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Research Paper

Effectiveness of Mathematics-Gammified Applications for Learners Interactive Numeracy Growth (Math-Galing) in Enhancing the Academic Performance of Grade 11 Learners

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Abstract

This study determined the effectiveness of the academic performance of Grade 11 learners using the Mathematics Gamified Application for Learner's Interactive Numeracy Growth (Math-GALING). This study used a quasi-experimental design. The participants of the study were selected through a match-pairing technique based on the results of their pretest among Grade 11 students, resulting in 29 pairs. These two groups of students, one from the Accountancy, Business, and Management strand and the other from the Humanities and Social Sciences strand, comprised the experimental and comparison groups, respectively. The participants' pretest, posttest, and formative test performances was evaluated using the mean and standard deviation. Similar to how independent t-tests were used to quantify the extent of the difference between two sets of scores, Cohen's d was used to determine the significance of the difference between the pretest and posttest results. The salient findings from the data were as follows: there is always an opportunity for improvement, particularly when the goal is to enhance teaching and learning processes to provide students with quality education. This study could conclude that using a gamified learning application (Math-GALING) in the teaching of statistics and probability enhanced learners' performances. It was found that the designed gamified learning application enhanced students' academic performances.

Keywords: *mathematics; gamified app; numeracy growth; academic performance*

INTRODUCTION

This study explores the potential of gamification in education, specifically focusing on its application in mathematics teaching to enhance student engagement and proficiency. Traditional mathematics instruction heavily reliant on lectures has been criticized for its limitations in promoting active learning and problem-solving skills. Many students find math challenging and tedious, leading to a need for innovative approaches (Tarasova & Savvina, 2019). Gamification, which incorporates game elements into educational contexts, has been identified as a promising strategy to overcome these challenges, supported by studies asserting its superiority over traditional methods (Al-Azawi et al., 2016; Welbers et al., 2019; Orbon & Sapin, 2022).

In the middle of the evolving landscape of education, former Education Secretary Leonor Briones stressed the urgency of adapting to the new learning modalities outlined in the Basic Education Learning Continuity Plan (2022). Despite continuous efforts by mathematics curriculum developers, Filipino learners exhibit persistent inadequacies in math proficiency, as evidenced by TIMSS results from 2003 and 2019 (IEA). This study recognizes the impact of the global pandemic, turning students into digital natives, necessitating a reevaluation of teaching methods that align with students' needs and preferences.

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Besavilla et al. (2022) and Asor, et al. (2023) underscored the importance of teachers employing various instructional strategies to foster motivation and active participation while aligning with modern pedagogical paradigms and ICT integration. In response, the study introduces a gamified application as a strategic intervention designed to address learners' needs and enhance motivation to learn mathematics in flexible environments.

This study emphasizes the Philippines' low rankings in the 2018 PISA, attributed to insufficient investment in learning resources, particularly in disadvantaged schools. The World Bank (2020) noted the correlation between lower spending per student and larger class sizes and lower performance. The integration of technology is proposed as a way to enhance teaching efficiency and student learning. Traditional teaching methods have been criticized for limiting critical thinking, highlighting the need for virtual learning environments that facilitate experiential learning.

Thuseon of technology in mathematics classrooms has been a focus for over two decades, with various tools recognized and embraced by teachers. However, the study identified a gap in the literature by exploring the potential of gamified applications to enhance learners' comprehension of mathematical concepts. Recognizing this need, the researcher aimed to develop and assess the effectiveness of a gamified application for teaching mathematics to Grade 11 learners, thus contributing to the ongoing discourse on innovative educational strategies in the digital age.

LITERATURE REVIEW

As implementers of the curriculum, teachers play a crucial role in supporting the teaching and learning process, particularly in the context of flexible learning in a new educational setup. It is vital to design interventions that effectively address the needs of target learners. In this study, an intervention in the form of an online or offline game is presented, which learners will utilize in the flexible learning mode. The subsequent sections provide support for the effectiveness of using game apps as a teaching tool for primary mathematics.

Technology Integration in Education

Universities worldwide have integrated e-learning platforms into their educational offerings, making e-learning a contemporary addition and, in some cases, a substitute for traditional education (Orbon & Sapin, 2022). The shift toward online teaching has been particularly pronounced in recent years due to factors like the COVID-19 pandemic, prompting higher education institutions to adapt and ensure continuous learning for students (Sofiadin & Azuddin, 2021). However, challenges have arisen in the form of declining student motivation and reduced engagement, as well as difficulties for teachers in maintaining student interest, leading to a partial abandonment of online education methods. To address these issues, gamification has been proposed as a way to create more engaging e-learning environments.

The 21st century has brought about significant global and societal changes driven by technological advancements and the rise of Industry 4.0 This transformation has impacted schools and educational systems, giving rise to the concept of Education 4.0, which emphasizes innovative learning environments and approaches (Kapp, 2012). Recognizing schools as crucial foundations of society, there has been a heightened emphasis on effectively integrating digital technologies into education to prepare students for their future professional lives. Individuals with strong technological integration skills are considered vital to maintaining high educational standards, reflecting the evolving landscape of Education 4.0.

In summary, the integration of e-learning platforms in universities responds to the contemporary educational landscape, with challenges such as declining motivation and engagement prompting the exploration of gamification as a possible solution. Additionally, the

emergence of Education 4.0 highlights the importance of adapting educational systems to technological advancements to prepare students for the demands of the 21st-century workforce.

Mathematics as an Essential Subject

Mathematics is widely acknowledged as a fundamental subject in schools, fostering analytical thinking and precise expression of ideas. Despite its importance, studies, such as Malabayabas et al. (2022), reveal that students often perceive mathematics as challenging, thus impacting a country's knowledge economy by hindering the production of highly skilled individuals in higher education. Negative beliefs about mathematics contribute to student dissatisfaction, and comparative research by Al-Azawi et al. (2016) identified barriers to effective mathematics teaching, including teachers' lack of prior knowledge and students' insufficient motivation, effort, and interest, along with challenges like limited time and parental support.

On the other hand, mathematics has historically been considered an indispensable tool in shaping educated individuals and contributing to reasoning skills and overall education (Rincon-Flores et al., 2023) particularly emphasized that an educated person possesses knowledge and the ability to approach daily affairs with objectivity and reasoning skills, with mathematics playing a vital role in this process. While the importance of mathematics in education is evident, the challenges faced by both students and teachers underscore the need for effective strategies to enhance mathematics learning and teaching.

Gamification in Education

Gamification in education has gained widespread recognition as an effective strategy for enhancing the teaching-learning process. Rincon-Flores et al. (2023) highlighted that incorporating gamified reward schemes, such as leaderboards and badges, positively influences student attitudes and fosters an engaging learning environment. Chen et al. (2023) further emphasized that gamified learning, through its integration of multiple representations, actively engages students, promotes critical thinking, and enhances their ability to solve complex mathematical problems. In contrast, traditional lecture-based mathematics teaching, which focuses on standard problem-solving steps and repetitive practice, has shown limited effectiveness in developing students' problem analysis and complex problem-solving skills, often leading to a lack of motivation and interest in mathematics (Lukowski et al., 2019; Safapour et al., 2019).

Moreover, the study notes that many students perceive mathematics as challenging and time-consuming, leading to a lack of interest and, in some cases, math anxiety (Tarasova & Savvina, 2019). This anxiety, as pointed out by Chen et al. (2023) and Lukowski et al. (2019), negatively impacts students' motivation and effectiveness in mathematics learning. To address these challenges, integrating gamification and other effective teaching tactics is crucial for reducing math anxiety, boosting students' confidence, and enhancing their proficiency in mathematics. Additionally, gamified learning has been found to increase motivation, social interaction, and affective behaviors, providing students with a more engaging and enjoyable learning experience (Al-Azawi et al., 2016; Manzano et al., 2021). Combining gamification with other teaching methods, as suggested by Arufe et al. (2022), can further enhance intrinsic motivation and self-directed learning.

Gamification in Preschoolers

Preschoolers develop a foundational understanding of mathematics during a critical period, setting the stage for formal mathematical instruction in the future. A recent study by Olmo et al. (2020) explored the impact of gamification on preschoolers' mathematical abilities and revealed that a program incorporating learning games, particularly using Kahoot on tablets, significantly

improved math proficiency. Gamification in education, recognized as a reflective method, provides feedback on students' performance during challenges, thus increasing engagement and enhancing cognitive development (Ding et al., 2018). In early childhood education, gamification is deemed especially effective, which aligns with young children's preference for learning through play (Fleer, 2020). Studies, such as those by Papadakis et al. (2022) and Vaiopoulou et al. (2023), have showcased the success of gamified educational apps like "Math Shelf" in significantly improving math knowledge and fostering new skills among preschoolers. These applications not only engage children emotionally but also serve as cost effective and effective tools for intervention, providing a fresh and effective approach to early education (Nicolaidou et al., 2022).

Gamification at the Secondary and Tertiary Levels

The integration of game-based activities in educational settings offers numerous benefits, as highlighted by Ramos et al. (2023). These advantages include the development of soft skills, improved decision-making, enhanced problem-solving abilities, peer collaboration, skill development in competitive environments, increased self-esteem, and reinforcement of learning progress through well-designed serious games that provide feedback and rewards. Workshops incorporating gamification components in supply chain management studies significantly improved students' retention of key concepts (Putz et al., 2020), highlighting its effectiveness in specific subject domains. Moreover, gamification positively impacts student motivation, with Rashid and Zaman (2018) noting a gradual rise in motivation over time when gaming is integrated into courses. However, the incorporation of games in education requires careful consideration of potential drawbacks, such as the associated costs and technical support challenges, as highlighted by Papadakis et al (2022). Additionally, teacher perspectives, as revealed in Ruggiero's survey (2013), indicate that games should not be the sole instructional activity, and teachers need to be experienced players to assess the efficacy of complex games in specific learning contexts. Challenges arise in evaluating collective learning outcomes due to variations in individual student gaming behaviors (Cojocariu & Boghian, 2014), which present potential hurdles in achieving standardized learning outcomes.

Gamification as a Motivational Tool

In today's technology-driven society, teachers face challenges in engaging and effectively communicating with students, especially children, thereby impacting their emotional well-being and academic performance. Stoyanova et al. (2018) highlighted the potential of information and communication technologies to address these challenges, emphasizing the need for educators across subjects to adapt teaching approaches to align with the realities of the modern world. Mathematics classes, which are often associated with low motivation and negative emotions, present a particular challenge when modifying traditional teaching methods for an abstract discipline. The integration of modern educational concepts, such as gamification offers a promising approach to engaging students of all ages in various fields of study. Gamification, as a contemporary teaching technique, has the potential to address the difficulties associated with traditional teaching methods and captivate students in the learning process.

In the modern era, teachers face challenges in engaging and communicating effectively with students. Traditional methods contribute to low motivation, particularly in mathematics classes. Information and communication technologies, including gamification, offer opportunities to address these challenges. Gamification, as a modern teaching technique, can enhance motivation, engagement, and learning experiences across various subjects and age groups.

Synthesis

Technology integration, especially through e-learning platforms, has become a cornerstone in higher education, complementing and even replacing traditional teaching techniques. This change has been expedited by the COVID-19 pandemic, which has caused problems, including decreased student engagement. As a result, creative solutions like gamification have been investigated to build engaging online learning environments.

Although mathematics is widely acknowledged as a foundational topic for cultivating analytical thinking abilities, it continues to face obstacles because students believe it is challenging, which affects a country's knowledge economy. Student motivation problems and teacher knowledge gaps are two obstacles to mathematics instruction. Notwithstanding these difficulties, mathematics has historically played a significant role in shaping intelligent people and in enhancing general education.

An effective approach for improving the teaching-learning process is gamification, especially in the mathematics education context. Mathematical education through traditional lecture-based techniques is not effective in helping students become motivated learners or solving problems. These problems are addressed by gamification, which also creates compelling learning settings and lessens math anxiety. Preschoolers have responded well to the program, which uses game features in non-gaming environments (such educational apps like Kahoot) to improve their basic math skills.

The advantages of gamification in secondary and postsecondary education include the development of soft skills, better decision-making, and increased teamwork. But obstacles like the price of technology and the requirement for professional assistance could prevent widespread adoption. Teachers' opinions on integrating video games differ; some emphasize the value of having experienced educators and identifying the unique gaming habits of each student.

In the current educational environment, where communicating and engaging students are difficult, particularly in math classes, gamification is a cutting-edge method that can be used for a variety of disciplines and age groups. Gamification is one of the information and communication technologies (ICTs) that educators can use to improve motivation, engagement, and learning experiences by addressing the complexities of the modern world.

RESEARCH METHOD

The study focused on evaluating the effectiveness of the Math-GALING gamified learning application, which was designed for Grade 11 students' Statistics and Probability courses at Laguna State Polytechnic University-Los Baños Campus. The research included two distinct groups: one using a gamified application and the other relying on traditional self-paced learning methods.

Research Design

This study employed quantitative research, as described by Mohajan (2021), using numerical data to investigate phenomena and generate statistics. The research design, stated by Orbon and Sapin (2022), implemented a pretest-posttest quasi-experimental approach because students were pre-assigned by the school administration and collaborated with existing groups. This design involved measuring the dependent variable before and after the implementation of the treatment, which aligns with the study's objective of evaluating the effectiveness of math-game apps. Additionally, a non-equivalent control group design was employed, where the treatment group underwent a pretest, received the intervention, and took a posttest, whereas the non-equivalent control group, which was also subjected to a pretest, did not receive the treatment but took a posttest. The study aimed not only to determine improvement within the treated group but also to assess whether their improvement exceeded that of the untreated group.

Participants of the study

The study involved Grade 11 students from Laguna State Polytechnic University-Los Baños Campus, using a match-pairing technique to assign participants to either the experimental or control group. This technique is known as "matching," involves pairing individuals based on specific criteria. After the score assessments, 29 students from the Accountancy, Business, and Management departments formed the experimental group, while 29 students from the Humanities and Social Sciences department constituted the control group. Additionally, 2 DepEd teachers, 3 private school teachers, and 3 university instructors, all teaching mathematics subjects, participated in validating the gamified learning app.

Research Instrument

In the development of the Math-GALING app, the term "instrument" refers to tools used for data collection. The app's creation follows a structured process, beginning with the planning phase, which involves defining competencies and addressing content, design, and validity considerations. The subsequent development phase translates the established criteria into a gamified application. Software evaluation was conducted using Technology Acceptance Model (TAM), which comprises 12 items that assess perceived usefulness (PU) and perceived ease of use (PEU). Responses were measured on a seven-point Likert scale. The software quality was further evaluated by experts using a Likert Scale. Validation and assessment involve Mathematics teachers at Laguna State Polytechnic University, employing criteria such as acceptability, relevance, usability, and appropriateness. To gauge students' academic performance, pretests, posttests, and formative tests are administered, with the latter covering Minimum Essential Learning Competencies (MELCs) weekly during the app's implementation.

Research Procedure

The researcher, with approval from the Senior High School department chairperson and the College of Teacher Education associate dean at Laguna State Polytechnic University, conducted this study. After obtaining approval, an orientation session familiarized Grade 11 learners with the gamified learning application, followed by the administration of a pretest. Using the match-pairing method based on the pretest findings, 29 participants were selected. Intervention occurred throughout the third quarter, accompanied by formative tests to monitor progress. Posttests were administered at the quarter's end, and all test results were collected, analyzed, and interpreted. Data from each assessment were entered into MS Excel spreadsheet, and a formula was used to calculate the highest, lowest, and range scores for analysis and visualization. Subsequently, statistical analysis will be conducted using IBM SPSS version 2.5.

FINDINGS AND DISCUSSION

1. Formative test mean mathematics scores of the students in the two groups

The test scores of the comparison group for Unit 1: Random Variables and Probability Distribution (M = 16.93, SD = 2.07) were compared with those of the experimental group (M = 19.24, SD = 0.87). Numerically, the test scores of the comparison group were lower than those of the experimental group. The results indicated that the mean score of the experimental group (M = 44.24, SD = 0.87) was higher than that of the comparison group (M = 35.03, SD = 6.03). This suggests that the performance of the experimental group during the formative test was very high, whereas the comparison group's performance was high.

In relation to the formative test results, the experimental group outperformed the comparison group. This implies that the use of Math-GALING increased students' motivation. This finding aligns with the study conducted by Rincon-Flores et al. (2022), who stated that the

motivation of students tends to increase over time when gaming is integrated into a course to assist students in their subject areas.

Table 1. Formative test mean mathematics scores of the students in the two groups

Lesson/Topic	No. of Items	Group	Mean	Std. Dev.	Descriptive Interpretation
Unit 1: Random Variables and Probability Distribution	20	Experimental	19.24	0.87	Very High
		Comparison	16.93	2.07	High
Unit 2: Normal distribution	25	Experimental	25.00	0.00	Very High
		Comparison	18.10	4.90	Average
Overall	45	Experimental	44.24	0.87	Very High
		Comparison	35.03	6.03	High

Legend: 18–20 = Very high; 15–17 = high; 10–14 = average; 6–9 = low; 1–5 = very low
23–25 = Very high; 19–22 = high; 13–18 = average; 7–12 = low; 1–6 = very low
41–45 = Very high; 34–40 = high; 23–33 = average; 12–21 = low; 1–11 = very low

2. Mean posttest mathematics scores of the students in the two groups

Table 2 shows that the experimental group had a higher mean score of 38.79 (SD = 2.19), while the comparison group had a mean score of 28.72 (SD = 4.88). The experimental group performed at a very high level, whereas the comparison group performed average. These findings highlight the effectiveness of the gamified learning application because the experimental group significantly improved from their low pretest scores to high posttest scores.

This finding supports the claim by Stoyanova et al. (2018) that Game-Based Learning (GBL) is an innovative instructional strategy applicable to any subject and suitable for all ages. This result is consistent with Chen et al. (2022) recent study, which demonstrated that gamification enhances student engagement, motivation, learning outcomes, and knowledge retention.

Table 2. Learners' Level of School Engagement

Group	Mean	Std. Dev.	Descriptive Interpretation
Experimental Group	38.79	2.19	Very High
Comparison Group	28.72	4.88	Average

Legend: 36–40 = Very High; 30–35 = High; 20–29 = Average; 11–19 = Low; 1–10 = Very Low

3. Test of significant difference between the mean formative test scores of the students in the two groups

To compare the mathematics performance of Grade 11 learners in a formative test, an independent sample t-test was performed, examining the outcomes of utilizing Math-GALING gamified apps versus self-paced learning modules. Table 3 presents a breakdown of the scores for each unit test. Notably, the comparison group displayed a wider distribution of scores (Mean = 18.10) for Unit 2, whereas the experimental group exhibited tighter clustering around high scores (Median = 25.00). A similar pattern was observed for Unit 1 scores.

Table 3 demonstrates a significant difference between the formative test scores of the gamified learning app (Mean = 44.24) and self-paced learning modules (Mean = 35.03) under the condition of [t (56) = 8.134, p-value < 0.01]. The effect size, as measured by Cohen's d, was also large. Thus, the null hypothesis of no significant difference between the mean scores of the formative test of the two groups is rejected.

These findings offer empirical support for the effectiveness of gamification in improving

students' statistics and probability performance. Gamification, as described by Oliveira et al. (2020), is a widely used approach for designing interactive learning activities that enhance student engagement, motivation, and positive experiences. This result is consistent with the research conducted by Arufe et al. (2022), which underscored the positive impact of combining gamification with other teaching methods on intrinsic motivation and self-directed learning.

Table 3. Test for significant difference between mean formative test scores in mathematics of students in both groups

Test	Group	Mean	Mean Difference	t-value	Cohen's d
Unit 1: Random Variables and Probability Distribution	Experimental	19.24	2.31	5.541**	1.45 (Very Large)
	Comparison	16.93			
Unit 2: Normal distribution	Experimental	25.00	6.90	7.577**	2.00 (Huge)
	Comparison	18.10			
Overall	Experimental	44.24	9.21	8.134**	2.14 (Huge)
	Comparison	35.03			

*df = 56; **Significant at .01 level; Cohen's d: Very small (0.01), Small (0.20), Medium (0.50), Large (0.80), Very large (1.20), and large (2.0)*

4. Test of significant difference between posttest mean mathematics scores of students in the two groups

As displayed in Table 4, the mathematics performance of Grade 11 learners in the posttest was evaluated by an independent sample t-test, comparing the utilization of Math-GALING gamified apps and self-paced learning modules. Table 4 presents the results of the analysis. The findings revealed a significant difference between the posttest scores of the game app group (Mean = 38.79) and the module-based learning activity sheets group (Mean = 28.72), with a condition of [$t(56) = 10.128$, p-value < 0.01]. The effect size, measured by Cohen's d, was large (2.66), providing additional support for rejecting the null hypothesis of no significant difference between the mean scores of the two groups on the posttest.

The results emphasize the effectiveness of Math-GALING as an intervention to enhance the teaching-learning process in Statistics and Probability, as indicated by the significant difference in mean posttest scores. Rincon-Flores et al. (2023) propose that gamified reward programs, which include features like leaderboards, avatars, and badges, can bring about a transformation in the learning environment and positively impact student attitudes. Additionally, Chen et al. (2023) also highlighted that gamified learning fosters student motivation, critical thinking skills, and problem-solving skills in mathematics.

Research has demonstrated that integrating gamified learning can enhance students' motivation to learn (Besavilla et al., 2022). Teachers can leverage game elements in their lesson plans, promoting group work, competition, and active engagement, to improve task completion and cultivate motivation, interpersonal engagement, and positive emotional behaviors among students (Manzano et al., 2021).

Table 4. Test of significant difference between mean post-test scores in mathematics of students in both groups

Test	Group	Mean	Mean Difference	t-value	Cohen's d
Posttest	Experimental	38.79	10.07	10.128**	2.66 (Huge)
	Comparison	28.72			

*df = 56; **Significant at .01 level; Cohen's d: Very small (0.01), Small (0.20), Medium (0.50), Large (0.80), Very large (1.20), and large (2.0)*

5. Test of significant difference between pretest and posttest mean mathematics scores of each group

It can be seen from Table 5 that to compare the mathematics performance of Grade 11 learners in the posttest, an independent sample t-test was conducted, as outlined in Table 5. The results revealed a significant difference in mean scores between the pretest and posttest for both the comparison group (Mean Difference = 13.27) and the experimental group (Mean Difference = 23.34). The t-values were 12.570 for the comparison group and 33.923 for the experimental group, both with p-values < 0.01. Cohen's d effect sizes were 3.26 for the comparison group and 8.79 for the experimental group. These findings confirm that there was a substantial and significant difference between the pretest and posttest mean scores in both groups.

The results indicate that the Math-GALING gamified application, known as the Mathematics Gamified Application for Learners' Interactive Numeracy Growth, is an effective intervention that enhances students' performance. This aligns with the idea that education should include specific learning targets and tasks to fulfill. Monitoring students' progress is crucial in both games and education because their actions and learning paths depend on their performance. Orbon and Sapin (2022) asserted that students' knowledge and skills play a significant role in shaping their learning trajectories.

Table 5. Test of significant difference between pretest and posttest mean mathematics scores of each group

Group	Test	Mean	Mean Difference	t-value	Cohen's d
Comparison	Posttest	28.72	13.27	12.570**	3.26 (Huge)
	Pretest	15.45			
Experimental	Posttest	38.79	23.34	33.923**	8.79 (Huge)
	Pretest	15.45			

*df = 28; **Significant at .01 level; Cohen's d: Very small (0.01), Small (0.20), Medium (0.50), Large (0.80), Very large (1.20), and large (2.0)*

CONCLUSIONS

Based on the findings of this study, several conclusions can be drawn. The hypothesis that there is no significant difference between the mean formative test scores of the comparison and experimental groups was rejected, indicating a significant difference between these scores.

The hypothesis stating that there is no significant difference between the mean posttest scores of the two groups was also rejected, suggesting that there is a significant difference in posttest performance.

The hypothesis that there was no significant difference between the mean pretest and posttest scores within each group was rejected, indicating a significant difference between these scores.

These findings support the conclusion that the use of Math-GALING or a gamified learning application in teaching mathematics can enhance student performances.

Furthermore, it can be concluded that students have a positive inclination toward participating in learning activities that incorporate technology. The intervention developed in this study was successful in addressing the numeracy challenges faced by students and fulfilling their educational requirements. In conclusion, these findings underscore the efficacy of the gamified learning approach in enhancing students' academic performance and satisfaction in mathematics education.

LIMITATION AND FURTHER RESEARCH

Using the findings and conclusions as the basis, the following recommendations are suggested:

1. The developed MATH-GALING app can be utilized by teachers teaching Statistics and Probability as a new teaching and learning approach to enhance students' academic performances. Moreover, it fosters the development of 21st-century skills and provides a conducive and effective environment for peer review, communication, and classroom interactions.
2. Curriculum implementers should consider designing interactive and technology-based mathematics lessons to increase student engagement and promote deeper understanding of the subject.
3. Parents are encouraged to support their children's academic performance by fulfilling their basic needs and fostering positive behaviors at home. By promoting efficiency and hard work in school activities, parents can contribute to their children's excellent academic performance.
4. Future researchers should develop effective interventions tailored to the specific needs of learners. Additionally, they can explore the creation and application of gamified learning applications in other subjects and grade levels, expanding the potential benefits of this approach in education.

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