



Improving Grade 7 Mathematics Outcomes through Game-Based Learning: An Action Research Study

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ABSTRACT

Amid ongoing challenges in mathematics education and the rise of blended learning in the Philippines, this action research explored the use of both digital and non-digital game-based learning (GBL) strategies to improve Grade 7 students' performance and perceptions under the MATATAG Curriculum. Conducted at a laboratory school in Cebu City during the first semester of AY 2024–2025, the study involved 28 purposively selected students. A one-group pretest-posttest design assessed academic performance, while a survey measured students' attitudes, motivation, and engagement. Findings showed a statistically significant increase in post-test scores and generally positive affective responses. GBL was found to enhance student participation, enjoyment, and achievement in mathematics. However, teacher-researchers noted that its effectiveness depended on thoughtful game design, sound classroom management, and inclusive practices. They also emphasized the need to pair GBL with strategies that build math self-efficacy, strengthen conceptual understanding, and support long-term learning among diverse learners.

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Introduction

Mathematics is widely recognized as the foundation of scientific and technological advancement, influencing many aspects of life and playing a key role in national socioeconomic development (Ayebale et al., 2020). Accordingly, it remains a core subject in the basic education curriculum in the Philippines. However, Filipino students continue to underperform in both national and international mathematics assessments. In the Grade 6 National Achievement Test (NAT) for SY 2020–2021, the mean percentage score in Mathematics was only 41%, reflecting a low level of proficiency (DepEd, 2023). Entering high school with such gaps poses serious academic challenges, particularly for Grade 7 learners under the MATATAG Curriculum. These findings point to the urgent need for effective, engaging teaching strategies during the early years of secondary education.

Grade 7 is considered a transitional phase marked by academic and emotional adjustments (Engels et al., 2019). Treceñe et al. (2021) highlight that learners at this stage face increasing academic demands and social pressures, making it a critical time for targeted instructional support. This reality was evident among Grade 7 students in the laboratory school where this study was conducted. These students came from different elementary schools and had varying levels of proficiency in mathematics. Baseline assessments revealed widespread difficulties in core areas such as geometry, integers, and percentage—skills essential for success in the junior high school curriculum. These foundational gaps suggest challenges in retaining and applying previous knowledge.

Socially, many students also showed hesitance in participating in class activities due to unfamiliar peers and a new school environment. They were still adjusting to new routines, often avoiding recitations and group tasks. Despite these challenges, the teacher-researchers observed a shift during game-based activities. Students actively collaborated and demonstrated enthusiasm and competitiveness, signaling the potential of Game-Based Learning (GBL) to support both academic learning and affective engagement.

This study therefore, aimed to evaluate the effects of GBL on academic performance and affective outcomes—specifically, student attitudes, motivation, and engagement—by integrating both digital and non-digital game-based learning into Grade 7 Mathematics instruction. While traditional lecture-based approaches still dominate Philippine classrooms (Wang, 2022), they often lead to disengagement and decreased academic achievement (Daschmann et al., 2011). In contrast, research has shown that Digital Game-Based Learning (DGBL) enhances performance in mathematics (Che Mansor et al., 2024; Drigas & Pappas, 2015; Hung et al., 2014; Ku et al., 2014; Letsa-Agbozo, 2023). Although less studied, Non-Digital Game-Based Learning (NDGBL) has also shown promise in improving performance in mathematics and related fields (Balakrishna, 2023; Yusof & Shahrill, 2021). Naik (2014) emphasized that both DGBL and NDGBL bring value to the classroom and are adaptable to various learning contexts.

Beyond academic gains, GBL has been shown to positively influence affective and non-cognitive outcomes such as attitudes, motivation, and engagement (Chen et al., 2020; Hui & Mahmud, 2023; Ku et al., 2014; Pratama & Setyaningrum, 2018). Research has also shown that integrating games into instruction improves students' attitudes toward mathematics (Dele-Ajayi et al., 2019; Katmada et al., 2014), increases their motivation (Gee, 2003; Pratiwi et al., 2020; Surendeleg et al., 2019), and enhances engagement (Hieftje et al., 2017; Fouze & Amit, 2018; Denham, 2019).

This study is informed by Constructivist Learning Theory and Self-Determination Theory. These frameworks emphasize that students construct knowledge through meaningful, hands-on experiences and that intrinsic motivation is key to effective learning. GBL aligns well with these principles, offering interactive and enjoyable activities that stimulate both understanding and participation.

By evaluating GBL in an actual classroom setting, this study contributes to the growing body of research supporting learner-centered pedagogies aligned with Sustainable Development Goal 4 (Quality Education). It also supports the MATATAG Curriculum's emphasis on inclusive and engaging instruction. The study applies Lewin's Action Research Cycle, comprising four phases: Plan (identifying student needs and designing GBL activities aligned with learning standards), Act (implementing these activities), Observe (gathering data through tests, surveys, and observations), and Reflect (analyzing results to refine teaching strategies). This cyclical process enabled teacher-researchers to respond adaptively to classroom realities and continuously improve their instructional practice.

Ultimately, this research offers practical insights for educators seeking to enrich their mathematics instruction. It highlights how GBL—when designed with purpose and implemented thoughtfully—can address academic gaps and foster positive attitudes and motivation among students. For mathematics teachers and pre-service educators, the study affirms the value of integrating game-based strategies into their lessons to make mathematics more accessible, enjoyable, and effective for learners at the crucial Grade 7 level.

Statement of the objectives

This study aimed to investigate the use of Game-Based Learning (GBL) as a teaching strategy in Grade 7 Mathematics under the MATATAG Curriculum through the lens of action research. Specifically, it sought to:

1. Identify learners' academic performance before instruction;
2. Assess learners' academic performance after the implementation of GBL;
3. examine learners' affective perceptions of GBL in terms of attitude,

motivation, and engagement; and

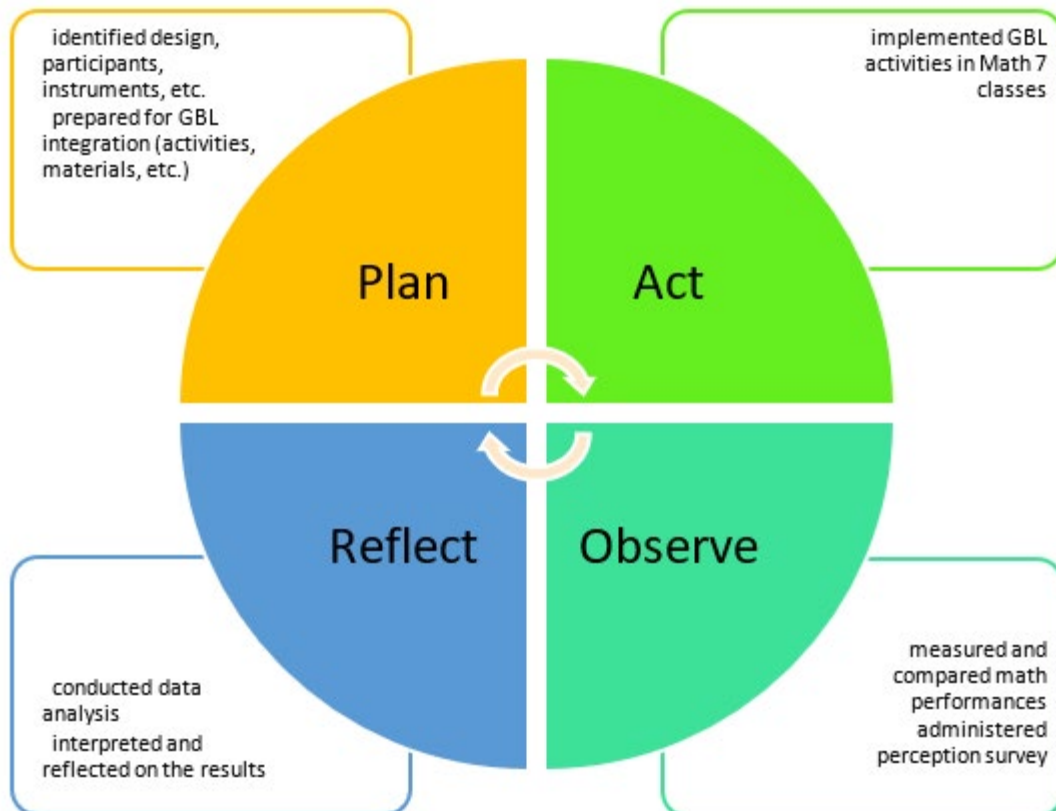
4. Analyze the effectiveness and limitations of GBL based on observed outcomes to inform future instructional improvements.

Methodology

This study adopted an action research design based on Lewin's (1999) Plan-Act-Observe-Reflect framework. In the planning phase, the pedagogical intervention—Game-Based Learning (GBL)—was carefully selected and designed. This was followed by the implementation of GBL in onsite and online Grade 7 Mathematics classes. The researchers then observed the intervention's effects on students' cognitive and affective outcomes. Lastly, a reflective analysis was conducted to evaluate the strategy's effectiveness and limitations. Due to time constraints and the off-campus deployment of teacher-researchers, only one action research cycle was completed.

Figure 1

Plan-Act-Observe-Reflect Action Research Cycle



Plan

The study employed a quantitative approach, using a quasi-experimental one-group pre-test–post-test design to assess GBL’s impact on student performance in Mathematics 7. A descriptive survey design was also used to evaluate students’ perceptions in terms of attitude, motivation, and engagement.

Participants

The participants included 28 Grade 7 students from a laboratory school in Cebu City enrolled under the MATATAG Curriculum during the first semester of AY 2024–2025. Purposive sampling was applied based on the students’ grade level and enrollment in the revised curriculum, ensuring alignment with the study’s goal of evaluating GBL among early secondary learners.

Instruments

The research tools included a researcher-developed 30-item test used for both the pre-test and post-test, focusing on competencies such as geometry, integers, and percentages . It was validated by a subject matter expert and a language expert. A 15-item Likert-scale survey questionnaire, adapted from validated instruments (Hui & Mahmud, 2023; Kim et al., 2019; Gao et al., 2016), was used to assess students’ perceptions of GBL. Validators ensured its relevance and clarity for the target learners.

Additionally, a series of GBL activities aligned with the Mathematics 7 competencies was incorporated into the teacher-researchers’ lesson designs and reviewed by the mathematics mentor before classroom use.

Pre-Implementation Procedure

This included obtaining ethics exemption, preparing materials, orienting fellow teaching interns, and briefing Grade 7 students on the study’s objectives and ethical considerations. The pre-test was then administered to establish baseline performance.

Act

GBL-integrated lessons were delivered over eight weeks, twice a week. A mix of digital and non-digital games aligned with the MATATAG Curriculum was used to reinforce key concepts. Activities included “Pick and Tell” (angle pairs), “Polygon Angle Exploration” (angles in polygons), “Get That Flag, Bruh!” (geometry quiz bee), “Integer Adventure Time” (introducing integers), “Fun with Integer Chips” (operations with integers), “Equation Scramble” (multiplying/dividing integers), and “How Far Am I?” (absolute value). Digital platforms such as Kahoot and Quizizz supported lessons on discounts, commissions, taxes,

and interest. The “Mystery Box” activity allowed students to apply financial concepts through problem-solving.

The BSEd Mathematics teacher-researchers and other teaching interns, under the close guidance of their on-campus mentor, facilitated the sessions. Pre-lesson conferences were held to review lesson plans and materials for accuracy and appropriateness. Post-lesson conferences provided formative feedback and space for teacher-researchers to share self-reflections, identify strengths, and pinpoint areas for improvement. Classroom management challenges during game-based activities were addressed by implementing strategic adjustments to enhance student engagement and instructional effectiveness.

Observe

Researchers observed students’ participation and behavior during GBL sessions. After the intervention, the post-test was administered to assess learning gains, and students completed the perception survey to evaluate their experience of GBL in terms of attitude, motivation, and engagement.

Reflect

Data from the pre-test, post-test, and perception survey were analyzed using descriptive statistics, such as mean and standard deviation, to summarize performance and affective outcomes. A Shapiro-Wilk test confirmed normality in score distributions ($W = 0.949$, $p = 0.190$), allowing for the use of a paired samples t-test. This test determined whether the differences between pre- and post-test scores were statistically significant, thereby assessing the impact of GBL on mathematical achievement.

To strengthen the validity of findings, triangulation was applied. Researchers cross-analyzed test results, survey responses, and field notes from classroom observations. Reflections and insights from teacher-researchers further enriched the interpretation of cognitive and affective outcomes.

Member checking was conducted through multiple-choice questions with open-ended prompts, allowing student-participants to confirm or elaborate on the researchers’ interpretations. Students were assured that their responses would remain confidential and would not affect their academic grades, thereby addressing potential bias resulting from the teacher-researcher–student relationship.

Peer debriefing involved teaching interns who were not part of the research team, allowing them to review the implementation process and provide independent insights into the outcomes. These validation strategies enhanced the study’s credibility and helped generate practical recommendations for integrating GBL into the Grade 7 Mathematics curriculum.

Results and Discussion

This section presents the key findings of the study based on the analysis of student performance and affective perceptions following the implementation of Game-Based Learning (GBL) in Grade 7 Mathematics. It further explores how these results deepen the understanding of GBL's effectiveness, incorporates the teacher-researchers' reflections on the outcomes, and discusses the instructional implications for mathematics education.

Grade 7 Students' Mathematics Performance Before and After GBL Implementation

Table 1

Pre and Posttest Scores of the Grade 7 Math Students

	N	Mean	SD
Pre-test	28	19.8	3.41
Posttest	28	23.5	3.99

Table 1 summarizes students' mathematics performance before and after implementing Game-Based Learning (GBL). In the pre-test, the 28 Grade 7 students had a mean score of 19.80 (SD = 3.41), below the passing mark of 22.5 (75% of 30). These students came from various elementary schools across Cebu City and nearby areas, resulting in diverse academic backgrounds. The moderate variability in scores likely reflects differences in prior instruction, exposure to key math concepts, and learning experiences, underscoring the need for an engaging and inclusive approach, such as GBL.

After the GBL intervention, the post-test mean increased to 23.50 (SD = 3.99), exceeding the passing threshold and indicating improved performance. However, not all students benefited equally. Observations and reflections revealed that some were more engaged and responsive than others, possibly due to variations in motivation, learning preferences, or receptiveness to game-based methods.

Throughout the implementation, the teacher-researchers consistently observed high levels of student engagement and enjoyment. While these affective outcomes were encouraging, they did not always translate into uniform academic improvement. The findings suggest that enjoyment alone may not guarantee conceptual understanding. Factors such as prior knowledge, learner confidence, and classroom dynamics likely influenced learning outcomes.

This experience emphasized the need to complement GBL with targeted support to address individual learning needs. The teacher-researchers concluded that effective integration of GBL requires continuous reflection and adaptation of instructional practices to ensure equitable learning gains for all students.

Effectiveness of GBL in Enhancing Grade 7 Students' Mathematics Performance

Table 2

Significant Improvement of Students' Performance After GBL

	t Statistic	df	p	Mean Difference	SE Difference	Effect Size
Posttest – Pre-test	5.57	27.0	<.001	3.75	0.674	1.05

Note. Significant at $\alpha=0.05$

A paired-samples t-test was conducted to compare students' mathematics performance before and after implementing Game-Based Learning (GBL). Results showed a statistically significant increase from the pre-test ($M = 19.80$, $SD = 3.41$) to the post-test ($M = 23.50$, $SD = 3.99$), $t(27) = 5.57$, $p < .001$. The mean difference of 3.75 points ($SE = 0.674$), with a large effect size ($d = 1.05$), indicates that GBL had a substantial and positive impact on student achievement.

The teacher-researchers found these results encouraging. They observed increased student participation, enthusiasm, and willingness to engage in math tasks during game-based activities. It was evident that the enjoyment students experienced during GBL extended beyond surface-level fun—it translated into measurable learning gains. These findings are consistent with prior studies demonstrating GBL's effectiveness in enhancing mathematics performance (Balakrishna, 2023; Che Mansor et al., 2024; Drigas & Pappas, 2015; Hung et al., 2014; Ku et al., 2014; Letsa-Agbozo, 2023; Yusof & Shahrill, 2021).

The large effect size further suggests that GBL created an interactive environment conducive to conceptual understanding. Student engagement, enjoyment, and healthy competition were reflected in the improved post-test scores. For the teacher-researchers, this affirms GBL as a promising strategy to support both cognitive and affective learning. However, they also acknowledge the need for thoughtful integration and complementary strategy to ensure equitable learning gains for all students.

Grade 7 Students’ Affective Perceptions (Attitude, Motivation, and Engagement) of GBL

Table 3

Students’ Perception of Game-Based Learning in Terms of Attitude

Statements	Weighted Mean	Verbal Description
1. Game-based learning in mathematics influences my willingness to participate actively in math-related activities.	4.2	Agree
2. Using games in mathematics classes promotes an enjoyable and effective learning environment.	4.44	Agree
3. I believe that incorporating games into mathematics education enhances my understanding of mathematical concepts.	3.96	Agree
4. I would recommend game-based learning to other students who are learning mathematics.	4.28	Agree
5. Game-based learning significantly enhances my positive attitude towards mathematics.	4.28	Agree

Note. The weighted mean is interpreted based on the following: 1.00-1.75 Strongly Disagree, 1.76-2.5 Disagree, 2.51-3.5 Neither Agree nor Disagree, 3.51-4.5 Agree, 4.51-5.00 Strongly Agree.

As shown in Table 3, Grade 7 students expressed favorable perceptions of Game-Based Learning (GBL) in terms of attitude. All five survey statements received weighted means between 3.96 and 4.44, indicating general agreement and a positive attitude toward integrating games in mathematics. Students appreciated the engaging environment, the progression systems in some games, and the social interaction during gameplay.

Teacher-researchers observed greater enthusiasm and participation among students during GBL activities compared to traditional lessons. This supports the idea that GBL fosters more positive attitudes toward mathematics and increases willingness to engage, findings consistent with studies by Dele-Ajayi et al. (2019), Katmada et al. (2014), O’Rourke et al. (2017), and White and McCoy (2019). These observations also align with the notion that a positive attitude fosters classroom participation and enhances perceptions of one’s mathematical ability and its practical applications (Daniel, 1969, as cited in Kurniasih et al., 2020).

However, Statement 3—“I believe that incorporating games into mathematics education enhances my understanding of mathematical concepts”—received the lowest mean score (3.96), though still within the “Agree” range. Two students disagreed that GBL improved

their learning attitude. One cited a general difficulty with math and scored slightly below the passing mark. These responses reminded the teacher-researchers that while most students find GBL enjoyable, enjoyment alone does not ensure conceptual mastery. This aligns with the findings of Salsabila et al. (2020), who noted that some students perceived educational games as distracting, thereby impeding their ability to grasp key mathematical concepts. The findings underscore the importance of identifying learners who may struggle with GBL and providing them with tailored support to address their unique learning needs.

Table 4

Students' Perception of Game-Based Learning in Terms of Motivation

Statements	Weighted Mean	Verbal Description
1. Game-based learning makes me want to learn more about mathematics.	4.04	Agree
2. I feel more motivated to learn mathematics when I participate in game-based activities.	4.2	Agree
3. I am more likely to participate in mathematics activities when they are game-based.	4.16	Agree
4. Game-based learning makes me feel more confident in my ability to learn mathematics.	3.84	Agree
5. I am more motivated in learning mathematics when I participate in game-based activities.	4.12	Agree

Note. The weighted mean is interpreted based on the following: 1.00-1.75 Strongly Disagree, 1.76-2.5 Disagree, 2.51-3.5 Neither Agree nor Disagree, 3.51-4.5 Agree, 4.51-5.00 Strongly Agree.

As shown in Table 4, Grade 7 students expressed an overall positive perception of Game-Based Learning (GBL) in terms of motivation. All five statements received weighted means between 3.84 and 4.20, indicating agreement that GBL enhanced their motivation to learn mathematics. Many students shared that games made them feel happy and excited during lessons. Teacher-researchers observed students smiling, joking, and actively participating—behaviors not typically associated with a subject often perceived as difficult. They concluded that GBL helped foster a more joyful and engaging environment, easing students' transition into junior high school's academic demands.

These findings support prior research showing GBL's motivational benefits (Calleros et al., 2020; Dele-Ajayi et al., 2019; Denham, 2019; Drigas & Pappas, 2015). Similar to Surendeleg et al. (2019) and Gee (2003), the study showed that gameplay increases students' willingness to engage with content and sustains motivation through interaction and immersion.

However, limitations were noted. Statement 4—"Game-based learning makes me feel more confident in my ability to learn mathematics"—received the lowest mean score (3.84). While Ku et al. (2014) found that GBL can enhance confidence, they noted that the effect

isn't universal. In this study, several students felt pressured by time constraints during games, which may have reduced their confidence. Some found the competitive nature overwhelming, especially those already struggling with math. Surprisingly, only one student highlighted scores, badges, and rankings as motivating, challenging the assumption that gamified feedback always drives motivation.

These insights suggest that while GBL effectively boosts motivation, its impact on confidence may vary. Teacher-researchers concluded that building learner confidence requires additional strategies, such as positive reinforcement and structured support. Going forward, they aim to balance the excitement of GBL with sensitivity to students' emotional and cognitive needs.

Table 5

Students' Perception of Game-Based Learning in Terms of Engagement

	Statements	Weighted Mean	Verbal Description
1.	I am more likely to remember mathematical concepts when I do game-based activities.	3.56	Agree
2.	Game-based learning activities in mathematics keep me focused during the class.	4.16	Agree
3.	The inclusion of game elements in my education encourages me to actively participate in class discussions.	4.08	Agree
4.	I feel that game-based learning activities make the process of learning mathematics more enjoyable and captivating, encouraging me to invest more effort in my studies.	4.36	Agree
5.	I find that engaging with mathematical concepts through game-based learning activities enhances my overall engagement in the subject matter.	4.08	Agree

Note. The weighted mean is interpreted based on the following: 1.00-1.75 Strongly Disagree, 1.76-2.5 Disagree, 2.51-3.5 Neither Agree nor Disagree, 3.51-4.5 Agree, 4.51-5.00 Strongly Agree.

The results in Table 5 show that Grade 7 students generally viewed Game-Based Learning (GBL) positively in terms of engagement in mathematics. All five statements had weighted mean scores within the "Agree" range, indicating that GBL helped sustain their attention and interest. Many students shared that GBL made them feel more involved, promoting both independent learning and peer collaboration through competitive activities. The teacher-researchers observed heightened energy and participation during GBL sessions, noting that the mix of cooperation and healthy competition made lessons more exciting and memorable. However, occasional disruptions due to excessive competitiveness were also observed, as well as instances when some students became disengaged.

These findings align with the existing literature, which affirms GBL's ability to boost engagement (Dele-Ajayi et al., 2019; Denham, 2019; Fouze & Amit, 2018; Hieftje et al., 2017; Nygren et al., 2019). Shu and Liu (2019) emphasized the role of enjoyment and autonomy in driving engagement, factors reflected in both student responses and classroom observations. Even typically quiet students became more active during game-based activities.

That said, the teacher-researchers' experience also revealed some limitations. They observed that not all students were equally engaged. Some group members remained passive, prompting questions about equitable participation. Factors such as anxiety, lack of confidence, or group dynamics may have affected involvement. Statement 1—"I am more likely to remember mathematical concepts when I do game-based activities"—received the lowest mean (3.56), suggesting that while students enjoyed GBL, its effect on memory retention was perceived as limited. This finding echoes earlier observations in the study and is supported by Rosillo (2022), who noted that game-based materials may hinder long-term retention for some learners.

Some enthusiastic students still struggled to reach the passing mark, showing that affective engagement doesn't always translate to academic success. This highlighted for the teacher-researchers the importance of balancing fun and educational value. They found it challenging to design GBL activities that were both engaging and instructionally rigorous, especially in a subject like mathematics. These reflections emphasized that GBL should complement, rather than replace, direct instruction, particularly for topics that require a deeper understanding. They also recognized the need for stronger teacher preparation in selecting and implementing GBL strategies that promote both active participation and academic achievement.

Reflections from the Field

In addition to quantitative results, the teacher-researchers' qualitative reflections reinforced both the value and complexity of implementing Game-Based Learning (GBL) in Grade 7 Mathematics. They consistently observed that GBL increased students' attention, motivation, and enthusiasm—responses often difficult to elicit in a subject widely viewed as challenging. Students became more participative, collaborative, and open to academic risks when games were integrated, aligning with the positive affective outcomes from the perception survey.

However, the teacher-researchers found that the success of GBL depended on the thoughtful design of games. Creating activities that were both fun and academically aligned required significant time, creativity, and effort, especially in mathematics, where abstract concepts must be made engaging and interactive. Balancing enjoyment with instructional rigor proved to be an ongoing challenge.

Classroom management was another concern, particularly in regulating noise, addressing excessive competitiveness, and encouraging participation from hesitant students. These challenges highlighted the need for clear expectations, inclusive structures, and differentiated support to cater to diverse learning styles and emotional needs.

Despite the difficulties, the teacher-researchers described the experience as personally rewarding and professionally enriching. GBL deepened their understanding of learner-centered instruction and highlighted the evolving demands of teaching in today's classrooms. It also affirmed the potential of GBL to not only improve academic performance but to foster positive attitudes and deeper engagement in mathematics. Their reflections underscored that, when intentionally designed and facilitated, GBL can be a transformative strategy that connects meaningful learning with student motivation and enjoyment.

Conclusion and Recommendations

This study investigated the application of Game-Based Learning (GBL) in Grade 7 Mathematics within the MATATAG Curriculum, assessing students' academic performance before and after GBL implementation, and examining their perceptions regarding attitude, motivation, and engagement.

Results showed a significant increase in post-test scores, with average performance rising from below 75% to above the passing mark, confirming the effectiveness of GBL in improving academic achievement. Students also reported positive affective responses, noting that GBL enhanced their motivation, engagement, and attitudes toward mathematics. However, they perceived GBL as less effective in deepening conceptual understanding, boosting confidence, and improving retention.

The findings affirm GBL's potential in promoting both cognitive and affective learning outcomes. Grounded in Constructivist and Self-Determination Theories, the study highlights motivation as a key element of active, student-centered learning. Teacher-researcher reflections supported this, emphasizing the engaging nature of GBL and its ability to foster a positive classroom climate. Nonetheless, they faced challenges in designing effective games, managing behavior, and aligning activities with learning outcomes. Balancing creativity with instructional rigor, along with intentional planning and clear structures, emerged as essential for successful GBL implementation. Despite the challenges, the process was described as professionally fulfilling and personally transformative.

These insights suggest that GBL, when thoughtfully designed and facilitated, can be a valuable alternative to traditional teaching. At the policy level, investing in the professional development of in-service and pre-service mathematics teachers is crucial. Training should equip educators to develop both digital and non-digital

GBL activities that focus on conceptual mastery, confidence-building, and long-term learning. Institutional support and resources are needed to sustain such efforts.

However, the study's scope was limited to one intact class of 28 students in a laboratory school, which affected its generalizability. The absence of a control group also limits causal claims. Future studies should involve larger, more diverse samples and include control groups to strengthen findings. Longitudinal studies and investigations into gender-based differences in response to GBL are also recommended.



Conflict of Interest

The authors report that there are no competing interests to declare.

Ethical Approval

The Office of the Ethics Review Committee of the Cebu Normal University granted exemption to the study with ERC Code: 1152 / 2024-08.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

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