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INTEGRATION OF GAME-BASED LEARNING IN TEACHING MATHEMATICS 7

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ABSTRACT

Mathematics 7 serves as a crucial foundation for learners transitioning to junior high school, yet many students experience low engagement and difficulty in understanding abstract mathematical concepts. Traditional teaching approaches often fail to address diverse learning needs and motivation levels. In response, game-based learning (GBL) has emerged as a learner-centered instructional strategy that integrates play, challenge, and feedback to enhance understanding and participation. This study examined the integration of game-based learning—both ICT-based and non-ICT-based—in teaching Mathematics 7 and its influence on learner performance and classroom instruction using a quasi-experimental non-equivalent control group design combined with a descriptive-evaluative approach involving 100 Grade 7 students and 25 mathematics teachers. Findings revealed a systematic and effective process for integrating GBL into lessons. Teachers expressed favorable assessments of GBL, particularly in enhancing instructional clarity, content relevance (mean = 4.06), student engagement (mean = 4.04), and classroom interaction. While both groups showed improvement, the experimental group demonstrated significantly higher post-test gains (mean = 82.22, Satisfactory) compared to the control group (mean = 74.98, Needs Improvement). Statistical analysis confirmed a significant difference between the post-test performances ($p < 0.001$), indicating the positive effect of GBL on student achievement. The study concludes that GBL is an effective and viable instructional strategy for teaching Mathematics 7.

Keywords: Game-Based Learning; Mathematics 7; Academic Achievement; Student Engagement; Instructional Strategies

1 INTRODUCTION

Mathematics is widely recognized as a fundamental discipline that develops logical reasoning, analytical thinking, and problem-solving skills essential for academic success and national development. Globally and nationally, however, students continue to demonstrate persistent difficulties in mathematics achievement, often rooted in prevailing math anxiety, a lack of intrinsic motivation, and the limitations of traditional, rote-heavy instructional methods [1]. As highlighted by Yumang [1], addressing persistent low mastery requires innovative pedagogical interventions that actively involve learners. In the Philippine basic education system, Mathematics 7 represents a critical and often daunting transition from elementary to junior high school. At this stage, learners encounter an abrupt shift toward abstract concepts—such as integers, algebraic expressions, linear equations, and basic geometry—which many find cognitively overwhelming [2,3]. Official directives from the Department of Education [2] and pedagogical analyses by Celedonio [3] emphasize the necessity of adapting instruction to meet the evolving cognitive needs of digital native learners. These challenges are frequently compounded by low retention rates and a perceived disconnect between abstract formulas and real-world application, a concern echoed by Jaranilla, Santos, and Ramos [4] in their examination of gamified learning environments.

Historically, mathematics instruction has been dominated by teacher-centered strategies characterized by lectures, rote drills, and procedural exercises. While these methods have long been practiced, they often fail to address diverse learning styles and the developmental needs of adolescent learners [5]. Cruzada and Arellano [5] demonstrated that designing tailored, non-ICT game-based materials can effectively bridge this gap, even in resource-constrained classrooms. In response, contemporary educational theories advocate active, experiential, and collaborative learning environments. Game-Based Learning (GBL), which integrates structured game elements into instruction, has emerged as a promising strategy to increase engagement and deepen understanding [6,7]. Research by Lane [6] shows that structured educational games cultivate 21st-century skills, while Concilio and Braga [7] demonstrated that gamified STEM instruction significantly boosts emotional engagement and intrinsic motivation. By incorporating competition, feedback, and interactive challenges, GBL can transform abstract mathematical concepts into meaningful learning experiences, as further substantiated by Mavridis, Tsiatsos, and Terzidou [8] in secondary education.

The integration of GBL in teaching Mathematics 7 is anchored in established learning theories. Constructivist Theory (Piaget and Vygotsky) asserts that learners actively construct knowledge through interaction with their environment [9,10]. Piaget [9] established the cognitive foundations of active knowledge construction, while Vygotsky's [10] Zone of Proximal Development (ZPD) provides the framework for peer scaffolding and immediate feedback necessary for skill mastery. Behaviorist Theory, articulated by Skinner [11], clarifies how gamified elements like points and rewards reinforce correct responses and sustain effort. Experiential Learning Theory by Kolb [12] highlights a cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Furthermore, Jerome Bruner's [13] Theory of Development illuminates how Discovery Learning and Instructional Scaffolding guide students through enactive, iconic, and symbolic stages of mathematical understanding.

Modern educational initiatives, such as the Department of Education's EdTech webinar series [14], emphasize the implementation of gamification tools to foster active participation. Recent evaluations by Sulpico, Torres, and Mendoza [15] confirm high teacher acceptance of GBL frameworks in public secondary schools. Incorporating compelling narrative structures and story-based mechanics, as explored by Betts [16], further enhances learner immersion across core subjects. Rooney [17] provided crucial theoretical frameworks connecting game dynamics with specific pedagogical strategies, while Moldez, Tan, and Garcia [18] documented significant improvements in learner retention through gamification mechanics in basic education. Specific structural frameworks, such as the LARO framework formulated by Libradilla, Ocampo, and Cruz [19], demonstrate how educational games enhance fundamental mathematical process skills.

Empirical applications in secondary mathematics demonstrate substantial cognitive gains across specific topics. Almonidovar and Almonidovar [20] proved that Math-Play interventions significantly enhance conceptual mastery in algebraic expressions. Similarly, mobile-based mathematical games evaluated by Dela Cruz [21] showed marked improvements in junior high school student performance. Validated instructional materials developed by Buan, Perez, and Ramos [22] confirm that structured game mechanics ensure aligned learning outcomes. Theoretical models like Cyril's [23] Motivation-Exploration-Implementation (MEI) framework and gamified physics and math simulations analyzed by Biedermann and Gstohl [24] underscore the versatile impact of gamification.

Comprehensive meta-analyses conducted by Tokac, Novak, and Thompson [25], Sailer and Homner [27], and systematic evaluations by Chen, Liu, and Shou [26] provide overwhelming evidence that digital and non-digital game-based learning yields significant positive effect sizes on cognitive mastery, affective engagement, and mathematical achievement. Furthermore, investigations by Zuo, Wang, and Zhang [28], Hopkins, Miller, and Davis [29], Zhang and Hasim [30], and Thurairasu [31] collectively establish that immediate interactive feedback, repetitive practice, and interactive digital platforms fundamentally enhance learner participation, skill mastery, and long-term retention in core curricula.

Despite its potential, the integration of GBL in Mathematics 7 classrooms remains inconsistent. Thus, this study sought to examine how GBL can be systematically integrated into Mathematics 7 instruction, assess mathematics teachers' perceptions of GBL across key pedagogical dimensions, and evaluate its impact on Grade 7 students' academic performance.

2 MATERIAL AND METHODS

2.1 Research Design

This study utilized a quasi-experimental non-equivalent control group design paired with a descriptive-evaluative approach. Using intact Grade 7 classes, the research compared traditional instructional methods against GBL-enhanced instruction—incorporating both ICT-based and non-ICT tools—to measure direct impacts on student academic performance via pre-test and post-test analysis. Simultaneously, a structured Likert-scale survey questionnaire captured teachers' assessments across eight instructional dimensions.

2.2 Participants and Sampling

The study involved two distinct groups of respondents within the Schools Division of Caloocan - AROMAR District. The teacher respondents consisted of 25 secondary school mathematics teachers selected through purposive sampling from a total population of 62 teachers (40.32% representation) across four schools: Maypajo High School (n = 8, 32.0%), Kasarinlan High School (n = 6, 24.0%), M.B. Asistio Sr. High School (n = 6, 24.0%), and M.B. Asistio Sr. High School Unit 1 (n = 5, 20.0%). The student respondents comprised 100 Grade 7 students from Maypajo High School, selected via cluster random sampling and divided equally into an Experimental Group (n = 50) exposed to GBL integration and a Control Group (n = 50) taught via traditional methods.

2.3 Research Instruments

Two main research instruments were utilized: (1) A Structured Survey Questionnaire administered to teacher respondents to evaluate the GBL framework across eight key dimensions on a 5-point Likert scale (5 = Highly Evident / Strongly Accepted to 1 = Not Evident / Strongly Rejected). Content validation was performed by an expert panel, and pilot testing yielded a Cronbach's alpha coefficient of 0.72, confirming acceptable internal consistency. (2) A 50-item Teacher-Made Achievement Test aligned with a Table of Specifications (TOS) covering Mathematics 7 competencies. Content validity was established by three doctoral-level education experts, and pilot testing with 40 non-participant students yielded a Kuder-Richardson 20 (KR-20) reliability coefficient of 0.77.

2.4 Data Gathering and Statistical Analysis

Administrative clearance and informed consent were secured prior to data collection. Pre-tests were administered to both student groups to establish baseline performance. The 4-week instructional intervention was then executed: the experimental group received lessons using 20 GBL-aligned lesson plans and activity sheets, while the control group received conventional lecture-based instruction. Post-tests were administered immediately following the intervention. Raw scores were transmuted using DepEd standard tables and analyzed using weighted means, standard deviations, percentage distributions, and Independent Samples t-tests at a 0.05 level of significance.

3 RESULTS AND DISCUSSION

3.1 Integration of Game-Based Learning in Mathematics 7

A total of 20 weekly lesson plans and 20 activity sheets were developed and validated. The integration framework systematically transitioned instruction from traditional teacher-centered models to active, learner-centered experiences grounded in Constructivism, ZPD, and Behaviorist feedback loops. Table 1 summarizes the instructional comparison between the experimental and control groups.

Table 1: Matrix of Instructional Comparison

Feature	Experimental Group (GBL-Integrated)	Control Group (Traditional / Non-GBL)
Instructional Design	Learner-Centered: Active knowledge construction and discovery.	Teacher-Centered: Lecture-based delivery and rote memorization.
Theoretical Basis	Constructivism & ZPD: Structured challenges and peer scaffolding.	Direct Instruction: 'Show-and-tell' model with teacher as sole source.
Lesson Plans	20 GBL-Aligned Plans: Explicitly integrated ICT and non-ICT game mechanics.	Standard Lesson Plans: Prescribed departmental format with direct lectures.
Learning Activities	Experiential Tasks: Manipulate symbols and explore patterns via games.	Passive Tasks: Listening, note-taking, and copying board examples.

Feedback & Assessment	Immediate & Reinforcing: Points, badges, instant feedback, 20 activity sheets.	Delayed & Evaluative: Traditional paper-and-pencil tests, checked post-class.

3.2 Mathematics Teachers' Assessment of GBL Integration

Mathematics teachers across the AROMAR District highly evaluated the integration of GBL across eight core instructional dimensions. As presented in Table 2, the overall Grand Weighted Mean was 4.01 ('Evident'), reflecting strong institutional and pedagogical readiness. Content Relevance and Accuracy achieved the highest mean rating (4.06), specifically highlighting the games' capacity to establish real-life connections (mean = 4.24). Student Engagement and Motivation ranked second (mean = 4.04), driven by the fostering of positive attitudes toward mathematics (mean = 4.08). Clarity of Objectives and Classroom Management both scored 4.02, demonstrating that GBL maintains academic rigor and creates a safe, low-anxiety learning environment.

Table 2: Summary of Mathematics Teachers' Assessments on GBL Integration

Instructional Criteria	General Weighted Mean	Verbal Interpretation	Rank
1. Clarity of Objectives	4.02	Evident	3.5
2. Content Relevance and Accuracy	4.06	Evident	1
3. Instructional Strategies	3.99	Evident	6
4. Assessment and Evaluation	3.98	Evident	7.5
5. Classroom Management	4.02	Evident	3.5
6. Instructional Materials and Resources	3.98	Evident	7.5
7. Student Engagement and Motivation	4.04	Evident	2
8. Development of 21st Century Skills	4.01	Evident	5
Grand Weighted Mean	4.01	EVIDENT	

3.3 Student Performance Before and After GBL Integration

Prior to the intervention, 100% of students in both groups performed at the 'Needs Improvement' level (< 75), with baseline mean transmuted grades of 66.52 for the Control Group and 66.30 for the Experimental Group, confirming equivalent entry-level difficulties in abstract concepts. Following instruction, the Experimental Group exhibited a dramatic improvement, achieving an overall mean grade of 82.22 ('Satisfactory'). In contrast, the Control Group achieved a mean grade of 74.98 ('Needs Improvement'), with 54.0% of learners remaining below passing standards. Table 3 illustrates the comparative post-intervention performance breakdown.

Table 3: Student Performance Distribution After Integrating GBL Approach

Proficiency Scale	Descriptor	Control Group (f)	Control Group (%)	Experimental Group (f)	Experimental Group (%)
90 – 100	Outstanding (O)	1	2.0	7	14.0
85 – 89	Very Satisfactory (VS)	2	4.0	12	24.0
80 – 84	Satisfactory (S)	3	6.0	13	26.0
75 – 79	Fairly Satisfactory (FS)	17	34.0	9	18.0
< 75	Needs Improvement (NI)	27	54.0	9	18.0
Total	100.0%	50	100.0%	50	100.0%
Overall Mean Grade		74.98 (NI)		82.22 (S)	

3.4 Test of Significant Difference

To determine whether a statistically significant difference existed between the two groups, Independent Samples t-tests were conducted at a 0.05 level of significance (df = 98). As shown in Table 4, the baseline pre-test difference was not statistically significant ($p = 0.55$). However, the post-test analysis revealed a highly significant difference between the Control and Experimental groups ($p < 0.001$), leading to the rejection of the null hypothesis. The Experimental Group achieved a net score increase of +15.92 points, demonstrating that GBL integration directly enhanced mathematical achievement.

Table 4: Test of Difference in Academic Performance Between Control and Experimental Groups

Test Period	Group	Mean Score	Descriptor	p-value	Decision	Interpretation
Pre-test	Control Experimental	66.52 66.30	Needs Improvement Needs Improvement	0.55	Fail to Reject Ho	Not Significant
Post-test	Control Experimental	74.98 82.22	Needs Improvement Satisfactory	< 0.001	Reject Ho	Statistically Significant

4 CONCLUSION

Based on the empirical findings, the study concludes that Game-Based Learning (GBL) is a highly effective, pedagogically sound, and viable instructional strategy for teaching Mathematics 7. The systematic integration of both ICT-based and non-ICT game mechanics successfully transforms traditional, teacher-centered classrooms into dynamic, learner-centered environments. GBL significantly improves student academic achievement, fosters active engagement, builds positive attitudes toward mathematics, and develops essential 21st-century skills. The approach effectively bridges the cognitive transition from elementary arithmetic to abstract secondary mathematics.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The author declares no conflict of interest regarding the publication of this research article.

Statement of ethical approval

The Institutional Research Ethics Committee of Eulogio "Amang" Rodriguez Institute of Science and Technology granted ethical approval.

Statement of informed consent

Informed consent was formally obtained from all teacher participants, and parental consent alongside minor assent was secured for all student participants. Data privacy and confidentiality were strictly maintained in accordance with national research standards.

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