Unleashing the Powers of Gamification on Students' Performance and Engagement in Mathematics

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ABSTRACT

Gamification is the utilization of game elements in a non-game context, has been gaining popularity as a strategy to enhance student performance and engagement in the classroom. This study investigated the effects of gamification on the academic performance and engagement of Grade 10 students in mathematics using a matching-only pre-test post-test control group quasi-experimental research design where pretest scores and average quarter grades in Mathematics subject were the basis of pair matching. An adapted mathematical engagement checklist and a validated researcher-made multiple-choice-type test on permutations and combinations were used as data collection instruments. A validated researcher-made gamified instruction module on permutations and combinations was used as the intervention material in the experimental group. The results revealed that both groups were at beginning level and very engaged in mathematics at the beginning of the intervention showing no significant differences between them. The post-test mathematics performance of the control group was at a developing level while the experimental group was at a beginning level. A significant difference existed between the post-test performances of the two groups. Both groups showed a significant increase in their mathematics performance before and after the intervention. However, only the experimental group showed a significant increase in their engagement after the intervention. A statistical difference was observed in both performance and engagement in mathematics, favoring the experimental group. Hence, gamified instruction is more effective than the conventional instruction in enhancing the performance and engagement of students in mathematics. This study recommends the use of gamified instruction in teaching mathematics.

Keywords*:* Mathematics instruction, teaching strategy, innovation, contextualization, involvement, funware

INTRODUCTION

Mathematics is one of the core subjects that is difficult to understand by many students due to their innate cognitive abilities, problem solving processes and procedures, and external factors including instructional strategies and materials (Waswa & Al-kassab, 2023). For many students, learning math can be challenging, boring, and intimidating. The traditional methods of teaching mathematics, such as lectures and rote memorization, may not be engaging enough for students leading them to perform poorly in the subject (Jameel & Ali, 2016). Educators need to find innovative and effective ways to make learning math more fun and engaging (Rijal, 2020).

Gamification as an Education Approach

Gamification is considered a relatively new approach in education (Dichev & Dicheva, 2017) and is defined as the process of applying game dynamics, psychology, and mechanics to situations and applications that are not

games (Rozman & Donath, 2019). This can be achieved with or without the use of technology. The highly engaging nature of gamification is one of the reasons why there is a growing interest in it in worldwide education (Early, 2023). Studies have repeatedly shown that driven and actively participating learners outperformed the less motivated ones in the classroom (see Fan & Wolters, 2014; Hung et al., 2014; Yildirim, 2017; Putwain et

al., 2018; Zabala, 2018; Lazuna, 2020; Karamert & Vardar, 2021; Manzano-Leon et al., 2021; Molano, 2022). Buljan (2021) asserted that gamification has many advantages over traditional learning approaches, including increasing learner motivation levels, improving knowledge retention, and better learner engagement through social mechanisms like badges, points, or leaderboards. It also provides students with a sense of achievement and reward.

Gamification enhanced attitudes, increased motivation and engagement levels, and improved academic performance (Chans & Castro, 2021). It was found to be an effective approach in enhancing the behavioral and cognitive engagement of the undergraduate students and a useful technique for encouraging people to engage with educational systems (Hung et al., 2014).

Debates on Gamification's Effectiveness

Studies indicated that gamification improves motivation and engagement (Watson-Huggins, 2018; Kimble, 2020). However, it did not always lead to better retention of concepts or sustained academic improvement (Lim, 2021). Some researchers argued that it enhanced critical, analytical and creative thinking skills, while others suggested that students may became motivated by competition rather than comprehension (Toda et al., 2018; Molano, 2022). These contradictory findings are attributable to poor game design, which closely correlates with the identified unfavorable outcomes (Toda et al., 2018). Dichev & Dicheva (2017) asserted that gamification can motivate students if designed and implemented properly as failure to do so may only make the learning process fun but with no gained learnings. Students tend to perform better academically if game mechanics aligned with learning objectives (Kimble, 2020). However, the benefits may short-lived if gamification emphasizes more on rewards rather than meaningful learning, particularly when students engage with game mechanics but fail to retain key mathematical concepts (Toda et al., 2018).

Despite the extensive research on gamification, the existing studies often focus on its effect on engagement rather than on the measurable academic improvements (Ortiz-Rojas et al., 2017). Most studies examine its general impact which leaves a gap in understanding how structured gamification modules improve performance (Molano, 2022). Additionally, gamification has been widely explored in technology-driven education, especially during the pandemic, it's role in traditional classroom instruction remains underexamined (Antonio & Tamban, 2022).

Gamification in the Philippines

The need for innovative teaching strategies in Philippine mathematics education is underscored by the achievement gap in mathematics among high school learners in the Philippines as revealed in the international assessments, such as the 2018 Programme for International Student Assessment (PISA) (Organization for Economic Cooperation and Development [OECD], 2019), 2019 Trends in International Mathematics and Science Study (TIMSS) (International Energy Agency, 2021), and in the most recent, 2022 PISA (OECD, 2023), where the country ranked at the bottom among the participating countries. These low rankings, however, have been one of the undying problems faced by the country. Filipino students face difficulties in mathematics which emphasize the need for alternative instructional approaches to improve their conceptual understanding and problem-solving abilities (Lazuna, 2020; Lim, 2021). While gamification has gained global attention, there is limited research on its effectiveness in Philippine secondary mathematics classrooms (Molano, 2022). This study sought to fill that gap by investigating whether gamification can enhance both engagement and performance in mathematics among Filipino students. By providing empirical evidence, this study aimed to contribute to the ongoing discourse on instructional innovation and support future improvements in the education system of the Philippines.

To find out the effects of gamification on performance and engagement in mathematics of Grade 10 students, the following questions would be answered:

1. What are the pre-test and post-test performances in mathematics of the students in the experimental and control groups?
2. What are the levels of engagement of the students in mathematics in the experimental and control groups before and after the intervention?

3. Are there significant differences between the experimental and control groups' pre-test and post-test performances in mathematics?
4. Are there significant differences between the experimental and control groups' engagements in mathematics before and after the intervention?
5. Are there significant differences between the pre-test and post-test performances in mathematics of the students in the experimental and control groups?
6. Are there significant differences between the engagements in mathematics of the students before and after the intervention in the experimental and control groups?

METHODOLOGY

Research Design

This study was conducted using a quasi-experimental design, specifically the matching-only pretest-posttest control group design to determine the effects of gamification on Grade 10 students' performance and engagement in mathematics. Quasi-experimental research design investigates the cause-and-effect relationship between an intervention and an outcome for a target population without randomly assigning subjects to a group (Maciejewski, 2020). The study used matching only as a technique where subjects in the experimental group were mechanically matched to those in the control group on certain variables which does not necessarily give assurance that subjects of both groups are equivalent of each other. In this study, the experimental and control groups were mechanically paired using their average grades in the first and second grading in mathematics subject and their pre-test scores. Only those who had equal average grades and pre-test scores were paired and included in this study.

Sample Size and Sampling Procedure

A purposive sampling technique was used in selecting the participants of experimental and control groups to ensure that the sample met the specific criteria required for the intervention. However, while random sampling technique, specifically the lottery method, was used to assign the two Grade 10 sections from two regular class sections as experimental and control groups, the sampling approach has limitations. The average of their 1st and 2nd quarter grades in mathematics and their pre-test scores were used as basis in mechanically matching the participants in the two groups. There were 22 pairs of participants with matching average of grades and pre-test scores. Although this ensured the comparability between experimental and control groups, the sample size remained relatively small which potentially limits the generalizability of findings beyond the selected population. The pre-determined samples were not informed that they will undergo the intervention to ensure the validity of the result.

This study followed institutional ethical guidelines for conducting research with human participants to ensure ethical compliance. All stakeholders, including school administrator, teachers, and parents, were informed of the study's objectives, methods and potential implications prior to data collection. Informed consent was obtained from participants and their guardians before the study was conducted through written consent forms. Additionally, the identity and personal data of all participants were protected by replacing identifiable information such as names with anonymous codes to ensure confidentiality throughout the conduct of the study.

Research Instrument

This study utilized three instruments for the pre-intervention stage, treatment stage, and post-intervention stage. The first instrument was a researcher-made module that covered the following topics: Permutations and Combinations. This was used during the treatment stage of the experimental group as the introduced intervention of the researcher who conducted the classroom instructions while the prepared DepEd learning module was used by the same researcher during the conventional instruction of the control group. The second instrument was a researcher-made 35-item multiple-choice test that measured the participants' knowledge about the concept of Permutation and Combination. This was used to determine the mathematics performance of the participants before and after the intervention. The third instrument was 30-item modified checklists by Magalona (2022) with a 5-point Likert scale (5 stands for strongly agree, 4 for agree, 3 for undecided/neutral, 2 for disagree, and 1 for

strongly disagree) to evaluate the participants' mathematical engagement for both experimental and control groups. The items in the checklist were divided into three categories of engagement namely the cognitive engagement (10 items); the behavioral engagement (10 items); and the affective engagement (10 items). The researcher-made module, mathematics performance test, and mathematical engagement checklists were submitted for content validations to the group of experts that possessed the following criteria: (a) completion of a bachelor's degree in mathematics education; (b) possession of a master's or doctorate degree in mathematics education; (c) have at least five years of mathematics teaching experience; and (d) current employment as a mathematics instructor/teacher. The suggestions and feedback of the validators were carefully considered and integrated into the final drafts. After the instruments were refined, a pilot test involving 150 Grade 11 students from two secondary schools in Capiz was conducted to assess their real-world functionality. Cronbach's alpha and KR-20 coefficients were calculated to ensure instruments' reliability. The engagement checklists yielded a Cronbach's alpha of 0.942, indicating that all items were measuring the same construct which was the engagement. Similarly, the mathematics performance test produced a KR-20 coefficient of 0.859, suggesting the items adequately measured the specified constructs.

Data Analysis Procedure

After the evaluation of the participants' responses on the given instruments, the data gathered were subjected to the data processing procedure for organization, presentation, and statistical treatment to analyze and interpret the results obtained. The statistical calculations were carried out using the Statistical Package for Social Sciences (SPSS) software. Mean, median, mean percentage score, and standard deviation were used in the descriptive analyses while Mann-Whitney U and Wilcoxon - Signed Rank tests set at 0.05 alpha level of significance were used in the inferential analyses.

RESULTS AND DISCUSSION

Pre-test and Post-test Performances in Mathematics of Experimental and Control Groups

The pre-test and post-test performances in mathematics of experimental and control groups is shown in Table 1. Results revealed that the pre-test performances of the experimental (M = 10.09, MPS = 28.83, SD = 2.07) and of the control (M = 9.32, MPS = 26.62, SD = 2.40) groups in mathematics were at the beginning level. These suggests that the students in both groups have not yet obtained the necessary foundational knowledge and abilities about the topics at hand, particularly in the Permutation and Combination. The students' struggle to grasp complex mathematical concepts might stem from their limited opportunity to delve deeply into these topics, which is understandable given that these subjects have not been thoroughly introduced to them yet. The results of the study align with the findings of Antonio & Tamban (2022). Both the experimental and control groups exhibited pre-test performance levels that fall below average. This is further supported by the pre-test scores, where neither group demonstrated strong proficiency in the topic being measured. These pre-test results indicate that both groups entered the study with similar levels of knowledge or skill regarding the topic.

On the other hand, the post-test performance of the experimental group was at the developing level (M = 26.68, MPS = 76.23, SD = 5.90). This means that students have the bare minimum of knowledge, abilities, and basic understanding but require assistance in completing authentic activities. This implies that students should be fostered with a supportive learning environment that boosts self-efficacy to empower them to overcome obstacles and pursue continual progress. Meanwhile, the control group post-test performance was still at the beginning level (M = 22.55, MPS = 64.43, SD = 6.65). This means that the students in the control group have not yet obtained fully the necessary foundational knowledge and abilities about the topics at hand, particularly in the Permutation and Combination. Their difficulty in understanding the involved math concepts may have influenced by the teaching strategy used during the teaching and learning process of the topics involved as well as the capability of the learners to understand the topic in a given amount of time. These results support the finding of Khaleel et al. (2020) and Antonio & Tamban (2022) who found out that the students in the experimental and control groups have improved their mathematics performance after the conduct of the study. However, the students from the experimental group who were exposed to gamification obtained a higher post-test result than the students from the control group. This indicated that students' knowledge has increased after the gamification intervention.

Test of Differences in the Pre-test and Post-test Performances in Mathematics Between the Experimental and Control Groups

The results of the test of differences in the pre-test and post-test performances between the experimental and control groups is shown in Table 2. The result revealed no significant difference in the pre-test scores between experimental group (*Md* = 10.00, *Mean rank* = 24.07, *n* = 22) and control group (*Md* = 9.50, *Mean rank* = 20.93, *n* = 22), *u* = 207.50, *p* = .412. This means that the pre-test scores of the two groups are the same or they performed equally in the pre-test. In essence, the pre-test mathematics performances of the two groups are comparable, suggesting that there is no apparent threat to the internal validity in terms of selection, as both groups started from a similar baseline level of mathematical proficiency. The homogeneity of the students from the two groups, such as similarity in prior academic achievement, may have reduced the likelihood of significant differences in pre-test scores between the groups. This supports the findings of the study by Ozturk & Korkmaz (2020) which also showed no significant difference between the students in experimental and control groups in terms of their academic success which suggests a comparable distribution of student performance across both groups.

Meanwhile, the result of the test of difference in the post-test performances between the experimental and control groups revealed a significant difference in the post-test scores for experimental group (*Md* = 28.00, *Mean rank* = 26.41, *n* = 22) and control group (*Md* = 22.50, *Mean rank* = 18.59, *n* = 22), *u* = 156.00, *p* = .043. Considering the mean ranks, it is understood that the post-test performance of the experimental group is higher than the post-test performance of the control group. This finding implies that gamification technique is more effective than the conventional one and can be incorporated into mathematics instruction to improve student performance. The effectiveness of gamification emphasizes how crucial it is to match curricular objectives and goals with dynamic, engaging teaching strategies in order to make the students be actively involved in the learning process. The current study's findings align with previous research by Zabala (2018), Molano (2022), and Antonio & Tamban (2022). These studies all demonstrated that gamification significantly boosted student performance in mathematics. This suggests that gamification not only fosters a strong interest and ability to grasp concepts, but also enables students to apply their understanding to real-life problems.

Table 1 Pre-test and Post-test Performances in Mathematics

Groups	*N*	Mean (*M)*	Mean Percentage Score (*MPS)*	Standard Deviation (*SD)*	Verbal Interpretation
Pre-test Performances					
Experimental	22	10.09	28.83	2.07	Beginning
Control	22	9.32	26.62	2.40	Beginning
Post-test Performances					
Experimental	22	26.68	76.23	5.90	Developing
Control	22	22.55	64.43	6.65	Beginning

Note. Interpretation is based on the scale: 74% and below (Beginning), 75% - 79% (Developing), 80% - 84% (Approaching Proficiency), 85% - 89% (Proficient), and 90% and above (Advanced)

Table 2 Differences in the Pre-test and Post-test Performances in Mathematics

Groups	*N*	Median (*Md)*	*Mean rank*	*U*	*p*-value
Pre-test Performances					
Experimental	22	10.00	24.07	207.50^{ns}	.412

Control	22	9.50	20.93		
Post-test Performances					.043
Experimental	22	28.00	26.41	156.00*	
Control	22	22.50	18.59		

Note. *Significant at 0.05

Engagement in Mathematics of the Participants in the Experimental and Control Groups Before and After the Intervention

Presented in Table 3 is the engagement in mathematics of the participants in experimental and control groups before and after the intervention. The results revealed that the engagement in mathematics before the intervention of the experimental group was moderate (M = 3.48, SD = 0.74). This means that the students display consistent interest and proficiency in understanding mathematical concepts. They consistently participate, show persistent effort and focus, and listen attentively during instruction and tasks. They display positive attitude and confidence with enthusiasm when engaged in mathematical tasks. However, the control group was very engaged in mathematics before the intervention (M = 3.78, SD = 0.44). This means that the students show a high level of interest and proficiency in understanding mathematical concepts. They actively participate, show persistent effort and focus, and listen attentively with a desire to solve problems. They always display positive attitudes, confidence and enthusiasm with optimism and perseverance when engaged in mathematical tasks. This suggests that students assigned to the control group are likely to exhibit improved performance in mathematics and maintain their interest in the subject even beyond the classroom environment. Additionally, they may develop a stronger sense of confidence in their mathematical abilities, which could motivate them to tackle more complex mathematical problems and challenges with greater enthusiasm and determination.

On the other hand, the students in the experimental (M = 3.95, SD = 0.51) and in the control (M = 3.69, SD = 0.47) groups after the intervention were both very engaged. These results indicate that students in both groups show a high level of interest and proficiency in understanding mathematical concepts after the conduct of the study. They actively participate, show persistent effort and focus, and listen attentively with a desire to solve problems. They always display positive attitudes, confidence and enthusiasm with optimism and perseverance when engaged in mathematical tasks. Furthermore, the students in both groups may have benefited from the teaching methods used during the learning process, although they were exposed to two different teaching methods. This suggests that both groups have a higher chance in excelling and continue to be interested in the subject even beyond the classroom. However, it is evident that the experimental group has a higher mean than the control group implying that the experimental group is somewhat more engaged than the control group but this is to be confirmed in the test of difference. These results support the findings of Ab Ghani, et al. (2022) emphasizing that better student engagement is possible when a course was delivered through gamification. Students who took part in the study view their experience positively. Similarly, the findings of this study conform Solekhah, et al. (2023) results stating that gamification in mathematics could highly increase the engagement of the students and despite of students' lack of mechanical skill, the students who won in the game were satisfied and the unsuccessful players wanted to play again to increase their scores.

Table 3 Engagements in Mathematics Before and After the Intervention

Group	*N*	Mean *(M)*	Standard Deviation *(SD)*	Verbal Interpretation
Before the Intervention				
Experimental Group	22	3.48	0.74	Moderately Engaged
Control Group	22	3.78	0.44	Very Engaged

Experimental Group	22	3.95	0.51	Very Engaged
Control Group	22	3.69	0.47	Very Engaged

Note. Interpretation is based on the scale: 4.50 – 5.00 (Extremely Engaged), 3.50 – 4.49 (Very Engaged), 2.50 – 3.49 (Moderately Engaged), 1.50 – 2.49 (Engaged), 1.00 – 1.49 (Somewhat Engaged)

Differences in the Engagements of Students in Mathematics Between the Experimental and Control Groups Before and After the Intervention

The result of the test of difference in the engagement in mathematics between the experimental and control groups is shown in Table 4. The result revealed no significant difference in the engagement between experimental (*Md* = 3.59, *Mean rank* = 19.91, *n* = 22) and control (*Md* = 3.80, *Mean rank* = 25.09, *n* = 22) groups, *U* = 185.00, *p* = .181. This means that despite having different levels of engagement with the control group with a level higher than the experimental group, the two groups' levels of engagement are comparable, indicating no potential threat to the internal validity in terms of selection. The reliability of the study findings is increased by this baseline equivalency. This supports the finding of the study by Hung et al. (2014). In their study, it was found that there was no significant difference between the engagement ratings of the experimental and control groups before the intervention.

Furthermore, the result revealed a significant difference in the engagement for experimental (*Md* = 4.02, *Mean rank* = 26.41, *n* = 22) and control (*Md* = 3.74, *Mean rank* = 18.59, *n* = 22) groups, *u* = 156.00, *p* = .043. Given the mean ranks, it is clear that the experimental group has a higher engagement than the control group. The intervention conducted for the experimental group may have successfully enhanced their engagement with the subject matter and made the subject more relevant and engaging to the students. This finding strongly proves that the intervention is effective in increasing student engagement. This shows the potential for gamification to improve learning experiences and outcomes in educational settings more particularly in Mathematics subject. This implies the need for a pedagogical shift toward more innovative and student-centered learning techniques that incorporate gamified elements with proper implementation and context. This finding supports the conclusions of Chans & Castro (2021) and Bouchrika et al. (2019) who found that gamification is an effective strategy in increasing motivation and engagement of the student. This is also in line with the findings of Ortiz-Rojas et al. (2017) who found a significant improvement in engagement of the students from the treatment group that considered.

Differences in the Pre-test and Post-test Performances in Mathematics of the Experimental and Control Groups

The results of the test of differences in the pre-test and post-test performances in mathematics of the experimental and control groups are shown in Table 5. The result revealed a high significant difference in the pre-test (*Md* = 10.00, *n* = 22) and post-test (*Md* = 28.00, *n* = 22) scores for experimental group, *z* = -4.115, *p* <.001. Similarly, a high significant difference also exists in the pre-test (*Md* = 9.50, *n* = 22) and post-test (*Md* = 22.50, *n* = 22) scores for control group, *z* = -4.060, *p* <.001. This means that the performances of the students in the control and experimental groups in mathematics have improved after the instruction of the Permutation and Combination topic. While both the gamified and non-gamified approaches demonstrably improved student performance in mathematics, the post-test results suggest that the gamified approach may have been more effective in enhancing student achievement.

Differences in the Engagement in Mathematics Before and After the Intervention of the Experimental and Control Groups

The result of the test of difference in the engagement in mathematics before and after the intervention of the experimental group is shown in Table 6. The result revealed a significant difference in the engagement in mathematics before (*Md* = 3.59, *n* = 22) and after (*Md* = 4.02, *N* = 22) the intervention of the experimental group, *z* = -2.365, *p* = .018. However, Table 6 shows no significant difference exists in the engagement in mathematics before (*Md* = 3.80, *n* = 22) and after (*Md* = 3.74, *n* = 22) the conventional instruction using the

DepEd module for the control group, z = -0,617, p = .537. This means that only the engagement in mathematics of the students in the experimental group has improved. This also means that only the gamification approach is effective in increasing the engagement of the students in mathematics.

Table 4 Differences in the Engagement in Mathematics Before and After the Intervention

Groups	*N*	Median *(Md)*	*Mean rank*	*U*	*p*-value
Before the Intervention					
Experimental Group	22	3.59	19.91	185.00^{ns}	.181
Control Group	22	3.80	25.09		
After the Intervention					
Experimental Group	22	4.02	26.41	156.00*	.043
Control Group	22	3.74	18.59		

Note. *Significant at 0.05

Table 5 Differences in the Pre-test and Post-test Performances in Mathematics

Variable	Ranks	N	Median (Md)	Mean Rank	Z	p-value
Control						
Pre-test	Negative Ranks	1	9.50	1.50	-4.060*	< .001
Post-test	Positive Ranks	21	22.50	11.98		
	Ties	0				
Experimental						
Pre-test	Negative Ranks	0	10.00	0.00	-4.115*	< .001
Post-test	Positive Ranks	22	28.00	11.50		
	Ties	0				

Note. *Significant at 0.05

Table 6 Difference in the Engagement in Mathematics Before and After the Intervention

Variable	*Ranks*	*N*	Median (*Md*)	*Mean Rank*	*Z*	*p*-value
Experimental Group						
Before	Negative Ranks	7	3.59	6.79	-2.365*	.018
After	Positive Ranks	14	4.02	13.11		
	Ties	0				
Control Group						
Before	Negative Ranks	14	3.80	10.39	-0.617	.537
After	Positive Ranks	8	3.74	13.44		
	Ties	0				

Note. *Significant at 0.05

Mean Gain of Students in Mathematics Performance of the Control and Experimental Groups

Table 7 showed the mean gain of the control and experimental groups in their Mathematics performance. It was found out that the experimental group obtained higher mean gain (16.59) than the control group (13.23). A notable mean gain difference (3.36) implies that gamification is more effective than the conventional approach in improving student's performance in Mathematics. This implies that gamification is more effective than the conventional instruction in significantly improving student's performance.

Table 7 Mean Gain in Mathematics Performance

Groups	N	Mean (*M*)		Mean Gain
Performance		Pre-test	Post-test	
Control	22	9.32	22.55	13.23
Experimental	22	10.09	26.68	16.59

CONCLUSIONS

Before the implementation of the intervention, students in both the experimental and control groups have not yet obtained the necessary foundational knowledge and abilities about the topics at hand, particularly in Permutation and Combination. They struggle with their understanding of the topics involved. The pre-test performances of the experimental and control groups are comparable, which rules out the possibility of having potential threat to the internal validity in terms of selection. Hence, this helps the study findings become more reliable. Before the conduct of the intervention, the students in the experimental group displayed consistent interest and proficiency in understanding mathematical concepts, while to that of control group showed a high level of interest and proficiency in understanding mathematical concepts. Despite having different engagement before the intervention was implemented, the engagement of the experimental and control groups was still comparable. This baseline equivalence rules out the threat to internal validity in terms of selection and increases the reliability of the study findings.

After the intervention, the students in the experimental group possessed the minimum knowledge and skills and core understanding but still need help throughout the performance of authentic tasks. Meanwhile, the students in the control group have not yet fully obtained the necessary foundational knowledge needed to understand the topics at hand. Gamification is an effective approach than the conventional method in enhancing student performance. This highlights the importance of aligning the curriculum goals and learning objectives with engaging and interactive instructional approaches, especially gamification to ensure that students are actively involved in the learning process. Furthermore, students in both the experimental and control group show a high level of interest and proficiency in understanding mathematical concepts after the implementation of the intervention. They actively participate, show persistent effort and focus, and listen attentively with a desire to solve problems. They also always display positive attitudes, confidence and enthusiasm with optimism and perseverance when engaged in mathematical tasks. Gamification successfully increases the engagement of the experimental group, which means that it is more effective than the usual approach of teaching. This underscores the potential of gamification to enhance learning experiences and outcomes in educational settings. Both the gamification and conventional approaches have improved the performance in mathematics of the students in the experimental and control groups, which means that both approaches are effective. Only the experimental group has successfully increased their engagement in mathematics. This means that only the gamification approach is effective in increasing the engagement in mathematics of the students.

RECOMMENDATIONS

Educators may use the gamification as teaching approach as it effectively increased the performance and engagement of the learners. The researchers-made module consisting the incorporation of gamification in the teaching and learning process can be further enhanced and be used as basis in developing gamification-based modules of other topics in mathematics. Similar quasi-experimental study may be conducted in the future but

with the focus on the learners with low engagement in mathematics and with different mathematical concept being covered in the module. A more extensive investigation covering a wider scope with expanded sample size that applies stratified or cluster sampling, such as division level might be taken into consideration to include students from diverse academic backgrounds and varied classroom settings. Moreover, similar topic may be investigated through various longitudinal designs to assess the sustained impact of gamification on engagement and performance across different grade levels. Curriculum planners and developers may include the gamification as teaching approach in developing a curriculum, especially when enhancing the teaching strategies teachers. School administrators may initiate a training in gamification that will address the poor mathematics performance of the students. It would also guide them in improving facilities needed in utilizing math games and game elements as it was found effective.

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