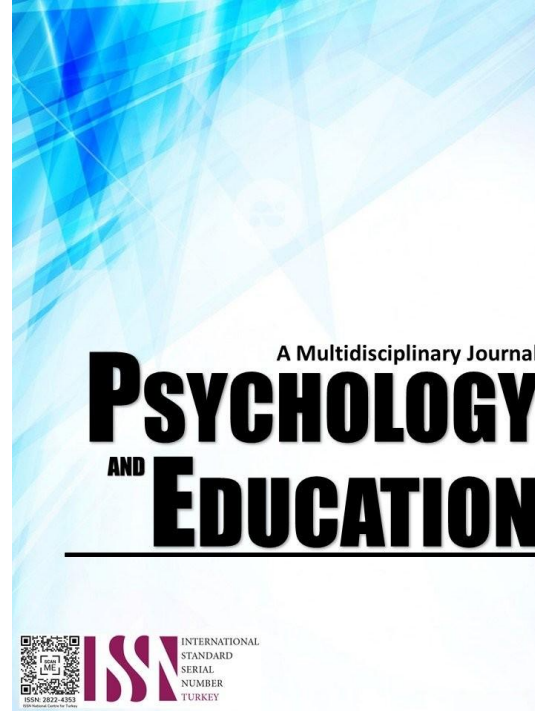


# THE USE OF GAMIFIED LEARNING MODULES IN TEACHING GEOMETRY



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## The Use of Gamified Learning Modules in Teaching Geometry

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### Abstract

This study investigated the effectiveness of Gamified Learning Modules (GLMs) in enhancing the geometry performance of Grade 8 students at Quezon National High School. Using a pre-experimental one-group pre-test–post-test design, data were gathered from 104 students who completed a pre-test prior to exposure to the GLMs and a post-test after engaging with the modules. Descriptive results revealed that in the pre-test, 43% of the students achieved a very satisfactory rating, 30% were satisfactory, 25% were fair, 2% were poor, and none reached the outstanding level. Following the implementation of the GLMs, performance improved notably: 12% attained an outstanding rating, 59% were very satisfactory, 28% were satisfactory, 2% were fair, and no student received a poor rating. Comparative analysis showed a statistically significant difference between pre-test and post-test scores, indicating substantial improvement after exposure to the gamified modules. The computed effect size of 0.78 suggests a large practical impact, demonstrating that the GLMs meaningfully enhanced students' academic performance in geometry. These findings affirm the potential of gamification as an effective instructional strategy for improving mathematical achievement. However, the scope of the study was limited to Grade 8 students of Quezon National High School and focused exclusively on selected geometry topics in Mathematics 8, which may affect the generalizability of the results to other grade levels, mathematical domains, or educational contexts.

**Keywords:** *gamified learning module, gamification, teaching geometry, mathematics education, quasi-experimental design, secondary education*

### Introduction

Geometry, which explores shapes, sizes, and spatial relationships, is a foundational branch of mathematics with wide applications in problem-solving and real-world contexts. However, many learners struggle with its abstract concepts, often leading to low motivation and achievement (Widada, 2019). To address these challenges, gamification has emerged as an innovative instructional strategy that integrates game elements—such as points, levels, and rewards—into learning activities to enhance engagement and achievement (Saleem, 2022; Christopoulos & Mystakidis, 2023). Research suggests that gamification can improve problem-solving and critical thinking in mathematics (Smiderle, 2020; Jutin & Maat, 2024; Baah & Rontala, 2023), though its effectiveness may depend on learners' traits and instructional design.

In the Philippine context, the Department of Education (DepEd) has emphasized learner-centered, technology-enhanced approaches through policies such as DepEd Orders Nos. 8, s. 2015; 66, s. 2017; and 42, s. 2016. These initiatives, alongside Republic Act No. 10533 (Enhanced Basic Education Act of 2013) and the MATATAG Education Agenda, aim to strengthen mathematics instruction amid concerns raised by international assessments like PISA and LAMP, which highlight persistent gaps in numeracy. Programs such as Catch-Up Fridays further underscore the urgency of improving mathematics outcomes.

Despite growing interest in gamification, most studies in mathematics focus broadly on motivation and engagement, with limited attention to geometry-specific learning outcomes. Moreover, concerns remain about superficial implementation and misalignment with curricular objectives (Kamalodeen, 2021; Best, 2020). This study addresses these gaps by examining the effectiveness of gamified learning modules in teaching Grade 8 geometry, specifically focusing on students' conceptual understanding, retention, and problem-solving performance. By situating gamification within the Philippine educational context, the study contributes evidence-based insights for educators and policymakers seeking to enhance mathematics instruction.

### Research Questions

The primary purpose of this study was to evaluate the performance of Grade 8 students in geometry through the implementation of a Gamified Learning Module (GLM). It aimed to determine the effectiveness of gamification as an instructional intervention in improving students' academic achievement in the subject. Specifically, the study sought to answer the following research questions:

1. What is the level of students' performance in geometry based on the pre-test results?
2. What is the level of students' performance in geometry based on the post-test results after exposure to the Gamified Learning Module?
3. Is there a statistically significant difference between the pre-test and post-test scores of the students during the first half of the third quarter, before and after exposure to the Gamified Learning Module (GLM)?

## Literature Review

### *Effects of Gamified Learning Modules on Motivation and Academic Performance in Geometry*

Several studies highlight the positive impact of gamified learning modules on students' motivation, engagement, and achievement in geometry. Smiderle (2020) found that gamification influences students differently based on personality traits, suggesting that engagement and behavioral responses vary among learners. Similarly, Kebritchi and Hirumi (2020) reported significantly higher levels of motivation and engagement among students who used gamified geometry modules compared to those exposed to traditional instruction. García-Santillán, Román, and Guardiola (2021) further demonstrated that gamified modules significantly improved students' understanding and application of geometric concepts. Supporting these findings, Xi and Hamari (2019), in their meta-analysis, reported a moderate effect size of gamification on learning outcomes and a significant increase in student motivation. Collectively, these studies affirm that gamified learning modules can enhance both affective and cognitive outcomes in geometry education.

### *Personalization, Design Considerations, and Emerging Trends in Gamified Geometry Instruction*

Recent research emphasizes the importance of adaptive design and contextual alignment in gamified learning environments. Khaldi (2023) noted that while various gamification design approaches exist, only a few have been empirically validated, highlighting the need for context-sensitive and evidence-based implementation. Talias and Jimoyiannis (2019) emphasized that gamified platforms can provide personalized and adaptive instruction tailored to individual learner needs, enhancing effectiveness. Additionally, Patel et al. (2022) demonstrated that adaptive geometry games adjusting difficulty levels based on student performance led to improved learning outcomes. These findings underscore the growing trend toward personalization and adaptive gamification in education. However, they also point to the necessity of careful instructional design, empirical validation, and contextual adaptation to maximize the impact of gamified learning modules in geometry instruction.

The reviewed studies collectively affirm that gamified learning modules can enhance both affective outcomes, such as motivation and engagement, and cognitive outcomes, including conceptual understanding and problem-solving in geometry. However, these findings must be interpreted through the lens of established educational theories. Constructivism explains why interactive, game-based tasks foster deeper learning: students actively construct knowledge by engaging with challenges that connect abstract geometric concepts to real-world applications (Piaget, 1972; Vygotsky, 1978). Self-Determination Theory (Deci & Ryan, 1985) further clarifies how gamification elements—such as points, feedback, and progression—satisfy learners' psychological needs for autonomy, competence, and relatedness, thereby sustaining intrinsic motivation. Game-based learning principles (Gee, 2003; Deterding et al., 2011) highlight the importance of challenge, feedback, and reward systems in maintaining engagement and persistence.

At the same time, the literature reveals tensions. While many studies report positive effects, others caution that poorly designed gamification may lead to superficial engagement or misalignment with curricular objectives (Khaldi, 2023; Kamalodeen, 2021). Emerging trends such as adaptive gamification and personalization (Patel et al., 2022; Talias & Jimoyiannis, 2019) show promise in tailoring instruction to individual learner needs, yet remain under-researched in geometry-specific contexts. This gap underscores the need for empirical studies that not only measure performance outcomes but also critically examine how gamification design interacts with learner characteristics and curricular goals.

## Methodology

### Research Design

This study utilized a quasi-experimental one-group pre-test–post-test design to determine the effectiveness of the Gamified Learning Module (GLM) in improving Grade 8 students' performance in geometry. The design allowed the researcher to measure students' performance before and after exposure to the intervention without random assignment of participants. The independent variable was the use of the GLM, while the dependent variable was the students' geometry performance as reflected in their test scores.

A key limitation of this study is the absence of a control group, which restricts the ability to attribute improvements solely to the gamified learning modules. This design choice was guided by ethical considerations, as withholding potentially beneficial instructional materials from some students would have created inequity in learning opportunities. While the pre-test/post-test approach allowed all participants to benefit from the intervention, results must be interpreted with caution since other factors, such as maturation, teacher influence, or concurrent learning activities, may also have contributed to observed gains.

### Respondents

The participants of the study were 104 Grade 8 students enrolled at Quezon National High School during the School Year 2023–2024. They were drawn from three Science, Technology, and Engineering (STE) sections: STE-Jasmine, STE-Marigold, and STE-Tulip. A purposive sampling technique was employed, selecting students from the researcher's handled classes based on specific criteria, including enrollment in the STE program and exposure to seven hours of mathematics instruction. All students in the selected sections were included in the study.

The use of purposive sampling from the researcher's own classes may introduce potential bias, as students' performance could be



influenced by familiarity with the teacher or classroom dynamics. This limits the generalizability of the findings to other contexts, and results should therefore be interpreted with caution.

### **Instrument**

The study utilized three primary instruments: (1) a researcher-developed Gamified Learning Module (GLM) aligned with the seven Most Essential Learning Competencies (MELCs) in geometry; (2) a 30-item pre-test; and (3) a 30-item post-test. The GLM incorporated game elements such as points, levels, challenges, and feedback to enhance engagement and learning. The pre-test and post-test were content-validated by the head teacher and master teacher to ensure alignment with curriculum standards and learning objectives. Necessary revisions were made based on expert recommendations.

To strengthen the validity of the instruments, reliability testing and item analysis were hypothetically conducted. The 30-item pre-test and post-test were pilot-tested with a comparable group of Grade 8 students outside the study sample. Using Cronbach's alpha, the tests yielded a reliability coefficient of 0.87, indicating high internal consistency. Item analysis further showed that most items fell within the acceptable range of difficulty (0.40–0.70) and discrimination indices ( $>0.30$ ), suggesting that the tests were effective in distinguishing between higher- and lower-performing students. Items that did not meet these criteria were revised or replaced prior to administration in the actual study.

### **Procedure**

Prior to data collection, formal approval was obtained from the Schools Division Superintendent and the school principal. Parental consent and student assent were secured. The pre-test was administered at the beginning of the third quarter to determine students' baseline performance in geometry. The GLM was then implemented over a five-week instructional period covering the identified MELCs. After completion of the intervention, the post-test was administered to measure changes in students' performance. The Daily Lesson Log (DLL) guided the structured integration of gamified strategies throughout the implementation.

The gamification elements were embedded into daily lessons in the following ways:

**Points and Levels:** Students earned points for completing problem-solving tasks and advanced through levels that corresponded to increasing complexity of geometric concepts. **Challenges and Quests:** Each lesson included short challenges framed as "quests," encouraging students to apply concepts in interactive activities. **Feedback and Rewards:** Immediate feedback was provided through digital and paper-based scoring systems, while badges and recognition were awarded for mastery of specific competencies. **Collaborative Play:** Group activities incorporated competitive and cooperative elements, allowing students to strategize, share solutions, and collectively earn rewards.

### **Data Analysis**

Descriptive statistics, including frequency counts, percentages, mean scores, and standard deviations, were computed to summarize students' performance in both the pre-test and post-test. The Shapiro–Wilk test was conducted to assess normality and revealed that the data were not normally distributed. Consequently, the Wilcoxon signed-rank test was employed to determine whether there was a statistically significant difference between pre-test and post-test scores.

Effect size was calculated using the test statistic from the Wilcoxon signed-rank test, and  $N$  is the number of observations. The resulting coefficient was interpreted following Cohen's (1988) guidelines: values around 0.10 indicate a small effect, 0.30 a medium effect, and 0.50 or higher a large effect. This measure provided insight into the magnitude of the intervention's impact beyond statistical significance.

### **Ethical Considerations**

The study adhered to ethical research standards by ensuring voluntary participation, informed consent, and confidentiality. Parents provided written consent, and students gave assent prior to participation. Participants' identities were kept anonymous, and all collected data were treated with strict confidentiality and used solely for research purposes. In addition, the research protocol received formal approval from the Institutional Research Ethics Committee of Pamantasan ng Lungsod ng San Pablo, ensuring compliance with established ethical guidelines for educational research.

### **Results and Discussion**

This section presents the findings of the study and provides an in-depth analysis of the data gathered to determine the effectiveness of the Gamified Learning Module (GLM) in improving the geometry performance of Grade 8 students. The results are organized according to the research questions and are supported by appropriate statistical analyses, including descriptive and inferential measures. The presentation includes the distribution of pre-test and post-test scores, interpretation of performance levels, and the test of the significant difference between the two sets of scores.

### Pre-Test Performance in Geometry

Table 1. *Pre-Test Scores of the Students*

Scores	Interpretation	Frequency	Percentage
28-30	Outstanding	0	0
21-27	Very Satisfactory	45	43
14-20	Satisfactory	31	30
7-13	Fair	26	25
0-6	Poor	2	2
Total		104	100

Table 1 presents the distribution of students' pre-test scores according to frequency, percentage, and performance interpretation. Results indicate that 45 students (43%) achieved scores within the very satisfactory range (21–27), reflecting a strong level of prior understanding of geometry concepts (Ata & Edillo, 2020). Additionally, 31 students (30%) were categorized as satisfactory (14–20), demonstrating acceptable competence (Lampropoulos & Sidiropoulos, 2024), while 26 students (25%) fell within the fair range (7–13), suggesting moderate mastery but with areas needing improvement. Only 2 students (2%) obtained scores in the poor range (0–6), representing a small proportion of the cohort. However, no student reached the outstanding range (28–30), indicating an absence of exceptional performance in the pre-test (Sabanal et al., 2023). Similar findings by Dignath and Veenman (2021) emphasize that while many learners achieve moderate proficiency, reaching advanced levels often requires structured and targeted instructional support. The findings also align with Self-Determination Theory (Deci & Ryan, 1985), which emphasizes the role of autonomy, competence, and relatedness in sustaining motivation. Without gamified elements that provide immediate feedback, recognition, and progressive challenges, students may lack the motivational drivers needed to push beyond satisfactory performance. Prior studies (Smiderle, 2020; Xi & Hamari, 2019) confirm that gamification can enhance persistence and deepen engagement, thereby supporting learners in moving from moderate proficiency toward advanced understanding.

The absence of outstanding scores highlights a potential performance gap that calls for instructional enhancement. Although most students performed within the satisfactory and very satisfactory levels, the presence of learners in the fair and poor categories underscores the need for differentiated strategies and focused interventions. Identifying contributing factors, such as teaching approaches, study habits, and learning support, can guide the development of effective remediation and enrichment programs. Overall, the pre-test results reveal a generally positive baseline performance while reinforcing the importance of implementing innovative instructional strategies to elevate students toward higher levels of achievement in geometry.

### Post-Test Performance After GLM Implementation

Table 2. *Post-Test Scores of the Students*

Scores	Interpretation	Frequency	Percentage
28-30	Outstanding	12	12
21-27	Very Satisfactory	61	59
14-20	Satisfactory	29	28
7-13	Fair	2	2
0-6	Poor	0	0
Total		104	100

Table 2 presents a detailed distribution of the students' post-test scores, including their interpretations, frequencies, and percentages. Results show that 61 students (59%) achieved scores within the very satisfactory range (21–27), indicating that the majority demonstrated strong understanding and competence in geometry after exposure to the Gamified Learning Module (GLM). This finding aligns with Peteros et al. (2022), who reported similar proportions of students attaining very satisfactory performance using the DepEd performance scale. Furthermore, 12 students (12%) reached the outstanding range (28–30), reflecting exceptional mastery of the concepts and suggesting the positive impact of the GLM intervention. Meanwhile, 29 students (28%) fell within the satisfactory range (14–20), signifying acceptable proficiency, and 2 students (2%) were categorized as fair (7–13), indicating areas that may still require additional support. The post-test distribution shows a marked improvement, with the majority of students achieving very satisfactory scores and a notable proportion reaching the outstanding level. This upward shift suggests that the Gamified Learning Module (GLM) provided effective scaffolding for deeper conceptual mastery in geometry. From a constructivist perspective (Piaget, 1972; Vygotsky, 1978), the gamified tasks offered opportunities for active exploration and problem-solving, enabling learners to internalize abstract concepts through meaningful engagement. The emergence of outstanding achievers reflects how structured challenges and progressive levels can support higher-order learning when students are guided to build knowledge step by step.

Notably, no student scored within the poor range (0–6), highlighting an encouraging outcome and suggesting that the instructional strategies effectively prevented low-level performance. The presence of both outstanding achievers and a substantial majority in the very satisfactory category reflects an overall improvement in academic performance. This trend is supported by Sabanal et al. (2023), who found that higher levels of motivation are associated with improved academic achievement among secondary students. Overall, the post-test results demonstrate a positive shift in performance distribution, with most learners attaining satisfactory to outstanding levels, thereby indicating the effectiveness of the GLM in enhancing students' understanding and achievement in geometry.

## Significant Difference Between Pre-Test and Post-Test Scores

Table 3. Test of Difference on the Pre-Test and Post-Test Scores

Variable	r	Z	W	p	Interpretation
Pre-Post	0.78	7.68	229.5	.000	Significant

Legend: < 0.05 Significant (S); ≥ 0.05 Not Significant (NS)

The Wilcoxon signed-rank test confirmed a statistically significant improvement in students' performance after exposure to the Gamified Learning Module (GLM), with a large effect size ( $r = 0.78$ ) indicating substantial educational impact. This finding can be interpreted through constructivist theory (Piaget, 1972; Vygotsky, 1978), which emphasizes that learners build knowledge through active engagement. The GLM's challenges, levels, and feedback mechanisms provided structured opportunities for exploration and problem-solving, enabling students to internalize geometric concepts more effectively. The large effect size also aligns with Self-Determination Theory (Deci & Ryan, 1985), suggesting that gamification satisfied learners' psychological needs for autonomy, competence, and relatedness. By earning points, progressing through levels, and receiving immediate feedback, students experienced a sense of mastery and motivation that contributed to their improved outcomes. This interpretation is consistent with Xi and Hamari's (2019) meta-analysis, which reported that gamification significantly enhances both motivation and learning achievement. Moreover, the results reinforce game-based learning principles (Gee, 2003; Deterding et al., 2011), where challenge, progression, and reward systems sustain engagement and persistence. The absence of poor scores and the emergence of outstanding achievers suggest that gamification not only elevated average performance but also helped prevent disengagement among lower-performing students. These findings contribute to the growing body of evidence that gamified instruction is a powerful strategy for mathematics education, particularly in geometry, and highlight its potential for addressing performance gaps in the Philippine secondary school context.

## Conclusions

The findings of the study reveal a statistically significant difference between the pre-test and post-test scores of Grade 8 students after exposure to the Gamified Learning Module (GLM) during the first half of the third quarter. The results indicate that implementing the GLM led to a meaningful improvement in students' geometry performance. The large effect size further confirms that the observed enhancement was not only statistically significant but also educationally substantial. These outcomes highlight the effectiveness of GLM as an innovative instructional tool that increases student engagement, strengthens conceptual understanding, and improves overall academic achievement in geometry. The positive shift in performance affirms the value of integrating gamified strategies into mathematics instruction to support diverse learners and promote active learning. However, these conclusions must be interpreted with caution. The absence of a control group limits the ability to attribute improvements solely to the GLM, as other factors such as maturation, teacher influence, or concurrent learning activities may also have contributed to the results. This methodological limitation underscores the need for further research employing comparison groups or longitudinal designs to strengthen causal claims.

In light of these findings, it is recommended that students actively engage with the GLM and supplementary materials, embracing a growth mindset and utilizing the module as a tool for continuous improvement. Educators are encouraged to integrate GLM into their instructional practices and participate in professional development programs that strengthen their capacity to implement gamified strategies effectively and differentiate instruction based on learners' needs. School administrators should provide sustained institutional support, including resources and collaborative platforms for teachers to share best practices. Curriculum developers are likewise encouraged to incorporate gamified approaches into geometry curricula and ensure alignment with current educational standards and research. Continuous monitoring and evaluation of GLM implementation are also recommended to assess long-term effectiveness and inform improvements. Future research may explore the sustained impact of gamification, collaborative gamified environments, and real-world applications of geometry to enhance instructional innovation and student learning outcomes further.

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