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EFFECTIVENESS OF GAMIFIED TEACHING APPROACH ON MATHEMATICS ACHIEVEMENT

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ABSTRACT

Mathematics is considered one of the most essential yet challenging subjects among senior high school learners. Traditional teaching approaches often result in low student motivation, limited participation, and poor academic performance. This study determined the effectiveness of a gamified teaching approach on students' mathematics achievement at Calanasan National High School, Schools Division of Apayao, during the fourth quarter of School Year 2025–2026. The study employed a quasi-experimental pretest-posttest control group design involving two intact Grade 11 sections. The control group consisted of 12 students who received traditional instruction, while the experimental group consisted of 18 students exposed to a gamified teaching approach integrating points, rewards, levels, feedback mechanisms, and classroom challenges. A validated 40-item teacher-made Mathematics Performance Test (MPT) served as the primary instrument for data gathering. Statistical tools such as mean, mean gain, paired samples t-test, and independent samples t-test were used to analyze the data at a 0.05 level of significance. Findings revealed that both groups improved after instruction; however, the experimental group obtained a significantly higher mean gain score than the control group. Results further showed statistically significant differences between the pretest and posttest scores of both groups, with the experimental group demonstrating greater improvement in mathematics achievement. The findings indicate that the gamified teaching approach significantly enhances students' mathematics achievement by increasing engagement, participation, and motivation during instruction. The study recommends the integration of gamified strategies into mathematics instruction and the provision of institutional support for innovative and learner-centered pedagogical approaches.

Keywords: gamification, mathematics achievement, gamified teaching approach, mathematics instruction, senior high school students



Introduction

Mathematics has long been recognized as a fundamental subject that builds critical thinking, problem-solving, and logical reasoning skills among learners. However, it remains one of the most challenging disciplines for students, often associated with anxiety, low motivation, and declining performance. In the modern educational landscape, where technology and innovation shape the way students learn, there is an increasing demand for teaching strategies that promote engagement, enjoyment, and deeper learning. Gamification—the integration of game-based elements such as rewards, levels, and challenges into non-game contexts has emerged as a promising pedagogical approach to address these learning barriers. By transforming traditional lessons into interactive and motivating experiences, educators aim to foster intrinsic motivation, improve participation, and enhance learning outcomes in mathematics.

Internationally, numerous studies have explored the potential of gamified instruction in improving students' academic performance and engagement in mathematics. For instance, Jutin and Maat (2024) systematically reviewed global research and concluded that gamification significantly enhances learners' engagement, retention, and performance by reducing math-related anxiety and fostering cognitive development. Similarly, Pereira et al. (2024) emphasized that integrating technological innovations and gamification in mathematics classes leads to a 20% improvement in students' achievement compared to traditional instruction, highlighting how interactive learning environments stimulate student motivation and social participation. Furthermore, Lucena (2025) identified key characteristics and challenges of gamified learning, noting that while it increases engagement and retention, educators must address issues such as cost and technological accessibility.

Empirical evidence from various regions further reinforces these findings. Attah et al. (2024) found that students exposed to gamified mathematics instruction performed significantly better than those under traditional methods, with female learners showing higher gains in comprehension and interest. Likewise, Parrales et al. (2024) demonstrated that integrating rewards, progression systems, and feedback mechanisms into mathematics teaching positively impacts students' motivation and academic outcomes, thereby validating gamification as an effective supplementary strategy for mathematics learning. Collectively, these international studies underscore the global momentum toward gamified pedagogies as a response to traditional teaching limitations.

While international and national studies provide substantial evidence of gamification's positive effects on mathematics learning, there is a scarcity of localized research focusing on rural or geographically isolated contexts like Apayao. Additionally, few studies have examined how gamification can be systematically integrated into intervention plans tailored to the unique challenges of students in such regions. The absence of region-specific empirical data limits educators' capacity to design effective, culturally responsive, and context-appropriate pedagogical interventions.

Hence, the study was conducted to explore how gamified teaching strategies influence students' mathematics performance within the local educational setting. The research aims to bridge



existing gaps by providing empirical evidence on the effectiveness of gamification as a pedagogical tool in Apayao. Conducting the study is crucial because it seeks to develop an intervention plan that enhances students' engagement, motivation, and achievement in mathematics — thereby contributing to both academic improvement and pedagogical innovation within local schools.

Statement of the Problem

The study aimed to determine the effectiveness of a gamified teaching approach on the mathematics performance of students through a pre-test – posttest design. Specifically, the study sought to answer the following questions:

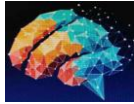
1. What is the mathematics achievement of the students in control and experimental groups before and after the implementation of the gamified teaching approach?
2. Is there a significant difference between the pretest and posttest scores of the control and experimental groups before and after the implementation of the gamified teaching approach?

Theoretical Frameworks

The study was grounded on several established theories that explain how gamified teaching strategies influence students' motivation, engagement, and performance in mathematics. These theoretical foundations provide a strong basis for understanding the behavioral and cognitive mechanisms that drive learning improvements under gamified instructional settings.

The first theory underpinning the study is the Self-Determination Theory (SDT) developed by Deci and Ryan (1985), which posits that motivation arises from the fulfillment of three innate psychological needs—autonomy, competence, and relatedness. When learners experience a sense of control over their learning, perceive themselves as capable of success, and feel connected to their peers, their intrinsic motivation is strengthened. In the context of gamified teaching, features such as choices in learning activities, level progression, feedback, and collaborative tasks directly address these psychological needs. Consequently, students become more motivated to participate actively and sustain their effort, leading to improved academic performance in mathematics over time.

The second theoretical foundation is the Constructivist Learning Theory advanced by Piaget and later expanded by Vygotsky (1978). Constructivism suggests that learners construct new knowledge through active engagement and social interaction, rather than by passively receiving information. Vygotsky's concept of the Zone of Proximal Development (ZPD) emphasizes that learning occurs most effectively when students are supported to perform tasks slightly beyond their independent capability. Through gamified activities that encourage exploration, collaboration, and problem-solving, learners can strengthen their conceptual understanding of mathematical concepts.



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Another theoretical basis for the study is the Behaviorist Learning Theory proposed by B.F. Skinner (1953), which emphasizes that learning is shaped by reinforcement. In the framework, behavior is influenced by external stimuli such as rewards and feedback. Within a gamified teaching environment, the use of points, badges, leaderboards, and rewards functions as positive reinforcement, encouraging students to repeat desired learning behaviors such as participation, persistence, and problem-solving. Over continued exposure, these reinforcements promote consistent engagement and the gradual enhancement of mathematical performance, which the pretest-posttest design seeks to measure empirically.

In addition, the Flow Theory by Mihaly Csikszentmihalyi (1990) supports the motivational dimension of gamified learning. The theory describes a mental state of deep concentration and enjoyment that occurs when individuals engage in tasks that balance challenge and skill. When gamified learning experiences provide clear goals, immediate feedback, and progressively challenging tasks, learners are more likely to enter a state of “flow.” In the state, they experience intrinsic satisfaction and heightened focus, reducing anxiety commonly associated with mathematics learning. The continuation of the state through sustained exposure to gamified instruction may explain improvements observed.

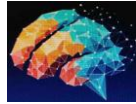
These theories collectively explain how gamified teaching enhances both students’ motivation and cognitive performance. They highlight how increased engagement, active participation, and reinforcement contribute to deeper understanding and improved academic outcomes in mathematics.

Research Paradigm

The study was anchored on the principle that instructional design significantly influences students’ academic performance, particularly in mathematics. It sought to determine whether the use of a gamified teaching approach can enhance students’ mathematics achievement compared to conventional teaching methods. The research follows a pre-test – posttest design, wherein two independent groups of students—the control group and the experimental group—are compared based on their posttest performance after receiving different modes of instruction. The experimental group is exposed to the gamified teaching approach, which integrates game-based elements such as points, badges, levels, feedback, and interactive challenges into the teaching of mathematical concepts. Meanwhile, the control group is taught through traditional instructional methods that rely primarily on direct teaching and conventional assessment practices.

In the paradigm, the independent variable is the gamified teaching approach, representing the instructional intervention applied to the experimental group. The dependent variable is the students’ mathematics performance, which is measured by their posttest score after the instructional period. By comparing the posttest results of both groups, the study aims to determine whether significant differences exist in mathematics achievement that can be attributed to the gamified teaching approach. The comparison allows the researcher to assess the relative effectiveness of gamified instruction in promoting understanding, engagement, and performance in mathematics.

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The research paradigm is further supported by the theoretical foundations of Self-Determination Theory, Constructivist Learning Theory, Behaviorism, and Flow Theory. These frameworks collectively explain how gamification enhances motivation, reinforces positive learning behavior, fosters active knowledge construction, and sustains engagement through balanced challenge and skill. Under the theoretical lens, it is hypothesized that students exposed to gamified learning will demonstrate higher levels of motivation and mastery, which in turn will result in superior posttest performance compared to those in the control group.

Conceptually, the paradigm establishes a cause-and-effect relationship: the gamified teaching approach (cause) influences students' mathematics performance (effect). External factors such as teacher competency, instructional time, and learning environment are controlled to ensure that any observed difference between the two groups' posttest scores can be primarily attributed to the intervention. The results of the comparison will form the empirical foundation for designing an intervention plan that aims to improve mathematics instruction through the structured integration of gamified strategies in the classroom.

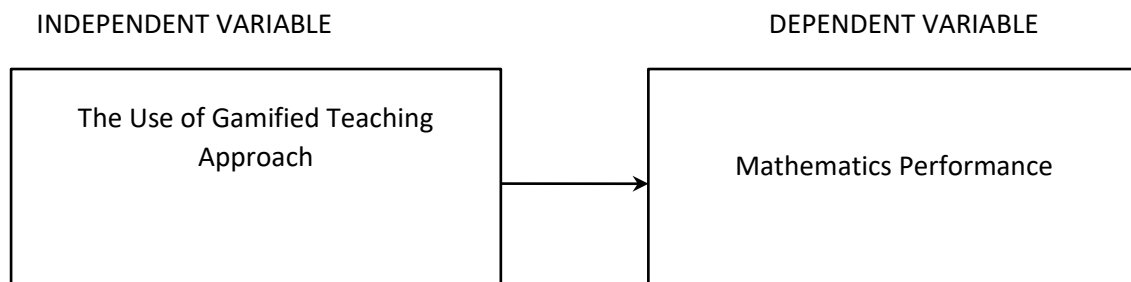


Figure 1: Research Paradigm

The figure illustrated the logical flow of the study. Both the control and experimental groups are taught using different instructional methods—traditional and gamified, respectively—and subsequently assessed through posttests. The posttest results are then compared to determine whether the gamified teaching approach produces a statistically significant improvement in students' mathematics performance. The insights derived from the comparison will be served as the basis for developing an evidence-based intervention plan aimed at enhancing mathematics instruction.

RESEARCH METHODOLOGY

Research Design

The study employed a quasi-experimental pretest-posttest control group design to determine the effect of the gamified teaching approach on students' mathematics performance. This design was considered appropriate because random assignment of students was not feasible due to the use of intact classes. Thus, two existing Grade 11 sections were designated as the control group and the experimental group.



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Before the implementation of the instructional intervention, both groups were given a pretest to determine their initial level of mathematics achievement. The experimental group (Grade 11–Paper Tree) received instruction using the gamified teaching approach, which integrated game-based elements such as points, badges, levels, rewards, feedback, and interactive challenges into mathematics lessons. In contrast, the control group (Grade 11–Bamboo) received instruction through the traditional teaching method, which included lectures, board work, discussions, and written exercises without the use of gamified elements. Both groups were taught the same mathematics competencies, covered the same lessons, and were given equal instructional time to maintain comparability of learning conditions.

At the end of the intervention period, both groups were given the same posttest to measure their mathematics achievement after exposure to the two instructional approaches. The results of the pretest and posttest were compared to determine the extent of improvement within each group and to examine whether the gamified teaching approach produced better learning outcomes than the conventional method. This design provided the basis for assessing the effectiveness of gamified instruction and for developing an intervention plan to further enhance mathematics teaching and learning.

Locale of the Study

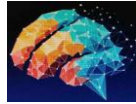
The study was conducted at Calanasan National High School, a public secondary school under DepEd–Schools Division of Apayao, located in the Municipality of Calanasan, Province of Apayao, during the fourth quarter of School Year 2025–2026. The school serves junior and senior high school learners from rural and geographically isolated communities in the northern Cordillera Administrative Region, where limited technological access and diverse learner readiness present instructional challenges. The locale was purposefully selected as it represents a typical GIDA (Geographically Isolated and Disadvantaged Area) public school, providing a relevant context for examining the effectiveness of a gamified teaching approach against traditional methods in mathematics.

Respondents of the Study

The respondents of the study consisted of two intact Grade 11 sections. The control group was composed of 12 students from Grade 11–Bamboo who received traditional instruction. The experimental group consisted of 18 students from Grade 11–Paper Tree who were exposed to the gamified teaching approach.

The respondents were selected using intact group sampling because reassignment of students was not feasible due to administrative considerations and classroom organization. Both groups were taught by the same mathematics teacher to maintain instructional consistency.

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Data Gathering Procedure

The data gathering procedure was systematically conducted during the fourth quarter of School Year 2025–2026 at Calanasan National High School, Calanasan, Apayao. The process followed a series of well-defined steps to ensure the validity, reliability, and ethical integrity of the data collected.

Prior to the implementation of the study, the researcher secured formal approval from the Schools Division of Apayao and the School Principal of Calanasan National High School. A letter of permission was also sent to the participating mathematics teacher and the parents or guardians of the Grade 11 students to obtain their informed consent. Upon approval, a detailed orientation was conducted to brief the participating teacher and students about the purpose of the study, the nature of the intervention, and the confidentiality of their responses.

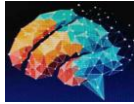
Two intact Grade 11 classes were identified and designated as the control group and the experimental group. Before the intervention, both groups were given a pretest to determine their initial level of mathematics achievement. The control group received instruction using traditional teaching methods, while the experimental group was exposed to the gamified teaching approach, which incorporated game elements such as points, levels, rewards, and feedback into classroom instruction. Both groups were taught by the same mathematics teacher, covered the same learning competencies and topics, and were given equal instructional time to maintain instructional equivalence. The intervention was implemented over a defined period during the fourth quarter.

After the instructional period, both groups took the same posttest simultaneously. The posttest was a teacher-made mathematics performance test validated by a panel of experts to ensure content relevance, clarity, and alignment with the Department of Education K–12 curriculum standards. The test served as the main instrument for assessing the students' level of mastery, problem-solving ability, and overall academic performance in mathematics. Test administration was conducted under standardized conditions to prevent testing bias.

The collected test papers were checked, scored, and tabulated using a predetermined scoring rubric. The data were then encoded and statistically analyzed. Descriptive statistics, particularly the mean, were used to summarize the students' performance, while inferential statistics, specifically the paired samples t-test and independent samples t-test, were employed to determine whether significant differences existed within and between the groups. The results of the analysis served as the empirical basis for developing an intervention plan designed to enhance mathematics instruction through gamified teaching strategies.

Instruments

The main instrument used in the study was a teacher-made Mathematics Performance Test (MPT) administered to both the control and experimental groups as a pretest and posttest. Initially, the researcher prepared a 50-item test aligned with the DepEd Grade 11 fourth-quarter mathematics



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competencies. The items were designed to measure students' knowledge, comprehension, application, and analysis of mathematical concepts. After validation and item analysis, only the 40 most appropriate items were retained for the final administration of the test.

To establish content validity, the instrument was developed using a Table of Specifications (TOS) and was subjected to expert validation by specialists in mathematics and educational research. The validators examined the items in terms of relevance, clarity, appropriateness, and alignment with the objectives and competencies of the study. Based on the evaluation, the instrument obtained a Content Validity Index (CVI) of 0.78, which indicates that the test had high validity. This result suggests that the items were generally appropriate and aligned with the intended mathematics competencies, although minor refinements were still necessary to further improve the instrument.

The instrument also underwent pilot testing prior to its actual use. Based on the item analysis results, the initial 50-item test was examined using the difficulty index and discrimination index. The results showed that 35 items were retained, 9 items were marked for revision, and 6 items were rejected or discarded. From these results, the researcher selected the 40 final items considered most suitable for the actual pretest and posttest administration.

The reliability of the instrument was established using the Kuder–Richardson Formula 20 (KR-20), which is appropriate for dichotomously scored items. Based on the pilot-test results, the instrument obtained a KR-20 coefficient of 0.762, indicating acceptable internal consistency. This suggests that the test possessed sufficient reliability and was suitable for use in the study.

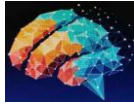
The finalized MPT was scored objectively, with one point assigned for each correct answer. The same 40-item instrument was used to determine the students' mathematics achievement before and after the implementation of the instructional intervention. The scores obtained from the pretest and posttest served as the basis for determining changes in students' mathematics performance and for assessing the effectiveness of the gamified teaching approach compared with the traditional method.

Statistical Analysis

The data gathered from the pretest and posttest were analyzed using both descriptive and inferential statistics. Descriptive statistics, specifically the mean, were used to summarize the mathematics achievement of the control and experimental groups before and after the implementation of the instructional intervention.

To determine the extent of improvement in students' mathematics performance, mean gain scores were computed for both groups. The paired samples t-test was used to determine whether there was a significant difference between the pretest and posttest scores within each group. Meanwhile, the independent samples t-test was used to determine whether there was a significant difference between the posttest scores of the control and experimental groups after the implementation of the gamified teaching approach.

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All statistical tests were interpreted at the 0.05 level of significance. The results of the analysis served as the basis for determining the effectiveness of the gamified teaching approach in improving students' mathematics achievement and in formulating an evidence-based intervention plan.

Ethical Considerations

The study strictly observed ethical standards in conducting educational research. Participation was voluntary, and students were informed about the purpose and procedures of the study. The respondents were also informed that they could withdraw from participation at any time without penalty.

To maintain confidentiality and anonymity, the names and personal information of the respondents were not disclosed in any part of the study. Codes and pseudonyms were used during data analysis and reporting. All collected data were used solely for academic purposes.

The researcher likewise ensured that the instructional activities implemented in the study did not expose students to physical, emotional, or psychological harm.

RESULTS AND DISCUSSIONS

This chapter presents the data gathered, the results of the statistical analysis, and the interpretation of findings regarding the Gamified Teaching Approach on the mathematics achievement of students.

Mathematics Achievement of the Control and Experimental Groups Before and After the Implementation of the Gamified Teaching Approach

The study aimed to determine whether there is a significant difference between the pre-test and post-test scores of the respondents before and after the implementation of the instructional intervention.

Table 1. Mathematics Achievement of Students in Control and Experimental Groups

Group	Test	Mean	Description
Control	Pretest	16.50	Average
	Posttest	23.00	Improved
Experimental	Pretest	16.61	Average
	Posttest	28.72	Highly Improved

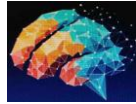


Table 1 shows that the control group obtained a mean pretest score of 16.50, while the experimental group obtained a mean pretest score of 16.61. The close pretest means indicate that the two groups started with nearly comparable levels of mathematics achievement prior to the implementation of the instructional intervention. This suggests that both groups had relatively similar baseline performance at the beginning of the study.

After the intervention, both groups showed improvement in their posttest scores. The control group's mean increased from 16.50 to 23.00, reflecting an improvement of 6.50 points. In contrast, the experimental group's mean increased from 16.61 to 28.72, reflecting a higher improvement of 12.11 points. These results indicate that while both the traditional and gamified teaching approaches contributed to better mathematics achievement, the experimental group demonstrated a greater increase in performance after exposure to the gamified teaching approach.

The higher posttest mean of the experimental group implies that the use of gamified instruction may have provided a more engaging and participatory learning environment for the students. Through the integration of game-based elements such as rewards, feedback, challenges, and progression, students may have been more motivated to participate actively in classroom activities, which contributed to improved mathematics performance.

Significant Difference Between Pretest and Posttest Scores

Table 2. Test of Significant Difference Between Pretest and Posttest

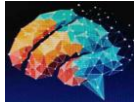
Group	Pretest Mean	Posttest Mean	Mean Gain
Control	16.50	23.00	6.50
Experimental	16.61	28.72	12.11

The mean gain scores show a clear difference between the two groups. The control group achieved a gain of 6.50 points, while the experimental group recorded a higher gain of 12.11 points which almost doubled that of the control group. This difference in improvement implied that the experimental group benefited more from the instructional approach used. The table also revealed that although both groups improved, the magnitude of improvement in the experimental group is notably greater, reflecting a stronger effect of the gamified teaching strategy.

To examine whether the improvement in the mathematics achievement of the participants is in control and experimental groups is statistically significant, a paired sample t-test was conducted.

Table 3: t - test of the control and experimental groups

Group	t - computed	Critical Value	Decision
Control	4.28	2.20	Statistically Significant
Experimental	9.84	2.11	Statistically Significant
<i>Significant at $\alpha = 0.05$</i>			



In the control group, table 3 showed a computed t-value of 4.28 with 11 degrees of freedom. When compared to the critical value of approximately 2.20 at a 0.05 level of significance (two-tailed), it appeared that the computed t-value is higher. This result led to the rejection of the null hypothesis, which states that there is no significant difference between the pre-test and post-test scores. Therefore, there is sufficient statistical evidence to conclude that a significant difference exists between the two sets of scores.

In the experimental group, the high increase of the participants scores from pre – test to posttest directly signified improvements in mathematics performance. The analysis yielded a computed t-value of 9.84 with 17 degrees of freedom, which exceeded the critical value of 2.11 at the 0.05 level of significance. Thus, the null hypothesis was rejected.

The findings revealed both groups significantly improved, and the experimental group showed stronger improvement based on its higher mean gain and t-value. The experimental group's higher mean gain suggests that the gamified teaching approach is more effective than the conventional method. This further implied that integrating game elements into instruction can significantly enhance students' mathematics achievement by fostering a more engaging and interactive learning environment.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

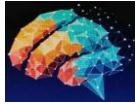
Summary

The findings of the study revealed that both the control and experimental groups had comparable mathematics achievement during the pretest, indicating similar baseline abilities. However, after the implementation of the respective teaching approaches, both groups showed improvement in their posttest scores. The control group demonstrated a moderate increase, while the experimental group exhibited a substantially higher gain in mean scores.

Furthermore, the distribution of scores in the experimental group shifted toward higher class intervals, indicating enhanced performance among students. The computed mean gain scores further confirmed that the experimental group outperformed the control group. These results suggest that the gamified teaching approach is more effective in improving students' mathematics achievement compared to traditional instructional methods. The increased engagement and motivation brought about by gamification may have contributed to this significant improvement in learning outcomes.

Conclusion:

Findings revealed that both the control and experimental groups exhibited comparable mathematics achievement during the pretest showing similar baseline knowledge and skills prior to the implementation of the instructional approaches. After the intervention, both groups showed improvement in their posttest scores. However, the experimental group demonstrated higher increase in mean scores compared to the control group. This revealed that while traditional teaching methods can support learning, the gamified teaching approach leads to greater enhancement of students'



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mathematics achievement. The results of the paired sample t-test revealed that both groups experienced statistically significant improvements in their mathematics performance after instruction. However, the experimental group obtained a much higher mean gain and t-value, indicating a stronger effect of the intervention. Hence, the null hypothesis stating that there is no significant difference between the pretest and posttest scores is rejected for both groups. Furthermore, the greater improvement observed in the experimental group suggested that the gamified teaching approach is significantly more effective than the conventional method in improving students' mathematics achievement. The study concludes that the gamified teaching approach positively and significantly enhances students' mathematics achievement. The integration of game elements in instruction promotes increased engagement, motivation, and active participation, which are essential factors in improving academic performance in mathematics.

Recommendations

In light of the findings and conclusions of the study, the following recommendations are proposed:

1. Teachers are encouraged to integrate gamified teaching strategies into their mathematics instruction to make learning more engaging and interactive. Incorporating elements such as rewards, challenges, and interactive activities can help improve students' motivation and academic performance.
2. School administrators may consider supporting the adoption of gamified instructional approaches by providing training, resources, and instructional materials that promote innovative teaching strategies in mathematics.
3. Curriculum planners may integrate gamification elements into the mathematics curriculum, ensuring that learning competencies are delivered through engaging and student-centered approaches.
4. Students may be encouraged to actively participate in gamified learning environments, as these approaches can enhance their interest, confidence, and performance in mathematics.
5. Future Researchers may explore the long-term effects of gamified teaching on mathematics achievement and investigate its impact on other variables such as motivation, attitude, and retention. A larger sample sizes or different grade levels is recommended for use to further validate and generalize the findings

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