Effectiveness of Gamification on Learner's Performance and Attitude towards Mathematics Amidst the COVID-19 Pandemic

Joann Mae A. Antonio[1] and Victoria E. Tamban[2]
[1]Jacobo Z. Gonzales Memorial National High School, Philippines
[2]Laguna State Polytechnic University, Philippines
Email: [1]itsolspulb@gmail.com and [2]victoria.tamban@lspu.edu.ph

***Abstract*—** The covid-19 pandemic has brought great threats in many aspects of our lives, including the disruption of the education of our youth. Nevertheless, the use of technology was highly utilized to continue the delivery of education amidst the pandemic. Gamification in learning is the process of applying game-related context in teaching and learning Mathematics. This study determined the effectiveness of gamification in improving the learners' performance and attitude towards learning Mathematics amidst the covid-19 pandemic. The researcher used a quasi-experimental design where participants of the study were given a pre-test and pre-survey before the conduct of the study. The two groups have the same level of performance in Mathematics 8 and most likely similar attitude towards Mathematics 8 before the study was conducted. The comparison group was taught using the conventional teaching technique in Online Distance Learning while the experimental group was taught with Gamification technique. After the conduct of the study, both groups have a positive attitude towards mathematics, but t-test results showed no significant difference between pre-survey and post-survey mean scores of the experimental group. Therefore, gamification does not have a significant effect in improving the attitude of the students. Thus, the performance of the students between the comparison and experimental groups also has no significant difference after the study. However, t-test results showed that there is a significant improvement in the level of performance of the experimental group in Mathematics 8 with a large effect on size.

***Keywords*—** Attitude in Mathematics, Gamification, Gamified Learning, Performance in Mathematics.

I. INTRODUCTION

The poor performance of Filipino students in Mathematics before the pandemic can be seen in the results of local and international learning assessments such as the National Achievement Test (NAT), Program for International Student Assessment (PISA), and Trends in International Mathematics and Science Study (TIMSS).

According to the performance of Grade 10 students in NAT from 2009 to 2015, the Filipino subject has the highest value at 57.2 % mean percentage score (MPS), followed by the English subject at 51.8% MPS. The mathematics subject trails behind with 47.8%, while the science subject has the lowest value with 44.5%. Based on its mean percentage score, Grade 10 performance in Mathematics was interpreted as having Average Mastery in the subject. The result of Mathematics performance in the local assessment is not that bad but the international result shows the poor performance of Filipino students in Mathematics.

In 2003 TIMSS, the Philippines ranked 41st out of 45 participating countries in Grade 8 Mathematics [1]. The result shows that we are underperformed by other East Asian countries such as Singapore, Korea, Hong Kong SAR, Chinese Taipei, and Japan, which ranked 1 to 5 respectively. This also marked as our last participation in TIMSS for Grade 8 Mathematics. The latest results of the Program for International Student Assessment (PISA) conducted in 2018 and TIMSS conducted in 2019 also showed that Filipino students lagged other participating countries in international assessment for Mathematics. Philippines ranked the lowest both in 79 participating countries on PISA 2018 and 58 participating countries on TIMSS 2019, which were conducted on 15-year-old and grade 4 students respectively [2]. According to DepEd Secretary Briones, considering that this is the first time the Philippines participated in PISA in 2018, it will define our baseline relative to the global standards and measure the effectiveness of our reforms plan in globalizing the quality of Philippine education [3].

To meet the challenges of providing quality education amidst the pandemic, trainings and webinars were conducted to upskill teachers' capability to use technology. However, Online Distance Learning still has been very challenging not only for the teachers but also for the students because engagement and participation are very limited.

Due to these limitations, the motivation and performance of students were greatly affected especially in Mathematics that requires application and practice of

knowledge and skills learned during the lesson. To cope with the challenges, teachers need to be more resourceful, flexible, and innovative in using technology in the current state of education in the Philippines. Since games reduce stress and enhance the mood of an individual, they are utilized in education to increase the motivation of students. Gamification, as defined by Deterding, Dixon, Khaled and Nacke [4], is the use of game-design elements in non-game contexts. Learning will become more active, fun, and engaging through games, promoting positive behavior and motivation to learn.

Engagement and motivation are critical to the success and learning of the student. Students who are engaged learn more, retain more, and enjoy learning activities more than students who are not engaged. Gamification is a developing approach in education to increase students' motivation and engagement [5]. As defined by Holloway [6], gamification in education is the use of game mechanics and design in the teaching and learning process by increasing participation, engagement, loyalty, and competition. Students will persevere more because of the motivation they gained through games and skills they practice through games will be more meaningful because of their engagement.

Motivation, playfulness, and participation are some of the assumptions that underlies the usefulness of gamification in the educational context. However, research on these assumptions remains inconclusive. Educational contexts have not yet been confirmed in which gamification is particularly useful [7]. Most of the studies on gamification focused on the use of a certain gamified application or video game but it is not limited to the usage of web properties and applications but rather on the use of game mechanics. Therefore, gamified learning is not limited to an actual game itself where learned concepts can be applied.

According to Haiken [8], there are different ways to gamify the classroom and boost students' engagement, collaboration, and learning. Teachers can adapt old-school games for classroom use where students can play in groups or individuals, and they can also use the internet to search for related topics as a guide to answer them. Students will also love engaging in quizzes and learning tasks in the form of games through Kahoot!, Quizizz, Mentimeter, and other learning platforms. These are free learning platforms that can be used to assess students' learning. It can be answered at their own pace during asynchronous class or in a form of competition within the synchronous class. It also uses a leaderboard that students can see during live competition. Other digital games, quests, and battles can also be used with an objective connected to the lesson.

Most studies show that gamification of education is a key variable in student motivation and engagement [8]. Gamification was also found effective in increasing motivation of the students in a physics course who uses gamified multiple-choice quizzes compared with students taking the traditional quizzes [10]. Studies also shows that the students using Kahoot expressed a sense of challenge and enjoyment [11] and increased learning perception [12]. Aside from motivation, some studies also concluded that attitude and performance of students using gamified quizzes are significantly correlated with increased engagement [13]. Findings of Sun-Lin and Chiou [14] also supported it through their findings that students' performance and attitude in solving algebra worded problems is significantly more positive compared to the students who did not use gamification.

In a critical review about gamification, Dichev and Dicheva [5] found out that most of the studies on gamification were conducted on college students with computer and information technology related courses. In this regard, researchers were encouraged to conduct more studies on gamification that will involve high school students or elementary students because college students are more motivated on task because of their maturity compared to high school or elementary students. In terms of learning activities, most of the studies they reviewed focuses on using gamification on course driven class or online learning activities. Dichev and Dicheva [5] also analysed the subject areas where it is applied and only few used it in Mathematics, which is the concern subject of this research. A study also proved that the use of gamification using the elements of giving points, ranking/ leaderboard and progress motivated continuous learning [15]. In contrast to points and the leaderboard, most of the students have seen badges as an incentive to work harder in learning, as this is a qualitative way of reward [16]. However, not all studies about gamification yield positive results.

In the Philippines, gamification was studied by Tolentino, Roleda and Prudente [17] and concluded that it has a significant increase in high school student's motivation and achievement in science but suggested for future researchers to have a deeper understanding on the specific elements that may contribute to the positive effect of gamification. In English, Samortin [18] concluded that gamified learning activities are effective in enhancing vocabulary retention in high school students but have no significant effect on performance.

On the other hand, Lanuza [19] integrated Filipino games in conducting a gamification technique in teaching mathematics courses in college. She used points and level as elements of the game and found out that the technique is an innovative way to increase students' performance but has some limitations on certain mathematics courses or content.

Using gamification may have been found inconclusive or no effect at all in some behavioral aspects of education but the increasing number of papers showing positive results are evidence that gamification can be an effective technique to increase engagement [13], motivation [17], attitude [14], [20], achievement [20], and performance [19], [14] of students.

The study was focused to determine the effectiveness of gamification in the performance and attitude toward learning Mathematics among Grade 8 students in one Junior High School in Biñan City, Laguna, Philippines.

II. MATERIALS AND METHODS

The research design used in this study was the quasi-experimental design because the participants were not randomly assigned to conditions before conducting the intervention. To eliminate the pre-existing differences between the two groups before the start of the treatment, matched-pairing technique was used to avoid the chance of accidental bias.

In a matched-pairing technique, participants between the comparison and experimental groups were paired in terms of important variables that might affect the result of the experiment. Participants having the same characteristics between the two groups were paired and received different conditions to make the experimental and comparison group as similar as possible.

Since the purpose of the study was to test the effectiveness of gamification which was implemented using gamified online learning platforms and learning tasks, learners using Online Distance Learning modality were purposely selected. Two sections using the said modality in grade 8 were selected as the participants of the study because the researcher was teaching in the said grade level. Simple random sampling, through coin flipping technique, was used to determine which section was the experimental group and comparison group. After the groups were assigned, the participants from the experimental group were matched paired to the participants from the comparison group based on the results of the pre-test and pre-survey on attitude to avoid accidental bias on result.

The participants of the study were selected Grade 8 students of A.Y. 2020 to 2021 of Jacobo Z. Gonzales Memorial National High School located at Barangay San Antonio, City of Biñan, Laguna.

The study used two sections of grade 8 students using Online Distance Learning (ODL) modality. One section was taught with the conventional method, which was the basis of comparison, while the second group was the experimental group, which received gamification techniques. Each student from the comparison group was paired in the experimental group based on similar attributes and characteristics that might have affected the result of the study.

The instrument of the study includes the digital gamified learning materials and platforms such as Quizziz, Mentimeter and other gamified tasks were used on the experimental group. Leaderboard was utilized on live games to see the participants' performance during their gamified learning experience. Students earned additional points based on their performance on the task. Data were gathered using test questionnaires and surveys on attitude towards Mathematics.

Pretest, posttest, and formative assessments were administered to measure the performance of the learners. The researcher utilized questions from previously used quarterly tests together with its table of specifications, which were provided by the Division Office for the pretest and posttest because this had been evaluated and tested. Each question's item number and choices were rearranged to avoid familiarity of the test to the learners. Learners were also given with formative tests after each lesson to measure their understanding of the lesson. This was also adapted from the Self-Learning Modules/ Learner's Packet provided by DepEd CALABARZON and DepEd Central Office to ensure its validity and reliability since these materials were made by Master Teachers and were checked by EPS's of the Region.

To measure the attitude of the students towards learning Mathematics, Attitude towards Mathematics Inventory (ATMI) was adapted. The said survey on attitude of students was developed by Martha Tapia and George Marsh in 1996. Reliability and validity of ATMI were established by different researchers [21], [22], [23], [24] using confirmatory factor analysis with a result of Cronbach's alpha 0.963. The said instrument was a 40-item 5-point Likert scale constructed to assess self-confidence, value, enjoyment, and motivation in Mathematics. The Rating and Descriptive Equivalent were the following:

5	Strongly Agree
4	Agree
3	Neutral
2	Disagree
1	Strongly Disagree

After securing all necessary permissions and instruments, pre-test, and pre-survey on attitude towards mathematics were administered on students of both groups. The mean scores of the pre-test were the basis in determining match-pairings between the participants of the comparison and experimental groups. Mean scores were used to show that the comparison group and experimental group were as similar as possible. Mean scores of the pre-test and pre survey were interpreted to describe the learners' performance level and attitude level in grade 8 Mathematics were the following:

Percentage	Descriptive Equivalent
96.00% - 100.00%	=Very Superior
86.00% - 95.99%	= Superior
66.00% - 85.99%	=Above Average
35.00% - 65.99%	= Average
16.00% - 34.99%	= Below Average

T-test was used to measure significant difference or increase on the results of the study. On the other hand, T-test for paired samples was used to measure the difference between before and after mean scores of the same individual or observation. Cohen's d was also used to determine the effect size between the means of the two independent samples. The study used two sections of grade 8 students using Online Distance Learning (ODL) modality. One section being the control group, which was

III. RESULTS AND DISCUSSION

Table 1 shows the participants' pre-test results which served as the basis on the match-pairing process.

Table 1: *Learner's Performance in the Pretest*

Groups	Mean Score	SD	MPS	Descriptive Equivalent
Experimental	10.47	2.80	34.90%	Below Average
Comparison	10.47	2.80	34.90%	Below Average

The result shows that the pre-test mean score of the experimental group was 10.47 (SD = 2.80) with a mean percentage score of 34.90%, same with the comparison group. Both the mean percentage scores were interpreted as below average in performance. It was an indication that the two groups under study were similar in terms of attributes. The pre-test mean-scores served as the match-pairing characteristic between the two groups. Table 2 and 3 showed the mean scores, standard deviations, and descriptive equivalents of the learner's level of attitude in terms of value, enjoyment, self-confidence, and motivation towards Mathematics before and after the study was conducted.

Table 2: *Learner's Level of Attitude towards Mathematics in the Pre-Survey*

Groups	Attitude	Mean	SD
Experimental	Value	4.25	0.57
	Enjoyment	3.76	0.68
	Self-Confidence	3.13	0.64
	Motivation		
	OVER-ALL	3.87	0.66
		3.67	0.56
Comparison	Value	4.37	0.47
	Enjoyment	3.76	0.56
	Self-Confidence	3.16	0.57
	Motivation		
	OVER-ALL	3.70	0.70
		3.67	0.47

Legend:4.50-5.00 Very Prositive
3.50-4.49 Positive
2.50-3.49 Neutral
1.50-2.49 Negative
1.00-1.49 Very Negative

The mean score of both experimental and comparison group's attitude towards mathematics is 3.67 with SD = 0.56 and SD = 47, respectively. Both were interpreted as having positive attitude in Mathematics. It was also observable that the experimental group's pre-survey mean score was more spread compared with the comparison group.

Table 3 showed the mean scores, standard deviations, and descriptive equivalents of the learner's level of attitude towards Mathematics after the study was conducted.

Table 3: *Learner's Level of Attitude towards Mathematics in the Post-Survey*

Groups	Attitude	Mean	SD
Experimental	Value	4.26	0.48
	Enjoyment	3.79	0.60
	Self-Confidence	3.27	0.66
	Motivation	3.89	0.41
	OVER-ALL	3.73	0.46
Comparison	Value	4.30	0.44
	Enjoyment	3.76	0.62
	Self-Confidence	3.17	0.66
	Motivation	3.73	0.70
	OVER-ALL	3.67	0.52

The over-all mean score was 3.67 (SD = 0.52) which was interpreted as having positive attitude in Mathematics.

The experimental group got a less disperse post-survey scores compared to the comparison group. Furthermore, it was observed that the post-survey mean score was the same with the pre-survey mean score in the comparison group. It was an indication that the group using conventional teaching method did not increase in their level of attitude compared to the group using the Gamification technique.

Table 4 displayed the posttest mean scores, standard deviations, and mean percentage scores of the experimental group and comparison group to determine their level of performance after they were taught in two different techniques.

Table 4: *Learner's Performance in the Post-test*

Groups	Mean Score	SD	MPS	Mean Difference
Experimental	13.47	4.52	44.90%	1.20
Comparison	12.27	4.53	40.90%	

Based on their pretest mean score result of 10.47, it was observed that both groups improved their mean scores after the conduct of study. But the mean difference of 1.20 showed that the experimental group have better improvement compared to the other group which used the conventional teaching technique. These results supported the findings of Hasegawa [15] that the use of some elements of games motivated continuous learning which drives improvement in learning performance. These game elements are badges, leaderboard, and point incentives.

Table 5 presented the result of t-Test for independent sample means on pre-surveys results between the experimental and comparison groups to measure the learner's level of attitude in terms of value, enjoyment, self-confidence, and motivation before the intervention on teaching techniques.

Table 5: *Results of t-Test of Independent Means of the Comparison and the Experimental Groups as Reflected by the Pre-Survey*

Attitude	Mean Score		Mean Difference	t-value (df=28)	p-value (α=0.05)
	Experimental	Comparison			
Value	4.25	4.37	- 0.12	0.613	0.544
Enjoyment	3.76	3.76	< 0.00	- 0.467	0.979
Self-confidence	3.13	3.16	- 0.03	0.109	0.914

Motivation	3.87	3.70	0.17	0.137	0.508

Based on the results, it can be concluded that there was no significant difference between the pre-survey mean scores of both groups in terms of motivation in mathematics. The results implied that the two groups were of equal level in terms of value, enjoyment, self-confidence and motivation in Mathematics before the study was conducted.

Table 6 exhibited the result of t-Test for independent sample means on the post-survey results between the experimental and comparison groups.

Table 6: *Results of t-Test of Independent Means of the Comparison and the Experimental Groups as Reflected by the Post-Survey*

Attitude	**Mean Score**		**Mean Difference**	**t-value (df=28)**	**p-value (α=0.05)**
	Experimental	**Comparison**			
Value	4.26	4.30	- 0.14	0.267	0.791
Enjoyment	3.79	3.76	0.03	- 0.144	0.887
Self-confidence	3.27	3.17	0.10	- 0415	0.681
Motivation	3.89	3.73	0.16	- 0.743	0.464

Based on the results, the null hypothesis was not rejected. There was no significant difference between the post-survey mean scores of both groups in terms of motivation in mathematics. These implied that the two groups were of equal level in terms of value, enjoyment, self-confidence, and motivation in Mathematics after the study was conducted.

Although it negated the findings of Yildrim [20] and Sun-Lin & Chiou [14] that it can effectively increase attitude, other factors might have affected these findings. Since our current educational setting is done remotely, students and teachers are still in the process of adapting in the new normal. Home environment is a lot more different in school environment that can potentially affect attitude and learning. Furthermore, future researchers were encouraged to use a different course content or approach to gamification to determine whether gamification significantly increases the students' attitude compared to the students who did not.

Table 7 showed the result of the test of significance difference between the comparison group's mean scores between the pre-survey and post survey.

Table 7: *Results of t-Test of Paired Sample Means of the Comparison Group as Reflected by the Pre-Survey and Post-Survey*

Attitude	**Mean Score**		**Mean Difference**	**t-value (df=14)**	**p-value (α=0.05)**
	Pre-survey	**Post-Survey**			
Value	4.37	4.30	- 0.07	1.126	0.140
Enjoyment	3.76	3.76	< 0.00	0.009	0.496
Self-confidence	3.16	3.17	0.01	- 0.286	0.390
Motivation	3.70	3.73	0.03	- 0.731	0.238

This reveals that the attitude of students in terms of value had a computed p-value of 0.140 which was greater than the level of significance (t_{14}=1.126; p>0.05); enjoyment had a computed p-value of 0.496 which was greater than the level of significance (t_{14}=0.009; p>0.05); self-confidence had a computed p-value of 0.390 which was greater than the level of significance (t_{14}=-0.286; p>0.05); and motivation had a computed p-value of 0.238 which was greater than the level of significance (t_{14}=-0.731; p>0.05). Thus, the null hypothesis in all factors of attitude was not rejected. There was no significant difference between the comparison group's pre-survey and post-survey mean scores in terms of value, enjoyment, self-confidence, and motivation.

Since the interest of students using the conventional teaching method in distance learning was short-lived, motivation and participation of students were also affected. That was why researchers were in continuous search for teaching techniques that can potentially

increase the attitude of students towards learning Mathematics.

Table 8 showed the result of t-Test for paired sample means between the pre-survey and post-survey results of the experimental group which used gamification.

Table 8: *Effects of Gamification on Learner's Attitude towards Mathematics as Reflected by the Pre-Survey and Post-Survey of the Experimental Group*

Attitude	Mean Score		Mean Difference	t-value (df=14)	p-value (α=0.05)
	Pre-	Post			
Value	4.25	4.26	0.01	- 0.071	0.427
Enjoyment	3.76	3.79	0.03	- 0.341	0.370
Self-confidence	3.13	3.27	0.14	- 0.128	0.110
Motivation	3.87	3.89	0.02	- 0.174	0.432

This shows that the experimental group's attitude in terms of value had a computed p-value of 0.427 which was greater than the level of significance (t_{14}=-0.071; p>0.05); enjoyment had a computed p-value of 0.370 which was greater than the level of significance (t_{14}=-0.341; p>0.05); self-confidence had a computed p-value of 0.110 which was greater than the level of significance (t_{14}=-0.128; p>0.05); and motivation had a computed p-value of 0.432 which was greater than the level of significance (t_{14}=-0.174; p>0.05). There was no significant difference between the experimental group's pre-survey and post-survey mean scores in terms of value, enjoyment, self-confidence, and motivation.

The results contrasted the findings of Hasegawa et al, [15] and Sanmugam et al., [16] that using leaderboard and badge as an element in gamification improve motivation of students to continuous learning. Although the results shown on Table 11 negated the findings previous research that the use of gamification is very promising and appealing in increasing the students' attitude in a positive way, there were other factors that might have affected this finding especially now that we are still adapting in the new normal setting of education. This gave the researcher future endeavors to further try a more thorough study on the effects of gamification on student's attitude using other game elements, designs and settings. Table 9 showed the result of t-Test for independent sample means on formative test results between the experimental and comparison groups.

Table 9: *Results of t-Test of Independent Means of the Comparison and the Experimental Groups as Reflected by the Formative Test*

No.	Lesson	t-value (df=28)	p-value (α=0.05)
1	Illustrates Triangle Inequality Theorems	1.199	0.241
2	Applies Theorems on Triangle Inequality	0.578	0.568
3	Proves Triangle Inequalities	0.611	0.546
4	Proving Properties of Parallel Lines Cut by a Transversal	1.078	0.290
5	Conditions that Guarantee Parallelism and Perpendicularity	0.800	0.430
6	Basic Concepts on Probability	0.848	0.404
7	Probability of Simple Events	1.126	0.270

As revealed by the computed p-values of 0.241 (t_{28}=1.199; p>0.05) and 0.270 (t_{28}=1.126; p>0.05); the two groups did not differ significantly. Therefore, the two groups had the same level of performance in the formative assessment number 1 and 7, respectively. These results supported one of the conclusions of Rose, Meara, Gerhardt & Williams [13] that the performance of student were correlated to their increased engagement using gamified quizzes which were also used as formative assessments in the experimental group of this study.

The use of gamified quizzes increases enjoyment and engagement of students even they were taking it in the remote setting. Additional incentives given by the teachers from time to time motivates them to do better to top the leaderboard and gain the rewards.

Table 10 showed the result of t-Test for independent sample means on the posttest results between the experimental and comparison groups to measure the level of performance of the students after the intervention on teaching techniques.

Table 10: *Results of t-Test of Independent Means of the Comparison and the Experimental Groups as Reflected by the Posttest*

Groups	Mean Score	Mean Difference	t-value (df=28)	p-value (α=0.05)
Experimental	13.47	1.20	0.727	0.473
Comparison	12.27			

This showed that the computed p-value was 0.473 which was higher than the level of significance t_{28}=0.727; p>0.05); thus, the null hypothesis was not rejected. There was no significant difference between the posttest mean scores of the experimental and comparison groups. Although the change in posttest mean score was not significant to conclude that the use of gamification improves the performance of the students much better compared to the use of conventional teaching technique, the mean score showed that the increase in scores was in favor of the experimental group.

The results supported the findings of Lanuza [19] that gamification technique was an innovative way to increase students' performance but had some limitations on certain mathematics courses or content. The researcher agreed with Tolentino et al, [17] that future researchers must have a deeper understanding on the specific elements that may contribute to the positive effect of gamification. Table 11 showed the result of t-Test for paired sample means between the pretest and posttest results of the comparison group.

Table 11: *Results of t-Test of Paired Sample Means of the Comparison Group as Reflected by the Pretest and Posttest*

Groups	Mean Score	t-value (df=14)	p-value (α=0.05)	Decision
Pre-test	10.47	- 1.390	0.093	H_0 was not rejected
Post-test	12.27			

This revealed that the comparison group had a posttest mean score of 12.27 which was higher than its pretest mean score of 10.47. The computed p-value was 0.093 which was higher than the level of significance (t_{14}=-1.390; p<0.05); thus, the null hypothesis was not rejected. There was no significant improvement in the performance of the learners taught with the conventional method as reflected in the pretest and posttest mean scores of the comparison group. The results support the findings of Realyvásquez-Vargas et al. [25] that research conducted during the Covid-19 pandemic showed impact on the performance of the students using remote learning since students still had to adapt on the changes and challenges brought by the pandemic. Table 12 showed the result of t-Test for paired sample means between the pretest and posttest results of the experimental group.

Table 12: *Effects of Gamification on Learner's Performance as Reflected by the Pretest and Posttest of the Experimental Group*

Groups	Mean Score	t-value (df=14)	p-value (α=0.05)	Effect Size (Cohen's d)	Decision
Pre-test	10.47	-3.029	0.005	0.782	H_0 was rejected
Post-test	13.47				

This showed that the experimental group had a posttest mean score of 13.47 which was higher than its pretest mean score of 10.47. The computed p-value was 0.005 which was lower than the level of significance (t_{14}=-3.029; p<0.05); thus, the null hypothesis was rejected. There was a significant improvement in the performance of the learners using Gamification as reflected in the pretest and posttest mean scores of the experimental group. In addition, Cohen's d of 0.782 showed that Gamification had a medium effect on learner's performance. This indicated that the group who underwent gamification strongly and significantly improved in terms of their performance in Mathematics 8. The results supported the findings of Sun-lin et al. [14], Lanuza [19], Mekler et al. [26], and Sousa Lima et al. [27], that gamification improved the performance of

students in Mathematics compared to the students who did not use gamification. This also proved that the use of gamified quizzes compared to traditional ones [10], [11], [12] further increased the performance of the students even in distance learning.

There were some instances that students using Online Distance Learning modality encountered problems in internet connectivity, but time-flexibility in answering the gamified learning activities gave them opportunities to still participate in the task. Since the use of gamified assessment like Quizizz allow students to immediately review their answers after taking it, immediate feedback was given. Although the result of gamification on attitude of students did not yield a significant improvement, the findings could not deny that Gamification was still an effective and innovative teaching method to significantly increase the learner's performance in Mathematics amidst the Covid-19 pandemic.

IV. CONCLUSION

Before the study was conducted, the similarity on the level of performance and attitude towards Mathematics between the experimental and comparison groups were established. After the implementation of the two different teaching techniques, the level of performance and attitude towards Mathematics between the two groups had no significant difference. Likewise, the pre-survey and post-surveys scores showed that the level of attitude of the students who were taught with Gamification did not improve significantly. However, the pretest and posttest mean scores differ significantly in favor of the experimental group. It suggested that although the level of attitude of the students who were taught with gamification did not increase significantly, their performance still improved significantly. Therefore, Gamification was an effective teaching technique in increasing the performance of grade 8 students in Mathematics.

Based on the findings and conclusions of the study, the following recommendations were given: Since it was proven that using Gamification significantly improves the performance of the students, it may be used to teach Mathematics in an Online Distance Learning Modality; Teachers may also use a variety of gamified learning activities based on their capability to implement such.; School administrators may provide capacity building seminars, workshops, and training that will increase the knowledge and skills of teachers in creating gamified learning activities; and Future researchers may conduct the further study using other variables, different age group and for a longer period to see if it will be effective.

ACKNOWLEDGMENT

The authors would like to humbly thank the President of Laguna State Polytechnic University, Dr. Mario R. Briones, the Vice President of RDE, Dr. Robert C. Agatep, the Director of R &D, Christian Paul P. Dela Cruz, and Associate Dean Dr. Karen A. Manaig of College of Teacher Education for their support for the product of this research study. The authors also want to give thanks to the respondents of the study and most of all to the Almighty God for the guidance and protection during the conduct of this study.

REFERENCES

[1] Espinosa, A., Monterola, S., & Punzalan, A. (2013). Career-oriented performance tasks: effects on students' interest in chemistry. Asia-Pacific Forum on Science Learning and Teaching. 14(2). Retrieved from https://www.eduhk.hk/apfslt/v14_issue2/espinosa/page2.htm

[2] Tadalan, C. (2021, February 1). Coronavirus pandemic highlights failures of Philippine education. BusinessWorld. Retrieved July 1, 2021, from https://www.bworldonline.com/coronavirus-pandemic-highlights-failures-of-philippine-education/

[3] Department of Education (2019, December 4). Statement on the Philippines' ranking in the 2018 PISA results. GOV.PH. https://www.deped.gov.ph/2019/12/04/statement-on-the-philippines-ranking-in-the-2018-pisa-results/

[4] Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness. https://doi.org/10.1145/2181037.2181040

[5] Dichev, C., Dicheva, D. (2017). Gamifying education: what is known, what is believed and what remains uncertain: a critical review. Int J Educ Technol High Educ, 14(9). https://doi.org/10.1186/s41239-017-0042-5

[6] Holloway, Suzanne (2018, May 2). Gamification in education: 4 ways to bring games to your classroom. Top Hat. https://tophat.com/blog/gamification-education-class/

[7] Molumby, M. J. (2016). Effects of gamification on motivation and engagement in secondary curriculum. [Master's thesis, University of Northern Iowa]. Graduate Research Papers. https://scholarworks.uni.edu/grp/627

[8] Haiken, M. (2020, February 12). Five ways to gamify your classroom. International Society for Technology in Education (ISTE) Blog. Retrieved February 25, 2021, from https://www.iste.org/explore/In-the-classroom/5-ways-to-gamify-your-classroom

[9] Ortiz, M., Chiluiza, K., & Valcke, M. (2016). Gamification in higher education and stem: a systematic review of literature. EDULEARN16 Proceedings, pp 6548-6558. https://doi.org/10.21125/edulearn.2016.0422

[10] Rose, J. (2015). The gamification of Physics education: A controlled study of the effect on motivation of first year life Science students.

[11] Laremenko, N. (2017). Enhancing English language learners' motivation through online games. Information Technologies and Learning Tools, 59, 126–133. https://doi.org/10.33407/itlt.v59i3.1606

[12] Hung, H.-T. (2017). Clickers in the flipped classroom: bring your own device (byod) to promote student learning. Interactive Learning Environments, 25(8), 983–995. https://doi.org/10.1080/10494820.2016.1240090

[13] Rose, J., Meara, J., Gerhardt, T., & Williams, M. (2016). Gamification: using elements of video games to improve engagement in an undergraduate physics class. Physics Education. 51. 055007. 10.1088/0031-9120/51/5/055007.

[14] Sun-Lin, H., & Chiou, G. (2019). Effects of gamified comparison on sixth graders' Algebra word problem solving and learning attitude. Journal of Educational Technology & Society, 22(1), 120-130. Retrieved February 25, 2021, from https://www.jstor.org/stable/26558833

[15] Hasegawa, T., Koshino, M., & Ban, H. (2015). An English vocabulary learning support system for the learner's sustainable motivation. Springer Plus: Innovative Cloud Application in Computer Intelligence, 4(99). doi: 10.1186/s40064-015-0792-2.

[16] Sanmugam, M., Abdullah, Z., Mohamed, H., Aris, B., Zaid, N. M., & Suhadi, S. M. (2016, May). The affiliation between student achievement and elements of Gamification in learning science. In 2016 4th International Conference on Information and Communication Technology (ICoICT). 1–4. IEEE. doi: 10.1109/ICoICT.2016.7571962

[17] Tolentino, A., Roleda, L., & Prudente, M. (2018). Gamified instruction and its effects to student motivation and achievement in science.

[18] Samortin, Mina (2020). Effects of gamified learning activities in enhancing junior high school students' English vocabulary retention. Asian Journal on Perspective in Education. 1(1) Retrieved from FEU Institute of Education https://www.feu.edu.ph/index.php/institutes/institute-of-education/asian-journal-on-perspectives-in-education/ajpe-volume-1-issue-1/effects-of-gamified-learning-activities-in-enhancing-junior-high-school-students-english-vocabulary-retention/

[19] Lanuza, M. H. (2020). Integrative gamification technique in teaching specialization courses in mathematics. International Journal of Science and Technology Research, 9(4), 1275-1281.

[20] Yildirim, I. & Sen, S. (2019). The effects of gamification on students' academic achievement: a meta-analysis study. Interactive Learning Environments, 1-18. 10.1080/10494820.2019.1636089.

[21] Tapia, M. & Marsh, G. E. (2004). An instrument to measure mathematics attitudes. Academic Exchange Quarterly, 8(2), 16-21.

[22] Lim, S.Y., & Chapman, E. (2013). Development of a short form of the attitudes toward mathematics inventory. Educational Studies in Mathematics, 82 145-164. https://doi.org/10.1007/s10649-012-9414-x

[23] Majeed, A. A., Darmawan, I. G. N. & Lynch, P. (2013). A Confirmatory Factor Analysis of Attitudes toward Mathematics Inventory (ATMI). The Mathematics Educator, 15(1) 121-135.

[24] Khine, M. S. & Afari, E. (2014). Psychometric properties of an inventory to determine the factor that affect students' attitudes towards mathematics. Psychology, Society and Education, 6(1) 1-15.

[25] Realyvásquez-Vargas, A., Maldonado-Macías, A. A., Arredondo-Soto, K. C., Baez-Lopez, Y., Carrillo-Gutiérrez, T., & Hernández-Escobedo, G. (2020). The impact of environmental factors on academic performance of university students taking online classes during the covid-19 pandemic in Mexico. Sustainability, 12(21), 9194. https://doi.org/10.3390/su12219194

[26] Mekler, E., Brühlmann, F., Tuch, A., & Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. Computers in Human Behavior, 71, 525–534. https://doi.org/10.1016/j.chb.2015.08.048

[27] Sousa Lima, M. A., Monteiro, A. C., Melo Leite, A. J. Jr., de Andrade Matos, I. S., Alexandre, F. S. O., Nobre, D. J., et al. (2019). Game-based application for helping students review chemical nomenclature in a fun way. J. Chem. Educ. 96, 801–805. doi: 10.1021/acs.jchemed.8b00540