improving the mathematics performance of Key Stage 2 learners. The consistent implementation of educational games created an engaging and learner-centered classroom environment that increased learners' motivation, confidence, participation, and conceptual understanding of mathematics.

The significant positive relationship between the implementation of Game-Based Learning Activities and learners' EGNA performance demonstrates that integrating interactive and meaningful learning experiences contributes substantially to the development of numeracy competencies. Consequently, Game-Based Learning Activities may serve as an effective supplementary teaching strategy for elementary mathematics instruction.

Furthermore, the development of the Game Learning Exercises in Mathematics provides teachers with a practical and curriculum-aligned instructional material that can be used during classroom instruction, remediation, enrichment, and intervention programs. The proposed learning exercises are expected to sustain learner engagement and further improve mathematics achievement among elementary learners.

Recommendations

Based on the findings and conclusions of the study, the following recommendations are offered:

1. **Strengthen the Integration of Game-Based Learning Activities.** Elementary mathematics teachers should continuously integrate educational games into daily classroom instruction to increase learner engagement, motivation, and numeracy achievement.
2. **Provide Continuous Professional Development.** School administrators should organize regular seminars, workshops, and capability-building programs that enhance teachers' knowledge and skills in designing and implementing Game-Based Learning Activities.

3. **Develop Additional Instructional Materials.** Teachers are encouraged to develop more innovative, localized, and curriculum-aligned game learning exercises that address different mathematical competencies and cater to diverse learner needs.
4. **Support Mathematics Intervention Programs.** Schools should incorporate the proposed **Game Learning Exercises in Mathematics** into remedial and enrichment programs to assist learners experiencing difficulties in numeracy and mathematical problem-solving.
5. **Strengthen Monitoring and Assessment.** Teachers should regularly monitor learners' progress through formative assessments such as the Early Grade Numeracy Assessment (EGNA) and use the results to improve instructional planning and intervention strategies.
6. **Conduct Future Research.** Future researchers may replicate the study using larger samples, different grade levels, or other learning areas. They may also investigate the long-term effects of Game-Based Learning Activities on learners' academic performance, critical thinking, and problem-solving skills.

3. OUTPUT OF THE STUDY

GAME LEARNING EXERCISES IN MATHEMATICS IMPLEMENTATION PLAN

RATIONALE

Mathematics plays a fundamental role in developing learners' numeracy skills, logical reasoning, and problem-solving abilities. However, the findings of the study revealed that many Key Stage 2 learners initially demonstrated low performance in the Early Grade Numeracy Assessment (EGNA), indicating the need for innovative instructional approaches that promote active participation and meaningful learning experiences.

The implementation of Game-Based Learning Activities (GBLA) was found to be Very Highly Implemented, while learners' mathematics performance significantly improved after the intervention. Furthermore, a statistically significant positive relationship was established between the implementation of Game-Based Learning Activities and learners' mathematics performance. These findings indicate that educational games effectively enhance learner motivation, engagement, and numeracy achievement.

Despite these positive outcomes, teachers continue to encounter challenges such as varying learner abilities, limited instructional resources, insufficient time for remediation, and the need for additional localized learning materials. Hence, the development and implementation of Game Learning Exercises in Mathematics is necessary to provide structured, engaging, and competency-based activities that will further strengthen learners' mathematical skills and sustain improved academic performance.

OBJECTIVES

This implementation plan aims to:

1. Improve learners' Early Grade Numeracy Assessment (EGNA) performance through engaging Game-Based Learning Activities.
2. Strengthen learners' mastery of fundamental mathematical concepts and numeracy competencies.

3. Increase learners' motivation, participation, confidence, and interest during mathematics instruction.
4. Provide teachers with innovative, learner-centered instructional materials aligned with the Most Essential Learning Competencies (MELCs).
5. Promote collaborative learning, critical thinking, and problem-solving through educational games.
6. Support remediation and enrichment programs for learners with varying levels of mathematical proficiency.
7. Establish continuous monitoring and evaluation of learners' progress to improve mathematics instruction.

SCHEME OF IMPLEMENTATION

Table 15

Game Learning Exercises in Mathematics Implementation Plan

Area of Concern	Objectives	Strategies	Budget (PHP)	Budget Source	Time Frame	Implementors	Evaluative Measures	Actual Accomplishment	Remarks
Number Recognition Games	Improve learners' ability to recognize and identify numbers accurately.	Conduct Number Hunt, Number Matching, and Flash Card Games during mathematics classes.	5,000	School MOOE / PTA	One Semester	Mathematics Teachers	Pretest and Posttest Scores; Observation Checklist	N/A	N/A
Place Value Learning Games	Strengthen learners' understanding of place value concepts.	Utilize Place Value Bingo, Build-a-Number, and Base-Ten Block Relay Games.	6,000	School Funds	One Semester	Mathematics Teachers	Quiz Scores; Classroom Observation	N/A	N/A
Addition and Subtraction Games	Improve computational fluency and accuracy.	Conduct Math Relay, Dice Games, Card	8,000	School MOOE	One Semester	Mathematics Teachers	Learners' Performance Assessment	N/A	N/A

		Matching, and Spin-and-Solve Activities.							
Multiplication and Division Games	Develop learners' multiplication and division skills.	Implement Multiplication Race, Bingo Games, and Division Challenge Activities.	8,000	School Funds / Donations	One Semester	Mathematics Teachers	Weekly Assessment Results	N/A	N/A
Problem-Solving Activities	Enhance critical thinking and mathematical reasoning.	Conduct Math Adventure, Puzzle Challenge, Escape Room Mathematics, and Real-Life Problem Solving Activities.	10,000	School Improvement Fund	One Semester	Teachers and Master Teachers	Performance Tasks; Rubrics	N/A	N/A
Remediation Through Educational Games	Assist struggling learners in improving numeracy competencies.	Organize after-class remediation sessions using differentiated game-based activities.	5,000	School MOOE	Whole School Year	Mathematics Teachers	EGNA Improvement Scores	N/A	N/A
Teacher Capacity Building	Enhance teachers' competence in designing Game-Based Learning Activities.	Conduct Learning Action Cell (LAC), workshops, and demonstration teaching on GBLA.	15,000	INSET / Division Training Fund	Whole School Year	School Head, Master Teachers	Training Evaluation; Classroom Observation	N/A	N/A

Monitoring and Evaluation	Monitor the effectiveness of Game-Based Learning Activities.	Conduct classroom observations, learner assessments, quarterly monitoring, and feedback sessions.	3,000	School Funds	Quarterly	School Head, Mathematics Coordinator	Monitoring Reports; EGNA Results	N/A	N/A
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