Gamified Learning Environment in Improving the Engagement and Mathematical Problem-Solving Ability of Grade 7 Students

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Abstract

Aim: This study determined the relationship and the impact of the gamified learning environment in improving the engagement and mathematical problem-solving ability of grade 7 students.

Methodology: This study used a correlational research design and a pre-experimental research design. It was conducted at one of the public high schools in Quezon with 30 Grade 7 student as the respondents selected using stratified random sampling technique. Surveyed questionnaires were used to determine how students perceived gamified learning environment in mathematics and the level of students' engagement after exposure to gamified learning environment as well as validated pretest and posttest for mathematical-problem ability. This study was conducted within three weeks of the third quarter.

Results: There is positive acceptance in gamified learning environment in Mathematics as to goal, access, feedback, challenges and collaboration. Moreover, there is engagement (behavioral, emotional cognitive and agentic) in gamified learning environment. Furthermore, the level of student's Mathematical problem-solviing ability improved after exposure to gamified learning environment, from poor ($\bar{x}$=31.13) to very satisfactory ($\bar{x}$=87.13). In addition, there is significant relationship between the perceived level of students in attending gamified learning environment and student engagement and there is significant difference in the level of student's mathematical problem-solving ability before and after exposure to gamified learning environment.

Conclusion: The students positively perceived gamified learning environment in mathematics as to goal, access, feedback, challenges, and collaboration. Moreover, the students are behaviorally, emotionally, cognitively and agentic engage in mathematics after exposure to gamified learning environment. Furthermore, the mean performance level of students' mathematical problem-solving ability before and after exposure to the gamified learning environment are 31.13 and 87.13. In addition, there is significant relationship between the perceived level of students in attending gamified learning environment and student engagement and there is significant difference in the level of student's mathematical problem-solving ability before and after exposure to gamified learning environment.

Keywords: Gamified Learning Environment, Engagement, Mathematical problem-solving ability

INTRODUCTION

Mathematics is a significant subject in the K-12 curriculum. It is part of everyone's life, regardless of age or situation. Its importance extends beyond the classroom and the school. In addition, critical thinking and problem-solving skills are the twin goal of the Philippine Mathematics Curriculum. These two goals are accomplished by a structured and challenging curriculum, a clearly defined set of advanced skills and procedures, desirable values and attitudes, and suitable tools while considering the many circumstances in which Filipino learners learn (DepEd, 2016). In addition, Sajadi et al., (2013) stated that Problem-solving is a subject in Standards and Focal Points. However, in Siniguian's (2017) study about the difficulty in solving mathematical problems, it was found that mathematical

problem-solving and the usage of correct mathematics are both lacking. A student with output issues finds it hard to maintain precision during mathematical work, cannot recall basic math facts, procedures, rules, or formulas, and is very slow to retrieve facts or pursue the process. They also have trouble writing legibly, which slows down or complicates written work.

Moreover, it has been established that student engagement has a significant impact on academic success and has been a focus of research in the field of education for decades. Student engagement is described in a study by Wang and Eccles (2012) as the level of focus, curiosity, interest, optimism, and passion that students exhibit while learning or being taught. Students who are actively participating in class, finishing their assignments on time, and remembering the material are more likely to be engaged. Additionally, they are more likely to be more motivated and enjoy learning. As a result, it is essential for teachers to promote student engagement using a variety of techniques, such as incorporating interactive activities and giving timely and meaningful feedback. Teachers can assist students in realizing their full potential and achieving their academic objectives by encouraging student engagement.

Furthermore, gamification have become increasingly popular in recent years to engage and motivate learners. In gamified learning environment, the researchers integrated the ranking/legend that was found in the mobile legends. Every time the learner participated in Math class, researcher gave a gem in a form of badge. Every week, they counted the number of points earned by each students and they received badges according to the number of points they received. For students who got 1 to 5 points, they received badge for "Warrior". For students who got 6-10 points they received a badge for "Elite". For students who got 11 to 15 points, they received a badge for "Master". For students who got 16-20 points they received a badge for "Grandmaster". For students who got 21-25 points, they received a badge for "Epic". For students who got 26-30 points, they received a badge for "Legend". For students who got 31-35 points, they received a badge for "Mythic". And last, for students who got 36 points and above, they received a badge for "Mythical glory". These served as feedback for their active participation and excellence performance. The researcher used Quizizz during introduction of the lesson or assessment of the lesson. Moreover, the researchers integrated the games snake and ladder, raise the flag challenge, ringing the bell, and guess the jumbled words with a twist. This has been shown to be effective in enhancing learners' motivation, engagement, and learning outcomes. Moreover, in the study of Sailer et al (2017) it was found that participants who used a gamification in learning environment had higher levels of motivation and engagement than those in traditional learning environment. Furthermore, the use of game attributes in gamified learning helps the achievement of learning outcomes through behavior change (Landers, 2014). Overall, gamified learning environment have the potential to improve the learning experience for students and should be considered as an effective teaching tool.

Research Questions
This study determined the relationship and the impact of the gamified learning environment in improving the engagement and mathematical problem-solving ability of grade 7 students. Its main goal is to answer the following questions:
1. How do the students perceive gamified learning environment in mathematics as to:
    1.1. goal;
    1.2. access;
    1.3. feedback;
    1.4. challenges, and
    1.5. collaboration?
2. What is the level of students' engagement after exposure to the gamified learning environment as to:
    2.1. behavioral;
    2.2. emotional;
    2.3. cognitive, and
    2.4. agentic?
3. What is the mean performance level of students' mathematical problem-solving ability before and after exposure to the gamified learning environment as to:
    3.1. understanding problems;
    3.2. planning for solving problems;
    3.3. solving problems, and
    3.4. looking back at the problem-solving result?
4. Is there any significant relationship between the perceived level of students in attending gamified learning environment and student engagement?

5. Is there any significant difference in the level of students' mathematical problem-solving ability before and after exposure to gamified learning environment?

Hypothesis

Given the stated research problem, the following hypotheses were tested on 0.05 level of significance:

Hypothesis 1: There is significant relationship between the perceived level of students in attending gamified learning environment and student's engagement.

Hypothesis 2: There is significant difference in the level of student's mathematical problem-solving ability before and after exposure to gamified learning environment.

METHODS

Research Design

This study used a correlational research design and a pre-experimental research design. Two different questionnaires were used to determine how students perceived gamified learning environment in mathematics and the level of students' engagement after exposure to gamified learning environment as well as validated pretest and posttest for mathematical-problem ability.

Population and Sampling

This study was conducted at one of the public high schools in Quezon within three weeks during Third Quarter of school year 2022-2023 with 30 respondents. Stratified random sampling was employed to ensure that every student from five sections has an equal chance of being chosen as a sample. In this study, the respondents derived relationships among angles formed by parallel lines cut by a transversal using measurement and by inductive reasoning, illustrated polygons: (a) convexity; (b) angles; and (c) sides and derived inductively the relationship of exterior and interior angles of a convex polygon.

Instrument

Surveyed questionnaires were used to determine how students perceived gamified learning environment in mathematics and the level of students' engagement after exposure to gamified learning environment as well as validated pretest and posttest for mathematical-problem ability. The researchers conducted pilot testing for the questionnaires. The instruments were researchers made and were validated by master teacher in mathematics, math coordinators and panelists.

Data Collection

The data was collected, examined, and analyzed in accordance with the study's objectives and research protocols.

Treatment of Data

In this study, descriptive and inferential statistics were used. Mean was used to determine how the students perceived Gamified Learning environment in mathematics and the performance level of a student's mathematical problem-solving ability, while Pearson Product Moment Correlation Coefficient (PMMC) was used to determine the significant relationship between the perceived level of students in attending gamified learning environment and student's engagement. Moreover, T-test was used to determine the significant difference in the level of student's mathematical problem-solving ability before and after exposure to gamified learning environment.

Ethical Considerations

The researchers diligently adhered to all ethical research protocols to safeguard the well-being and interests of all individuals and organizations involved in the study.

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RESULTS and DISCUSSION

PART I. GAMIFIED LEARNING ENVIRONMENT
Table 1. Student's perception in gamified learning environment in mathematics in terms of goal.

Indicators	Mean	SD	VI
1. I participate actively in the discussion because I can earn points.	3.53	.507	Strongly Agree
2. I become more encouraged to answer Math problems because I know, I will be earning points or badges.	3.53	.507	Strongly Agree
3. I become more engage in the discussion because I want to receive more point or badge.	3.47	.507	Agree
4. I make sure to accomplish the learning objective because I want to receive more badge or point.	3.47	.629	Agree
5. I become more competent in solving problems because of receiving point.	3.47	.571	Agree
Overall	**3.49**	**.378**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree).

Table 1 contains the perception in the gamified learning environment in mathematics about goals. The overall mean of 3.49 indicates that most students agreed with the statements about the goal in the gamified learning environment in mathematics. The result implied that the students positively perceived the gamified learning environment in mathematics as goal oriented. A standard deviation of 0.378 in relation to a mean of 3.49 suggests that the data points are closely clustered around the mean, indicating a relatively precise and reliable estimate of the central tendency. It also implies that the dataset is relatively homogeneous, with limited variation or outliers.

The findings from the study strongly corroborate the positive impact of a gamified learning environment on students' perception in mathematics, specifically in terms of goal-related factors. The positive perception of students towards earning points and badges indicates that these extrinsic rewards can be used as incentives to drive student efforts and encourage their involvement in discussions and problem-solving activities.

Furthermore, it was evident that during the implementation of the gamified learning environment in Mathematics, students showed positive acceptance. For example, when there is seatwork about pair of angles formed by parallel lines cut by a transversal, or angles of a polygon, the students wrote their answers in their notebook and passed this on the teacher's table as soon as possible to get high points. In addition, during activities like guessing the word with a twist, the students tried their best to get the word faster and they received badges. The students volunteered to write, on the board, the solution to the problem because they wanted to receive two points, and they explained it clearly, to get additional two (2) points. While playing Quizizz, the students clicked the answer fast and correctly because their goal is to be included in the top ranks (first, second, and third). These actions observed in the students showed that they were goal-oriented in the gamified learning environment.

Table 2. Student's perception in gamified learning environment in mathematics in terms of access.

Indicators	Mean	SD	VI
1. I can earn points or badges by participating in every activity.	3.43	.504	Agree
2. I am capable of accessing the Quizizz application.	3.40	.563	Agree
3. I am capable of reviewing the discussion anytime.	3.30	.535	Agree
4. I am capable of reviewing the questions in our activity anytime.	3.23	.504	Agree
5. I am capable of expressing my ideas and opinion in Math class freely.	3.27	.521	Agree
Overall	**3.33**	**.354**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree).

The student's perception in a gamified learning environment in mathematics, in terms of access, has an overall mean score of 3.33. The verbal interpretation of the mean score generally "agree" implied that the students

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perceived learning in the gamified learning environment as more accessible. A standard deviation of 0.354 in relation to a mean of 3.33 suggests that the data points are relatively close to the mean, indicating a narrower spread and less variability in the dataset. It also implies that the mean is a precise and reliable estimate of the central tendency. These findings underscore the positive implications of gamified learning environment in mathematics education and emphasize the importance of designing engaging and student-centered learning experiences.

Furthermore, during the implementation of gamified learning environment, students received an advance copy of the lessons and examples of mathematical problems about pairs of angles formed by parallel lines cut by a transversal and angles of a polygon.

In addition, students communicated with their classmates during group activities. They earned badges every time they have finished the activity. Moreover, when playing Quizizz, they participated freely with free internet connection. They confidently participated in all activities in the gamified learning environment. Additionally, they expressed their ideas and opinion freely. These instances proved equal and open access to the gamified learning environment.

Table 3. Student's perception in gamified learning environment in mathematics in terms of feedback.

Indicators	Mean	SD	VI
1. I can easily understand the lesson whenever explanation of the answers instantly appeared after answering the mathematical problem in real-time.	3.23	.504	Agree
2. I feel motivated whenever I receive points or badge.	3.40	.675	Agree
3. I become confident in answering mathematical problem every time I got the correct answer.	3.80	.407	Strongly Agree
4. I try my best to perform better whenever my teacher gives point or badge during the discussion,	3.67	.479	Strongly Agree
5. I practice solving problem so that I can get more points during the activity.	3.57	.568	Strongly Agree
Overall	**3.53**	**.321**	**Strongly Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree).

The given data presents the mean, standard deviation, and verbal interpretation (VI) of the feedback indicators from student's perceptions in a gamified learning environment in mathematics. The overall mean of 3.53 implied that the students generally accepted feedback in the gamified learning environment in mathematics positively with strong agreement in all the statements. The standard deviation, 0.321 suggests that the data values are relatively close to the mean, with a small amount of variability or dispersion around that value. These findings reinforce the potential of gamified learning environment to positively impact students' perception, motivation, confidence, and performance in mathematics. Educators can leverage these implications to design and implement effective gamified strategies that promote meaningful learning experiences and support students' mathematical growth.

Furthermore, during the implementation, students correctly answered the next given problem after an instant explanation of the previously given problem. The student received the badge or points right after answering the questions correctly. They counted their earned points and received the corresponding legend through badges every Friday. This excites them to earn more points. In addition, they were proud sharing the number of points they received. Sometimes they said, "Ma'am I have already earned enough points to become Legend, Elite, Master or Higher rank". Every Friday, they were excited to remind the researchers about counting their points. They always asked "Ma'am, are we going to count the number of points we received?".

Moreover, when playing Quizizz, the correct answer followed by the leaderboard are presented after the allotted time. Moreover, after the leaderboard was revealed, those students who are on the top ranks shouted, jumped, and clapped with extreme happiness while those who ranked below show disappointment and sadness.

It was highly observed, during implementation, how instant feedback boosted the eagerness and excitement of the students to the fact that they shouted, jumped, and clapped after getting the correct scores.

Similarly, the study of Raymer (2011) suggested that providing frequent feedback, measuring progress, offering character upgrades, rewarding effort, and utilizing peers as a source of motivation can help to increase student's engagement.

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Table 4. Student's perception in gamified learning environment in mathematics in terms of challenges.

Indicators	Mean	SD	VI
1. I practice solving problem because I want to be the rank 1 in math class.	3.40	.621	Agree
2. I perform better because I want to improve my ranking in Math class.	3.57	.504	Strongly Agree
3. I become more engage in Math class because of challenging games and activities.	3.63	.556	Strongly Agree
4. I solve Math problems eagerly whenever I got the highest rank or points in every games.	3.50	.509	Strongly Agree
5. I feel pressured whenever I am, given time in answering Mathematical problems.	3.03	.718	Agree
Overall	**3.43**	**.359**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree).

The results with overall mean 3.43 and standard deviation 0.359 show positive acceptance of gamified learning environment in terms of challenges. The standard deviation of 0.359 suggests that the data points may be spread out a bit more, with some values deviating from the mean by a larger amount. This implied that the students agree with the indicators about challenges in gamified learning environment. Moreover, they accepted the challenges positively. They strongly agreed that ranking, challenging games, and activities made them perform better, be more engaged, and solve math problems eagerly. In addition, they agreed that they practiced solving problems because they wanted to be ranked 1 in math class. Additionally, they feel pressured when there is limited time to answer Mathematical problems.

Furthermore, the students eagerly participated in all activities when there was time pressure, points, badges, music, and leaderboard in the gamified learning environment. Every time the students played Quizizz, they tried to click the answer faster than the other because of the time pressure and the goal of being in the top rank. They were pressured to do all the tasks within a limited time as if they were in a raise. Sometimes they shouted "wait po ma'am" due to pressure of not meeting the time limit. Moreover, happiness and satisfaction, through their actions, are observed after getting the correct answer to mathematical problems. They received high points, sometimes badges, every time they did the mathematical problem on time.

Challenges boosted the eagerness of the students in Math class.

These results suggest that students are motivated by their rankings, responsive to challenging activities, seek recognition through achievements, but also experience some pressure under time constraints. Understanding these implications can help educators tailor their teaching strategies to foster motivation, engagement, and support students in managing time effectively.

Similarly, Lee and Hammer (2011) recognize the value of concrete challenges perfectly tailored to the student's skill level, increasing in difficulty as the student's skill grows.

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Table 5. Student's perception in gamified learning environment in mathematics in terms of collaboration.

Indicators	Mean	SD	VI
1. I become more engage in Math class during group activity.	3.43	.568	Agree
2. I feel better whenever I answer Mathematical problems as a group.	3.37	.490	Agree
3. I answer Mathematical problems confidently whenever I interact with my groupmates.	3.50	.509	Strongly Agree
4. I feel relaxed every time I am solving Math problems while collaborating with groupmates.	3.23	.568	Agree
5. I find it easy to solve Mathematical problems when done in group.	3.23	.626	Agree
Overall	**3.35**	**.360**	**Agree**

Legend: 1.0-1.49 (Strong Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree).

The overall mean score of 3.35 implied that students accepted collaboration in the gamified learning environment in Mathematics. Based on the standard deviation 0.360, this suggest that the data set is relatively clustered around the mean, with minimal variation or dispersion. Furthermore, the result suggests that students perceived collaboration as a positive experience that helps boost their confidence in solving mathematical problems and creates an engaging, comfortable, and supportive learning environment. Moreover, these results suggest that collaboration in the gamified learning environment positively affects students' engagement, confidence, relaxation, and problem-solving ease in Mathematics.

In the group activity, like snake and ladder, the students supported one another. The performance of one student will affect the overall performance of the group. In every group activity, the students helped each, finished their task ahead of time and received high points.

Furthermore, every time the students played Quizizz, as a group, they showed more of their emotions, their joy, happiness, satisfaction, or disappointment in group rather than doing the activity alone. Moreover, the students are engaged and confidently showed their answers in every mathematical problem knowing that they finished the work as a group combining the knowledge of one another.

PART II. STUDENT'S ENGAGEMENT
Table 6. Student's behavioral engagement after exposure to gamified learning environment

Indicators	Mean	SD	VI
1. I study the sample Mathematical problems by myself because I want to receive badge or points.	3.40	.498	Agree
2. I remove all distracting environmental factors when participating in Math class.	3.30	.651	Agree
3. I devoted more time in managing my own learning in Math class.	3.30	.535	Agree
4. I eagerly improve my performance in Math class.	3.57	.568	Strongly Agree
5. I eagerly participate in answering my teacher's question.	3.47	.571	Agree
Overall	**3.41**	**.358**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree)

The students generally agreed with the five behavioral engagement indicators after exposure to a gamified learning environment with an overall mean of 3.41. The standard deviation 0.358 implies that the data set is close to the mean with minimal variation or dispersion. This implied that the students are engaged in improving their performance in Math class. Additionally, students agreed that they studied the sample mathematical problems and removed all distracting environmental factors. Moreover, they devoted more time to managing their learning, and

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they eagerly participated in answering the teacher's questions. Furthermore, these results imply that the students in demonstrate positive study habits, engagement in class, and a drive to improve in mathematics.

In fact, during the implementation of gamified learning environment, the students answered the given mathematical problems in advance because they were informed that the teacher will distribute badges or points to the student that will write the correct solution to the given mathematical problems on the board. In addition, students raised their hands every time the researchers ask questions. Whenever they find difficulty in solving mathematical problems, they never stopped instead they showed persistency and asked for help from their classmates or the researcher. Furthermore, they practiced solving mathematical problems. Some students asked the researcher, "Ma'am is my solution correct?", "Ma'am I cannot solve this problem, will you please help me", or "Ma'am where did this answer came from?"

Similarly, they showed high engagement and cooperation every time they play Quizizz.

Table 7. Student's emotional engagement after exposure to gamified learning environment

Indicators	Mean	SD	VI
1. I enjoy understanding the Mathematical problems.	3.33	.547	Agree
2. I like finding real life application of the given mathematical problems.	3.07	.691	Agree
3. I interact with my classmates in Math class	3.37	.490	Agree
4. I enjoy participating in Math class.	3.50	.572	Strongly Agree
5. I tried to exchange understanding of the discussion in Math class.	3.53	.507	Strongly Agree
Overall	**3.36**	**.346**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree)

The overall mean score of 3.36 and a relatively low SD of 0.346 indicate a consistent trend of agreement among the respondents. The results suggest that the respondents enjoy understanding mathematical problems, are interested in finding real-life applications, interact with their classmates, enjoy participating in math class, and actively exchange their understanding. The overall findings demonstrate a positive attitude and engagement towards mathematics among the respondents.

These findings implied that the gamified learning environment can contribute to positive emotional engagement among math students, particularly in their interest, enjoyment, and curiosity.

Furthermore, during the implementation of gamified learning environment, the students jumped, shouted yehey, and clapped every time they got the correct answer while playing Quizizz. The same emotions are observed in every activity, for example, playing snake and ladder, stopping the music with a twist, group activity, raising the flag challenge, and guessing the words with a twist.

Moreover, during seatwork, students show extreme happiness when they passed the notebook faster than others and got the correct answer because they received additional points through a badge. Otherwise, when ten students passed their notebooks, those who passed the notebook late showed sadness and asked the researchers to raise the number of students to receive additional points.

Table 8. Student's cognitive engagement after exposure to gamified learning environment

Indicators	Mean	SD	VI
1. I solve difficult problems with my classmates and take it as a challenge.	3.60	.621	Strongly Agree
2. I eagerly answer the Mathematical problems that my classmates ask.	3.17	.648	Agree
3. I make sure to derive new interpretation of the problems from the knowledge I have learned during discussion.	3.13	.629	Agree
4. I analyze the answer and its solution in given problems.	3.67	.479	Strongly Agree
5. I evaluate the problem result by checking.	2.90	.607	Agree
Overall	**3.29**	**.385**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree)

The overall mean score of 3.29 indicates an agreement with the statements on average. The standard deviations (SD) are relatively low, indicating a relatively narrow range of responses, which adds to the consistency of the results.

The results indicate that the individual student is actively engaged in problem-solving activities with their classmates and exhibits a positive attitude towards challenging problems. They are willing to participate in discussions and share their knowledge to derive new interpretations of problems. Furthermore, the students show a strong inclination towards analyzing problem solutions and evaluating the results. In addition, the results suggested that students accepted gamified learning as engaging. Because of that, students demonstrate engagement in solving challenging mathematical problems with their classmates, and they analyzed their answers and its solution. While the students answered the problems, the researchers observed that they collaborated with their classmates and exchanged their knowledge on solving the problem. Those who are fast learners answered the questions asked by their classmates and helped in understanding the solution.

In addition, students derived new interpretations of the problems from the knowledge they learned during the discussion by applying the knowledge to solving the mathematical problem. For example, the students derived the formula for finding the sum of the measures of all angles of a polygon through the group activity. In the group activity, the students drew diagonals from one point to another and counted the number of dissected triangles. After finishing the task, the students evaluated the result and stated the relationship between the number of sides of the polygon and the number of dissected triangles. The students realized that the number of dissected triangle was obtained by subtracting two (2) from the number of sides of a polygon. Another learning is that they don't need to get the number of dissected triangles to find the sum of the interior angles of a polygon but to use the formula $(n-2)$ 180 degrees where n is the number of sides.

Additionally, in answering mathematical problems, the students evaluated the problem results by checking.

Table 9. Student's agentic engagement after exposure to gamified learning environment

Indicators	Mean	SD	VI
1. I solve Math problems in advance.	3.00	.587	Agree
2. I raise my hand to answer the given math problem.	3.53	.507	Strongly Agree
3. I volunteer to explain the given example of Math problem	2.93	.640	Agree
4. I share my understanding with my classmates.	3.37	.556	Agree
5. I find different solutions or shorter steps/process in solving problems.	3.20	.551	Agree
Overall	**3.23**	**.317**	**Agree**

Legend: 1.0-1.49 (Strongly Disagree); 1.50-2.49 (Disagree); 2.50-3.49 (Agree); 3.50-4.0 (Strongly Agree)

The overall mean score of 3.23 indicates an agreement with the given statements, reinforcing the notion that the student actively engages with mathematics and demonstrates a positive attitude towards problem-solving. The overall SD of 0.317 indicates relatively low variability in the agreement levels among the indicators.

The results suggest that the student actively participates in math-related activities, engages in problem-solving, and demonstrates a positive attitude towards mathematics.

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PART III. STUDENT'S MATHEMATICAL PROBLEM-SOLVING ABILITY

Table 10. Student's performance level in mathematical problem-solving ability before and after exposure to gamified learning environment.

Mathematical Problem Solving	Gamified Learning Environment					
	Before			After		
	Mean	SD	VI	Mean	SD	VI
Understanding problems	15.30	3.88	Satisfactory	24.53	1.25	Outstanding
Planning for solving problems	5.07	4.23	Unsatisfactory	22.10	3.02	Outstanding
Solving problems	6.07	4.03	Unsatisfactory	19.93	3.89	Very Satisfactory
Looking back at the problem result	4.70	4.15	Unsatisfactory	20.57	4.42	Very Satisfactory
Overall	**31.13**	**11.86**	**Poor**	**87.13**	**9.63**	**Very Satisfactory**

Legend: 0-5.99 (Poor); 6-10.99 (Unsatisfactory); 11-15.99 (Satisfactory); 16-20.99 (Very Satisfactory); 21-25 (Outstanding)

The result of student's performance level in mathematical problem-solving ability before and after exposure to gamified learning environment implied that during pretest, student's ability in understanding the problem has mean of 15.30 which interpreted as satisfactory. While in posttest, the mean became 24.53 which interpreted as outstanding.

Figure 2. Answer of student A in problem 1 in mathematical problem-solving ability pretest as to understanding the problem.

Figure 2 showed an example of student's answer that is satisfactory. As you can see, the student has completed answer in all questions, but the other answers are not accurate to the questions. In the first question in number 1 problem, the answer should be the value of x, but the student answered the measure of angle ABC. Another one is that she is unable to translate the statement, the measure of angle ABC is equal to 2x, in mathematical equation.

Figure 3. Answer of student A in problem 3 in mathematical problem-solving ability posttest as to understanding the problem.

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Figure 3 showed that student A understands the problems and comprehends the given questions. Her answers were complete and accurate. This is an example of outstanding level of mathematical problem-solving ability as to understanding the problem.

In addition, the result of student's performance level in mathematical problem-solving ability before and after exposure to gamified learning environment as to planning for solving problems implied that during pretest, student's ability in planning for solving problems has mean of 5.07 which interpreted as unsatisfactory. While in posttest, the mean became 22.10 which interpreted as outstanding.

Figure 4. Answer of student B in problem 1 in mathematical problem-solving ability pretest as to planning for solving problem.

Figure 4 showed the unsatisfactory performance of the student to planning for solving problem in mathematical problem-solving ability pretest. As shown in the figure, the student B, did not write the appropriate equations that will be used in solving the problems.

Figure 5. Answer of student B in problem 2 in mathematical problem-solving ability posttest as to planning for solving problem.

Figure 5 shows Student B's performance in planning to solve mathematical problem-solving ability. As evidenced by her complete and accurate answers in the posttest, her performance is outstanding. This implied that Student B was able to identify the main question in the problem, select an appropriate equation, and break down the problem into step-by-step process or solution.

Moreover, the result of student's performance level in mathematical problem-solving ability before and after exposure to gamified learning environment as to solving problems implied that during pretest, student's ability in solving problems has mean of 6.07 which interpreted as unsatisfactory. While in posttest, the mean became 19.93 which interpreted as very satisfactory.

Figure 6. Answer of student C in problem 2 in mathematical problem-solving ability pretest as to solving problem.

Figure 6 showed the solution of student C in solving problems 2 during mathematical problem-solving ability pretest. It was evident in his answers that his performance level is unsatisfactory because he wrote an incorrect solution in the given problem. Though he was able to write the value of x but the solution is far from correct.

Figure 7. Answer of student C in problem 2 in mathematical problem-solving ability posttest as to solving problem.

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Figure 7 showed the correct yet incomplete solution of student C in problem 2 during mathematical problem-solving ability posttest. It was interpreted as very satisfactory because the student wrote the correct solution however there is one incorrect symbol and one missing variable.

Furthermore, the result of student's performance level in mathematical problem-solving ability before and after exposure to gamified learning environment as to looking back at the problem-solving result implied that during pretest, student's ability to check the problem result has mean of 4.70 which interpreted as unsatisfactory. While in posttest, the mean became 20.57 which interpreted as very satisfactory.

Figure 8. Answer of student D in problem 5 in mathematical problem-solving ability pretest as to looking back at the problem result.

Figure 8 showed the checking of student D in the given problems. She wrote the checking in correct in the problems during mathematical problem-solving ability pretest. This performance is interpreted as unsatisfactory because she wrote an incorrect answer.

Figure 9. Answer of student D in problem 2 in mathematical problem-solving ability posttest as to looking back at the problem result.

Figure 9 is an examples of student answer that shows very satisfactory. It was evident that she wrote the correct checking yet some numbers or symbols are missing.

Table 11. Significant relationship between the perceived level of students in attending gamified learning environment and student engagement.

	Gamified Learning Environment				
	Goal	Access	Feedback	Challenge	Collaboration
Behavioral Engagement	.556**	.689**	.436*	-	.431*
Emotional Engagement	-	-	-	.420*	.414*
Cognitive Engagement	.479**	.598**	.487**	-	.386*
Agentic Engagement	.513**	.385*	-	-	.390*

**Correlation is significant at the 0.01 level (2-tailed).   *Correlation is significant at the 0.05 level (2-tailed).

According to the provided correlation coefficients, there seems to be a significant correlation between student engagement and perceived student attendance in gamified learning environment. The findings specifically showed a positive relationship between student's behavioral, emotional, cognitive, and agentic engagement and their perceptions of access, feedback, challenge, and collaboration in a gamified learning environment.

For instance, the correlation coefficients indicate that students are more likely to be behaviorally, cognitively, and agentic engaged in the learning process when the gamified learning environment is goal oriented and easy to access. Likewise, they become more behaviorally and cognitively engage when there are automatic feedbacks in every activity that they have participated. For example, in playing Quizizz, there is always a feedback

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after answering a question. The leaderboard presented the student or group that received a high points after clicking the answer correctly and fast. Similarly, in the study of Espasa et al (2022), about prior experience with online feedback: its influence on student's engagement in distance education, it was found out that students were more engaged when the feedback was clear, specific, and focused on helping them improve their learning outcomes. Similarly, the frequency, intensity, and immediacy of feedback are also important for sustaining engagement throughout the learning process (Kapp, 2012). In addition, Raymer (2011) suggested that providing frequent feedback, measuring progress, offering character upgrades, rewarding effort, and utilizing peers as a source of motivation can help to increase student's engagement.

Moreover, the students are more likely to emotionally engage in gamified learning environment when there are challenges. During the implementation of gamified learning environment, their biggest challenge is to receive lots of points because every week the number of points they got was counted by the researcher and they were given their legend according to the number of points they have collected after participating in the discussion.

Furthermore, the students are more behaviorally, emotionally, cognitively, and agentic engage in gamified learning environment when there is collaboration. It was evident that during the implementation of gamified learning environment there are many group activities. For example, in playing Quizizz, since there are limited mobile phones, the researchers divided the class into groups with two to four members and let the group use only one mobile phone so that everyone can participate in the activity. Another group activity is the stop the dance challenge where they are given one object and past it around their classmates. The one holding the object will answer.

These results collectively implied that gamified learning environment can significantly increase student engagement in the learning process through their design and implementation. Educators can boost student engagement, interest, and investment in the learning process when the environment is goal oriented with automatic feedback and accessible to interesting and challenging learning experiences, and collaboration.

The results are related to the study of Zhao, F. (2019) about using Quizizz to Integrate Fun Multiplayer Activity in the Accounting Classroom. It was found out in their study that using Quizizz as a fun multiplayer activity had a positive impact on student engagement and learning outcomes. Specifically, the study found that students who participated in the Quizizz activity reported higher levels of engagement, enjoyment and performed better on quizzes and exams than those who did not. Moreover, the study also found that students appreciated the social and collaborative aspects of the Quizizz activity, as well as the instant feedback provided by the platform.

Similarly, in the study of Sailer et al., (2017) it was found that participants who used a gamification in learning environment had higher levels of engagement than those in traditional learning environment.

Table 12. Significant difference in the level of student's mathematical problem-solving ability before and after exposure to gamified learning environment.

Mathematical Problem-Solving Ability	Before		After		Mean Difference	t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD				
Understanding problems	15.30	3.88	24.53	1.25	9.233	15.098	29	.000
Planning for solving problems	5.07	4.23	22.10	3.02	17.033	20.667	29	.000
Solving problems	6.07	4.03	19.93	3.89	13.867	16.595	29	.000
Looking back at the problem result	4.70	4.15	20.57	4.42	15.867	17.798	29	.000
Overall	**31.13**	**11.86**	**87.13**	**9.63**	**56.000**	**26.767**	**29**	**.000**

The results indicated a statistically significant difference in the level of student's mathematical problem-solving ability before and after exposure to gamified learning environment. The mean scores for all aspects of mathematical problem-solving ability (understanding problems, planning for solving problems, solving problems, and

looking back at the problem result) were significantly higher after the exposure to gamified learning environment compared to before.

The overall mean of mathematical problem-solving ability increased by 56.000 points, which is a substantial improvement. The p-values for all aspects of mathematical problem-solving ability were less than 0.05, indicating a high level of statistical significance. These results suggest that gamified learning environment can be an effective way to enhance student's mathematical problem-solving ability.

In addition, gamified learning environment provide immediate feedback to students, which allows them to learn from their mistakes and adjust their approach. This can be particularly useful in math, where students need to understand where they went wrong to improve their problem-solving skills. Moreover, it allows students to track their progress. This can be motivating for students, as they can see how much they have improved and set goals for themselves. Quizizz is an example of application that has leaderboard which allows students check their performance. At the same time, during the implementation, the general rule of the researchers in the discussion is a way of determining student's progress. Every week they check their legend and ranking in class according to the number of points they have received. Likewise, the activities made by the researchers were designed to be engaging and fun, which can help students stay motivated and focused on their learning. For example, the snake and ladder, the stop the dance with a twist and the raise the flag challenge was engaging to the students and they were enjoying the games while learning. They are also encouraged to collaborate with their classmates during group activities, especially in playing Quizizz.

Furthermore, the use of game elements in gamified learning helps the achievement of learning outcomes through behavior change (Landers, 2014). Overall, gamified learning environment have the potential to improve the learning experience for students and should be considered as an effective teaching tool. In addition, in the study of Dicheva et. al (2015), it was found that effective gamified learning environment require well-defined goals, rules, and feedback mechanisms that allow learners to understand their progress and performance. Similarly, Dominguez et al. (2013) indicate that frequent, meaningful, and rapid feedback can improve student results.

Summary, Conclusions, and Recommendations

The student's perception of a gamified learning environment in Mathematics was favorable. This can be attributed to the fact that presenting the teaching and learning material in an enjoyable and stimulating manner increases the student's ability to take risks and assume responsibility in their learning of Mathematics, which in turn can result in a more profound comprehension of the subject.

The level of student's engagement significantly increased after exposure to a gamified learning environment that yields positive results, as the incorporation of game elements such as rewards, challenges, leaderboard, music and time pressure can foster a sense of achievement and motivation to continue learning.

Gamified learning environment can be an effective approach to improve student's mathematical problem-solving ability. It suggests that incorporating gamification elements in the learning process can be a useful strategy for mathematics teachers to enhance student's performance in solving mathematical problems.

The design and implementation of gamified learning environment have a significant relationship on student engagement. By providing students with access to exciting and challenging learning experiences, opportunities for collaboration, and feedback, and a goal-oriented learning environment, educators can enhance student behavioral, emotional. cognitive, and agentic engagement.

The statistical analysis indicated that there is a significant difference in the mathematical problem-solving ability of the students before and after they were exposed to a gamified learning environment. This suggests that the inclusion of game elements in teaching and learning process is an effective way to enhance the student's mathematical problem-solving ability.

Based on the findings of the study, there is significant relationship between the perceived level of students in attending gamified learning environment and student's engagement and there is significant difference in the level of student's mathematical problem-solving ability before and after exposure to gamified learning environment.

It was recommended to the students to embrace gamified learning environment and engage with the game elements. The rewards, challenges, leaderboard, music, time and pressure can help them stay engaged and interested in solving Mathematical problems. Moreover, teachers from different areas of specialization should incorporate game elements while considering their alignment with their learning objectives and supporting student learning. Moreover, they should regularly evaluate the effectiveness of their gamified learning environment through student feedback, assessment results, and other metrics. Make changes and adjustments as necessary to improve the learning experience. While the current findings suggest that gamified learning environment can be effective in

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improving engagement and mathematical problem-solving ability, it would be useful for the future researcher to conduct more longitudinal studies to explore the long-term impact of gamification on these outcomes.

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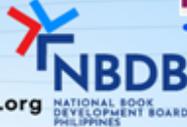
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