JOURNAL OF INTERDISCIPLINARY PERSPECTIVES

ISSN Print: 2984-8288, ISSN Online: 2984-8385
Vol. 2, No. 12, pp. 6-15, December 2024

Gamified Learning in Selected Business Mathematics Topics: A Mixed Methods Approach

Cherry Ann S. Dueñas*[1], Marichou L. Carreon[2]
[1]Nug-as National High School, Alcoy, Cebu, Philippines
[2]Cebu Technological University - Argao Campus, Argao, Cebu, Philippines

*Corresponding Author Email: cherryannduenas2017@gmail.com

Date received: September 23, 2024
Date revised: October 8, 2024
Date accepted: October 25, 2024

Originality: 85%
Grammarly Score: 99%
Similarity: 15%

Recommended citation:
Duenas, C.A., & Carreon, M. (2024). Gamified learning in selected Business Mathematics topics: A mixed methods approach. *Journal of Interdisciplinary Perspectives*, 2(12), 6-15. https://doi.org/10.69569/jip.2024.0520

Abstract. In the 21st century, numerical and problem-solving skills are crucial, yet many Filipino students struggle in these areas, prompting the need for effective educational interventions. Gamification, integrating game design elements into learning, has shown a potential to enhance student engagement and skills, although previous research provides mixed results. This study aimed to explore the effects of online gamification in teaching mathematics to Grade 12 Filipino students, focusing on its benefits and challenges. Using a mixed-method convergent design, the study involved 94 students who were assessed through pre-test and post-test evaluations. Z-tests, paired t-tests, and t-tests for two independent samples were used to measure performance changes. Interviews were conducted and analyzed through Miles and Huberman's Thematic Framework to understand students' experiences. Findings revealed that the experimental group, which used online gamification, showed significantly more improvement in pre-and post-test scores than the control group. However, post-test performance levels between both groups were similar, indicating that gamification is as effective as traditional teaching methods in the long term. Despite challenges such as connectivity issues and limited computer skills, students reported positive experiences with gamification, including increased enjoyment, enhanced motivation, personalized progression, and reduced pressure. The study underscores that while online gamification can boost student engagement and initial learning outcomes, its effectiveness is comparable to traditional methods over time. To optimize its benefits, improvements in digital infrastructure, more platform options, and enhanced computer literacy training are recommended. Overall, online gamification holds promise as a valuable educational tool, particularly for initial learning phases.

Keywords: Online gamification; Numeracy; Problem-solving skills; Mixed-method; Convergent.

1.0 Introduction

In the 21st century, numerical and problem-solving skills have become indispensable for individuals to thrive in an increasingly complex and data-driven world. These competencies are critical in everyday life and fundamental to driving scientific, technological, and economic advancements. The global shift towards industries reliant on technology and data has heightened the demand for a workforce proficient in these areas. Unfortunately, Filipino students have consistently lagged behind their global peers in mathematics and problem-solving, signaling a significant challenge within the Philippine education system. The 2022 PISA report, which places the Philippines below the OECD average in Mathematics, reveals a severe deficiency in the ability of students to apply theoretical knowledge to practical, real-world scenarios (Chi, 2023). Furthermore, the 2019 TIMSS results ranked the Philippines' performance in mathematics as the lowest among participating nations, raising alarms about the country's education state (Mullis et al., 2020).

The urgency of addressing this gap cannot be overstated. With global industries rapidly evolving, Filipino students risk being left further behind, limiting their opportunities in an increasingly competitive world. Immediate, innovative interventions are needed to raise performance in mathematics and equip students with the problem-solving skills crucial for navigating the modern world. One promising approach that has emerged in recent years to address these educational challenges is gamification.

Gamification is applying game design elements, such as points, leaderboards, badges, and interactive tasks, in non-game contexts to enhance user engagement and motivation (Lister, 2015). In education, gamification transforms traditional learning environments into more dynamic, interactive spaces that can mimic the engagement seen in video games. Platforms like Kahoot, Quizizz, and Classpoint have integrated these elements to foster a competitive yet enjoyable learning experience. These platforms make quizzes more interactive, encouraging students to solve problems quickly and efficiently. ClassDojo, which incorporates gamification for behavior management, has also shown the potential to improve students' engagement with numeracy skills. Gamification provides students immediate feedback, a sense of progression, and a playful environment that contrasts conventional teaching methods. While gamification has been lauded for enhancing student motivation and engagement, its effectiveness in developing higher-order thinking skills, such as critical thinking and problem-solving, remains under-researched, particularly in the context of the Philippines.

The existing literature on gamification presents optimistic and cautious perspectives on its efficacy in education. On one hand, numerous studies have shown that gamification can significantly enhance students' motivation, engagement, and learning outcomes. Research by Perttula and Tuomi (2017) highlights how gamified learning environments can promote active learning and collaboration, fostering the development of critical thinking and problem-solving skills. Similarly, Turan, Avinc, Kara, and Goktas (2016) found that gamification enhances student engagement and enjoyment, encouraging a more interactive and participatory learning experience. Including game elements has increased student satisfaction and improved academic performance across various subjects (Hamari et al., 2014). Additionally, gamification can make learning more personalized, allowing students to progress at their own pace while receiving instant feedback on their performance (Abramovich et al., 2013). However, while the positive effects of gamification are well-documented, there are still gaps in understanding how these benefits translate specifically into improved numeracy and problem-solving skills, especially for Filipino students.

On the other hand, several concerns have been raised regarding integrating gamification into educational contexts. Critics argue that overemphasizing extrinsic rewards, such as badges and points, may undermine intrinsic motivation, shifting students' focus from mastering the subject to merely accumulating rewards (Kapp, 2012). This shift could detract from deeper learning and critical thinking, as students might prioritize quick wins over genuine understanding. Moreover, gamified environments can sometimes become distractions, with students becoming more engaged in the competitive aspects of the game rather than the educational content itself (Tondello et al., 2017). Another challenge is that not all students may engage with gamification equally, potentially leading to disparities in learning outcomes. Deterding et al. (2011) caution that gamification may inadvertently exclude less competitive students or lack access to reliable technology, further widening the educational gap. Additionally, prolonged exposure to gamified tasks without proper oversight could result in students focusing more on the game than the academic objectives, possibly leading to a decline in performance (Gentile et al., 2017). These concerns highlight the importance of balancing the benefits of gamification with the potential risks, ensuring that its integration supports meaningful learning rather than superficial engagement.

Despite these contrasting views, a gap exists in understanding how gamification specifically impacts the development of numeracy and problem-solving skills, particularly in the Philippines, where educational challenges are compounded by issues such as limited resources, unequal access to technology, and varying levels of computer literacy. To address this gap, this study investigates the effects of online gamification on students' numeracy and problem-solving skills. By focusing on these specific competencies, the research aims to contribute to a more nuanced understanding of gamification's potential benefits and drawbacks in education. The study also seeks to provide evidence on how gamification can be effectively implemented in Philippine classrooms to improve student engagement and learning outcomes. Furthermore, the research hopes to reconcile the conflicting perspectives on gamification by offering insights into how it can be optimized to enhance educational experiences

without compromising deeper learning objectives. By addressing both the advantages and limitations of gamification, this study aims to inform educators, policymakers, and researchers about leveraging this approach to address the country's persistent educational challenges.

2.0 Methodology

2.1 Research Design

This study employed a mixed-method convergent design to investigate the impact of online gamification on students' numeracy and problem-solving skills over one month. A mixed-method design integrates quantitative and qualitative approaches, providing a fuller understanding of the research problem. In a convergent design, quantitative and qualitative data are collected simultaneously and then analyzed separately, with the findings compared and integrated to form a comprehensive understanding of the phenomenon. This approach allowed the statistical evidence of students' performance to be complemented by qualitative insights into their experiences and perceptions, offering a more holistic view of how gamification influenced their engagement and skill development.

2.2 Research Locale

The study is conducted at Nug-as National High School, located in the remote barangay of Nug-as in Alcoy, Cebu, Philippines. This school, approximately 14 kilometers from the town center, serves as a critical educational institution for students in this rural area. The school's location in a secluded region presents distinct challenges, including limited mobile phone reception, though it is equipped with internet connectivity. This unique combination of isolation and technological access provides a valuable setting for investigating the effects of online gamification in education. The school's environment, largely free from the distractions of constant digital connectivity but still capable of engaging with online resources, offers an ideal context to explore how technology-based learning interventions can impact students' academic performance in remote areas.

2.3 Research Participants

The study involved 94 Grade 12 students from Nug-as National High School, a public school in Alcoy, Cebu, Philippines. These students were from the Business Mathematics class taught by the researcher and were chosen based on similar performance levels in mathematics, as indicated by their first-quarter grades.

Table 1. Frequency and percentage distribution of respondents in terms of sex

Group	Male	Female	Total
Control Group	28	19	47
Experimental Group	26	21	47

The intervention involved two groups, each consisting of 47 students: the experimental group engaged with online gamification platforms such as Kahoot, Quizizz, Bamboozle, Classpoint, ClassDojo, ClassTools, MultiBuzzer, and Educaplay, while the control group received conventional instruction without gamified elements. Only respondents from the experimental group were interviewed for the qualitative part of the study. Selection criteria included diverse academic performance (high achievers, average performers, and those struggling with math), gender balance, and varying attitudes toward math. To uphold privacy and confidentiality, pseudonyms were assigned to each participant, replacing identifying information throughout the research process. These criteria collectively contributed to a diverse, representative sample, enhancing the study's validity and generalizability while maintaining ethical considerations and protecting participant anonymity.

2.4 Research Instrument

The research employed two primary researcher-made instruments: a Pre-Test and Post-Test Questionnaire and an Interview Questionnaire. The pre-test and post-test were designed to assess students' proficiency in numeracy and problem-solving skills, specifically targeting topics on salary and wages from Business Mathematics Subjects. A 30-item multiple-choice test was developed for this purpose, with the content validated by experts, including the School's Mathematics Key Person from Nug-as National High School and a professor from Cebu Technological University-Argao Campus. The test was pilot-tested at Dalaguete National High School to ensure reliability.

The pre-test, administered before the intervention, established a baseline for students' mathematical capabilities. Following the intervention, a post-test was conducted to evaluate any changes in performance. This allowed for a

comparative analysis of pre-test and post-test results, providing quantitative data on the effectiveness of online gamification in enhancing numeracy and problem-solving skills.

In addition to the quantitative data, qualitative insights were gathered through interviews with randomly selected students. The interview questions were designed to explore the students' experiences with online gamification, including its influence on their motivation, engagement, and learning outcomes. These interviews provided a deeper understanding of how the intervention impacted students beyond test scores, offering valuable perspectives on its educational and motivational effects.

2.5 Data Gathering Procedure

This study aimed to assess the impact of online gamification on students' numeracy, problem-solving skills, and engagement in Business Mathematics. It focused on comparing the performance of students exposed to Online Gamification and Conventional Instruction across six competencies. Key research questions included examining the pre-test and post-test score distributions for both groups, identifying significant differences within each group, and comparing the mean gains between groups.

Data gathering employed a non-equivalent pretest-posttest quasi-experimental design for the quantitative phase. Due to practical limitations, random assignment was not feasible, so a control group using conventional methods served as a reference point. The assessment tool, a 30-item multiple-choice test, was validated by experts, pilot-tested, and achieved a Kuder-Richardson 20 (KR-20) reliability coefficient of 0.802. Pre-tests were administered to both groups at the start to establish a baseline, followed by post-tests after one month of instruction. Quantitative data were analyzed using a z-test and paired t-test to compare pre-test and post-test scores for each group. In contrast, the t-test for two independent samples examined the mean gain differences, highlighting any significant performance improvement between groups.

For qualitative analysis, interviews were conducted with students from the experimental group to explore their experiences with online gamification. Thematic analysis was applied to these interviews based on the framework by Miles and Huberman (1994). The process involved four stages: Data Collection, Data Reduction, Data Display, and Conclusion Drawing and Verification. This qualitative approach provided nuanced insights into the effects of gamification on learning, motivation, engagement, and students' overall educational experiences, revealing perceived benefits, challenges, and recommendations for future interventions.

2.6 Ethical Considerations

This study, approved by the Graduate School Committee of Cebu Technological University-Argao Campus, adhered to the ethical principles outlined by Brinkmann and Kvale (2015). Key considerations included securing informed consent, maintaining confidentiality, and minimizing potential participant harm. These principles were complemented by broader ethical standards in research, emphasizing integrity, originality, and accuracy.

3.0 Results and Discussion

3.1 Pre-Test Scores

Table 2 illustrates the pre-test performance of both the experimental and control groups across six key competencies. The data indicates below-average performance for almost all competencies, highlighting the need for intervention. For Competency 1 (defining salary, wage, income, and benefits), the experimental group achieved a mean of 6.15, with a z-score of 8.99. Similarly, the control group scored a mean of 5.15 with a z-score of 12.86. Both groups showed a performance significantly below average. For Competency 2 (computing gross and net earnings), the experimental group had an actual mean of 1.83 with a z-score of 15.86, and the control group had an actual mean of 2.30 with a z-score of 15.29. Both groups again demonstrated below-average performance. Similarly, Competency 3 (differentiating gross from net earnings) saw both groups underperform, with the experimental group achieving an actual mean of 0.81 and a z-score of 8.92, while the control group had an actual mean of 0.98 and a z-score of 5.35.

In Competency 4 (defining benefits given to wage earners), the experimental group performed slightly better, with an actual mean of 1.45 and a z-score of 0.56, indicating average performance. In contrast, the control group performed below average, with a mean of 1.15 and a z-score of 3.37. Competency 5 (enumerating standard

deductions) and Competency 6 (computing overtime pay) were particularly challenging for both groups. The experimental group had actual means of 2.57 and 0.15, with corresponding z-scores of 14.29 and 11.57, while the control group had means of 2.77 and 0.23, with z-scores of 10.82 and 8.35. Both groups struggled considerably with these competencies.

Table 2. Pre-test score distribution for the experimental and control groups per competency

Learning Competencies	No. of Items	Group	h.m.	a.m.	s	z-score	Description
1. Define salary, wage, income, benefits	12	Experimental	9.00*	6.15	2.17	8.990	Below Average
		Control		5.15	2.05	12.86	Below Average
2. Compute gross and net earnings	6	Experimental	4.50*	1.83	1.15	15.86	Below Average
		Control		2.30	0.99	15.29	Below Average
3. Differentiate gross from net earnings	2	Experimental	1.50*	0.81	0.53	8.920	Below Average
		Control		0.98	0.67	5.350	Below Average
4. Define each of the benefits given to wage	2	Experimental	1.50*	1.45	0.65	0.560	Average
		Control		1.15	0.71	3.370	Below Average
5. Enumerate the standard deductions with the corresponding computation	7	Experimental	5.25*	2.57	1.28	14.29	Below Average
		Control		2.77	1.57	10.82	Below Average
6. Compute overtime pay	1	Experimental	0.75*	0.15	0.36	11.57	Below Average
		Control		0.23	0.42	8.350	Below Average
Overall	**30**	**Experimental**	**22.50***	**12.96**	**4.42**	**14.80**	**Below Average**
		Control		**12.57**	**3.89**	**17.51**	**Below Average**

*computed from 75% of DepEd-standard items
a.m. – actual mean; h.m. – hypothetical mean; s – standard deviation

The COVID-19 pandemic likely exacerbated these learning gaps, disrupting traditional learning environments and contributing to these poor results, as observed in other studies (Sooknanan & Seemungal, 2023; Torres, 2021). Furthermore, the poor performance in the pre-test across all competencies aligns with Bernardo et al.'s (2022) findings that Filipino students often struggle with problem-solving and critical thinking, particularly at Level 1 proficiency. These students tend to rely on explicit instructions and lack deeper comprehension, a difficulty also highlighted by Vidad and Quimbo (2021). Their study found that students frequently fail to apply mathematical concepts or translate real-world problems into mathematical equations, further confirming the challenges seen in this study.

3.2 Post-Test Scores

Table 3 shows the post-test scores of the experimental and control groups across six business math competencies, providing insights into students' proficiency levels after the intervention. Comparing actual mean scores to the hypothetical mean (75% of total items per competency) offers a clear understanding of student's achievement relative to expected standards.

Table 3. Post-test score distribution for the experimental and control groups per competency

Learning Competencies	No. of Items	Group	h.m.	a.m.	s	z-score	Description
1. Define salary, wage, income, benefits	12	Experimental	9.00*	9.00	1.99	0.00	Average
		Control		8.49	2.06	1.70	Average
2. Compute gross and net earnings	6	Experimental	4.50*	4.55	1.13	0.32	Average
		Control		4.43	1.18	0.43	Average
3. Differentiate gross from net earnings	2	Experimental	1.50*	1.64	0.52	1.81	Average
		Control		1.57	0.61	0.84	Average
4. Define each of the benefits given to wage	2	Experimental	1.50*	1.60	0.53	1.23	Average
		Control		1.53	0.65	0.34	Average
5. Enumerate the standard deductions with the corresponding computation	7	Experimental	5.25*	3.74	1.28	8.07	Below Average
		Control		3.17	1.62	8.83	Below Average
6. Compute overtime pay	1	Experimental	0.75*	0.45	0.50	4.18	Below Average
		Control		0.40	0.49	4.83	Below Average
Overall	**30**	**Experimental**	**22.50***	**20.98**	**4.32**	**2.41**	**Below Average**
		Control		**19.60**	**4.99**	**3.99**	**Below Average**

*computed from 75% of DepEd-standard items
a.m. – actual mean; h.m. – hypothetical mean; s – standard deviation

The post-test results in Table 3 provide further insights. For Competency 1 (defining salary, wage, income, and benefits), the experimental group achieved an actual mean of 9.00 and a z-score of 0.00, indicating average performance. The control group, with an actual mean of 8.49 and a z-score of 1.70, also performed at an average level. Both groups showed improvement compared to their pre-test scores. For Competency 2 (computing gross

and net earnings), the experimental group had a mean of 4.55 and a z-score of 0.32. In contrast, the control group scored 4.43 and a 0.43 z-score, indicating average performance for both groups. In Competency 3 (differentiating gross from net earnings), the experimental group had a mean of 1.64 and a z-score of 1.81. In contrast, the control group had a mean of 1.57 and a z-score of 0.84, indicating average performance. Similarly, for Competency 4 (defining wage benefits), the experimental group scored a mean of 1.60 and a z-score of 1.23. In contrast, the control group had a mean of 1.53 and a z-score of 0.34, maintaining average performance levels.

However, in Competency 5 (enumerating standard deductions) and Competency 6 (computing overtime pay), both groups continued to struggle. The experimental group achieved a mean of 3.74 and a z-score of 8.07 for Competency 5 and a mean of 0.45 and a z-score of 4.18 for Competency 6, indicating below-average performance. The control group had similar results, with a mean of 3.17, a z-score of 8.83 for Competency 5, and a mean of 0.40 and a z-score of 4.83 for Competency 6. Despite the challenges in Competencies 5 and 6, the experimental group's overall post-test mean score of 20.98, with a z-score of 2.41, surpassed the control group's mean of 19.60 and a z-score of 3.99 but was still below the hypothetical mean of 22.50. This suggests that while both groups struggled, the experimental group performed slightly better after the intervention, possibly due to the implementation of online gamification. However, the experimental group's standard deviation of 4.32 reflects variability in individual performance, suggesting that some students responded better to gamification than others.

Supporting the findings of this study, previous research by Su & Cheng (2015), Zamora-Polo et al. (2019), and Zainuddin et al. (2020) has demonstrated that gamification enhances students' learning outcomes by increasing motivation, engagement, and performance. The slight advantage observed in the experimental group's post-test scores underscores the potential of gamification as an effective instructional strategy. This finding is consistent with the results reported by Karamert and Vardar (2021), which found that students exposed to gamification showed a significantly greater increase in achievement test scores compared to the control group. These findings collectively suggest that incorporating gamification into classroom instruction can lead to tangible improvements in student performance.

3.3 Comparative Analysis of Pretest and Post-Test Scores

Table 4 expresses the comparative analysis of the pretest and post-test results. This is used to determine if there are significant improvements in the test scores of the two groups of students. Table 4 reveals that respondents' scores increased when exposed to online gamification and conventional/traditional methods.

Table 4. Paired t-test for pre-post mean gain of experimental and control groups

Group	Mean		Mean Gain	p-value	Decision	Interpretation
	Pre-Test	Post-Test				
Experimental Group (Online Gamification)	12.96	20.98	8.02	0.0000	Reject H_o	Significant**
Control Group (Conventional Teaching)	12.57	19.60	7.03	0.0000	Reject H_o	Significant**

** Significant at 0.05 using Paired T-Test

For the experimental group, the pre-test mean score was 12.96, which increased to 20.98 in the post-test, resulting in a mean gain of 8.02. The computed t-value of 14.99 exceeds the critical t-value of 2.01, yielding a p-value of 0.0000. This indicates a statistically significant improvement in the test scores, allowing for rejecting the null hypothesis (Ho). The findings suggest that using online gamification as a teaching strategy effectively enhanced students' learning outcomes in this group. Similarly, the control group improved from a pre-test mean of 12.57 to a post-test mean of 19.60, reflecting a mean gain of 7.03. The computed t-value of 11.96 also surpassed the critical t-value of 2.01, with a p-value of 0.0000, leading to the rejection of the null hypothesis (Ho). This result indicates that conventional teaching methods also led to significant gains in student performance.

The data shows a significant difference between the experimental and control groups' pre-test and post-test results. Both groups exhibited statistically significant increases in post-test scores, with the experimental group showing a greater improvement, as indicated by the t-test results (14.99 for the experimental group vs. 11.96 for the control group). This suggests that online gamification significantly enhanced the experimental group's math proficiency compared to their initial levels. The increase in the experimental group's mean scores indicates that integrating online gamification into the Business Math class effectively boosts student performance.

The research by Derasin (2024) reinforced the current study's findings, suggesting that gamification significantly enhances students' mathematical skills, extending its potential applicability beyond specific subjects like mathematics. Iwamoto et al. (2017) also noted that classroom games improve academic performance, aligning with the observed improvements in both groups. Additionally, the studies by O'Donovan et al. (2013) and Ibanez et al. (2014) contributed to understanding the positive impact of gamified learning activities on engagement and learning outcomes, echoing the observed improvement in the current study. Furthermore, research by Rosas et al. (2003) and Wang (2015) highlighted the broader benefits of games in education, suggesting that gamification techniques can positively influence various aspects of the learning experience, ultimately contributing to improved academic performance and student engagement.

3.4 Difference in the Gains of Scores Between Groups

Table 5 shows the significant difference in score gains in the two groups of respondents. Gain is defined as the difference between pretest and posttest scores.

Table 5. Independent samples t-test for the difference of the mean gain between groups

Group	Mean Gain	p-value	Decision	Interpretation
Experimental (Online Gamification)	8.02	0.16	Accept H_o	Not Significant***
Control (Conventional Teaching)	7.03			

*** Not Significant at 0.05 using T-Test for two independent samples

Based on the data above, the experimental group achieved a mean gain of 8.02, while the control group recorded a mean gain of 7.03. The computed t-value for the mean gain is 1.42. This value is compared against the critical t-value of 1.99, resulting in a p-value of 0.16. Since the p-value exceeds the conventional alpha level of 0.05, the null hypothesis (Ho) is accepted, indicating no statistically significant difference between the mean gains of the two groups. Table 5 indicates no substantial difference in mean gains between the control and experimental groups. This demonstrates that while the experimental group showed slightly more improvements, these were not significantly greater than the control group, rendering the learning gains statistically insignificant. Thus, integrating online games did not yield a statistically significant difference compared to conventional teaching methods. The observed difference fell short of the 5% threshold, suggesting the impact of online gamification on math proficiency is statistically negligible compared to traditional instruction.

This finding is supported by the study of Ebner and Holzinger (2007) and Crocco et al. (2016), who reported that while gamification increased motivation, it did not result in significant differences in learning outcomes compared to traditional methods. However, contrary to these findings, Huang et al. (2016), as cited by Nacional (2024), reported that gamification leads to better learning outcomes and increased satisfaction. However, the current study refutes this, as it did not find a statistically significant difference in performance between the gamified and traditional groups. This discrepancy may be due to the novelty of gamification, requiring more time for students to adjust and become familiar with the method. Many students' lack of computer skills extended the learning curve, affecting their ability to engage with the gamified content fully. Nonetheless, it is notable that online gamification did not lead to significantly inferior results compared to traditional methods. This study indicates that incorporating online gamification into classroom instruction did not significantly decline student performance.

3.5 Student's Experiences During the Conduct of Online Gamification

Table 6. Student's experiences during the conduct of online gamification

Themes	Categories
Benefits and Advantages	Enjoyment and Engagement
	Learning and Skill Development
	Motivation and Achievement
	Individualized Progression
	Reduced Intimidation and Pressure
Challenges and Drawbacks	Connectivity Issues
	Platform Restrictions
	Limited Computer Literacy
Suggestions for Improvement	Infrastructure improvements
	Expansion of platform options
	Computer Literacy Training

Theme 1: Benefits and Advantages

Integrating quantitative and qualitative findings in this study highlighted several key benefits of online gamification in enhancing student engagement and learning experiences. Quantitative data revealed significant improvements in students' numeracy and problem-solving performance, aligning with qualitative insights from participant interviews. Respondents consistently emphasized the motivational effects of interactive elements, such as rewards, progress tracking, and personalized feedback, which increased enjoyment and sustained engagement with the learning material. This simultaneous convergence of data suggests that the gamified approach led to measurable performance gains and fostered a deeper emotional connection to the learning process.

Respondents emphasized their enjoyment and engagement with online gamification, highlighting the appeal of colorful graphics, entertaining tasks, and challenging activities. They find the immersive and interactive nature of gamified learning akin to playing games, driven by elements like quests, rewards, and time limits. This approach not only captivates their attention but also motivates active participation. Importantly, they view online gamification as making learning enjoyable and effectively transforming educational tasks into stimulating activities. This positive perception underscores how gamification elements enhance their overall learning experience despite the academic nature of the tasks. Studies by Ibanez et al. (2014), O'Donovan et al. (2013), and Casuso-Holgado et al. (2013) further supported this positive impact of gamified exercises on student engagement and understanding, emphasizing the potential for increased enjoyment to contribute to improved academic performance.

Respondents also contrasted online gamification with conventional teaching methods, noting that conventional methods often rely on passive instruction. This sentiment is supported by Bhat (2023), who reported that technological advancements enhance student engagement. Respondents also appreciated the benefits of having fun while improving their mathematical understanding and problem-solving abilities. This underscores the effectiveness of online gamification in blending educational content with engaging gameplay. Additionally, students noted that gamified learning challenges them to push their limits, apply knowledge in real-world scenarios, and refine their problem-solving skills through interactive games and puzzles. Gamification's dual benefit of fun and enhanced understanding also aligns with the findings of Caballero et al. (2022), which emphasized its positive impact on critical thinking and skill development.

Moreover, respondents reported that online gamification was highly motivating, giving them feelings of achievement and satisfaction. They felt motivated, excited, and enthusiastic about challenging tasks and competition, viewing these as opportunities for growth—the quest-based structure and rewards, like points and badges, incentivized active participation and mastery. The sense of accomplishment from these rewards validated their progress and kept them engaged with the content.

Respondents also emphasized that online gamification offers immediate feedback, aligning with their preference for personalized progression. This feature allows them to track their performance, identify areas for improvement, and adjust their learning strategies accordingly. The respondents highly valued the rapid feedback, providing insights into their strengths and weaknesses during engagement with educational content. They appreciated the flexibility of individualized progression, enabling them to learn at their own pace without feeling pressured. This flexibility allowed them to focus on areas of interest or revisit challenging topics, enhancing their overall learning experience. This aligns with Turan et al. (2016), who highlighted gamification's stimulating effects and the role of rewards and feedback in shaping student behavior, monitoring progress, and motivating continuous learning.

Finally, respondents highlighted that online gamification made learning math less intimidating by creating a game-like atmosphere. They felt empowered to tackle challenges creatively and participate actively without fear of judgment. The option for anonymity further supported a comfortable learning environment. Despite potential competitive aspects, respondents found gamification inclusive and empowering, contrasting with traditional concerns about classroom anxiety. This supports another study's findings that games positively influence interest, engagement, and motivation (Barata et al., 2013) and foster competition without intimidation (Nicholson, 2012).

Theme 2: Challenges and Drawbacks

While the benefits were evident, both qualitative and quantitative data highlighted challenges that hindered the full potential of online gamification. Challenges have also emerged from interviews, highlighting connectivity issues, platform restrictions, and limited computer literacy. Connectivity issues, particularly in areas with unreliable internet access, hinder students' engagement, while restrictions on gamified platforms limit effective integration into the curriculum. Limited computer literacy poses another challenge, impacting students' ability to navigate complex interfaces, exacerbating inequalities in access to quality education, and impeding the effectiveness of gamification initiatives.

Respondents identified halting internet connectivity as a major challenge during gamification activities, disrupting participation and causing delays in accessing content. This interruption affects learning experiences and outcomes, hindering timely interactions and feedback crucial for comprehension and engagement, leading to frustration, demotivation, and disconnection. Uzunboylu et al. (2020) supported these findings, noting similar challenges with internet connectivity in online learning and gamification contexts, underscoring their impact on students' ability to benefit from gamified activities fully.

Some respondents also expressed frustration with limited availability or slots for gamified platforms, which resulted in feelings of exclusion and unfairness. Restricted availability means only a limited number of users can access platforms concurrently, leading to challenges in joining activities and delays in accessing content. Another issue identified during the interview was the respondents' limited computer literacy, which hindered their ability to navigate online platforms and understand instructions. This resulted in frustration and difficulties keeping up with their peers. This is supported by Tomaro (2018), who highlighted that insufficient infrastructure and equipment in Philippine schools hinder the development of computer literacy among students.

Theme 3: Suggestions for Improvement

The convergence of quantitative and qualitative findings also led to actionable suggestions for optimizing gamification in education. Both data sets emphasized the importance of infrastructure improvements, particularly reliable internet access, to enhance learning experiences and minimize disruptions. Respondents also suggested expanding platform options to accommodate more students. Moreover, comprehensive computer literacy training emerged as a critical need in gamified environments. These findings suggest that targeted improvements in infrastructure, platform access, and training could significantly enhance the effectiveness of online gamification as a teaching tool.

4.0 Conclusion

The study reveals that despite the experimental group's exposure to online gamification, which resulted in a higher mean score than the control group, no significant difference was observed between online gamification and the conventional teaching method, indicating their comparability. Despite technical challenges, gamification promotes positive attitudes toward mathematics, enhances enjoyment and engagement, facilitates learning and skill development, boosts motivation and achievement, supports individualized progression, and reduces intimidation and pressure, as evidenced by the interviews. Addressing technical barriers—such as connectivity issues and computer literacy—emerges as a critical priority to fully harness the potential of gamification in mathematics education. By overcoming these obstacles, educational stakeholders can better leverage gamified approaches to create more dynamic and interactive learning environments. Moreover, continued research and targeted interventions are essential to refine gamification strategies, ensuring they align effectively with educational goals and enhance overall student outcomes.

5.0 Contributions of Authors

The completion of this thesis was the result of a collaborative effort between the two authors. The first author, Cherry Ann S. Dueñas, a Senior High Teacher at Nug-as National High School in Alcoy, Cebu, Philippines, was responsible for writing, editing, and encoding the manuscript, ensuring clarity and adherence to academic standards. She also managed the technical aspects of formatting and organizing the document. The second author, Dr. Marichou L. Carreon, Associate Professor V of Cebu Technological University-Argao Campus, who holds a Doctorate in Education, focused on proofreading and verifying the accuracy of the data gathering and analysis procedures. Her meticulous review ensured the reliability and accuracy of the research findings. Both authors worked closely to produce a coherent and well-researched study.

6.0 Funding

This research was conducted without any financial support or external funding. The authors independently provided all resources used throughout the study, with no sponsorship or grants from any institution, organization, or funding agency.

7.0 Conflict of Interests

The authors have no conflicts of interest to declare that they are relevant to the content of this article.

8.0 Acknowledgment

We extend our heartfelt appreciation to Dr. Ariel L. Ramos, Dean of the Graduate School at Cebu Technological University-Argao Campus, for his encouragement and invaluable insights that enriched our research. Additionally, we thank Mrs. Judith M. Aleguen and Mr. Renante R. Laguda for their time, expertise, and constructive feedback, which significantly enhanced the quality of our study.

9.0 References

Abramovich, S., Schunn, C., & Higashi, R. M. (2013). Are badges useful in education?: It depends upon the type of badge and expertise of learner. Educational Technology Research and Development, 61(2), 217-232. https://doi.org/10.1007/S11423-013-9289-2

Barata, G., Gama, S., Jorge, J., & Goncalves, D. (2013). Engaging engineering students with gamification. In 2013 5th International Conference on Games and Virtual Worlds for Serious Applications, VS-GAMES 2013. https://doi.org/10.1109/VS-GAMES.2013.6624228

Bhat, R. (2023). The impact of technology integration on student learning outcomes: A comparative study. International Journal of Social Science, Educational, Economics, Agriculture Research and Technology, 2, 592-596. https://doi.org/10.54443/ijset.v2i9.218

Bernardo, A. B. I., Cordel II, M. O., Lapinid, M. R. C., Teves, J. M. M., Yap, S. A., & Chua, U. C. (2022). Contrasting profiles of low-performing mathematics students in public and private schools in the Philippines: Insights from machine learning. Journal of Intelligence, 10, 61. https://doi.org/10.3390/jintelligence1003006

Caballero, L., Ferrer, M., & Tiria, R. (2022). The role of gamification in the academic performance of junior high school students in language subject. Journal of Intelligence, 8, 1-4. https://tinyurl.com/5xdyzwft

Casuso-Holgado, M. J., Cuesta-Vargas, A. I., Moreno-Morales, N., Labajos-Manzanares, M. T., Barón-López, F. J., & Vega-Cuesta, M. (2013). The association between academic engagement and achievement in health sciences students. BMC Medical Education, 13(1), 1–7. https://doi.org/10.1186/1472-6920-13-33

Chi, C. (2023, December 6). Philippines still lags behind the world in math, reading and science — PISA 2022. Philstar.com. Retrieved from https://tinyurl.com/rkyk43ud

Crocco, F., Offenholley, K., & Hernandez, C. (2016). A proof-of-concept study of game-based learning in higher education. Simulation & Gaming, 47(3), 403-422. https://doi.org/10.1177/1046878116632484

Derasin, L. M. (2024). The impact of digital gamification and traditional based learning on student's mathematics achievement: Evidence from the Philippines. Shu Ju Cai Ji Yu Chu Li/Journal of Data Acquisition and Processing, 38, 2108-2116. https://doi.org/10.5281/zenodo.778108

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments, MindTrek 2011, 11, 9-15. https://doi.org/10.1145/2181037.2181040

Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. Computers & Education, 49(3), 873-890. https://doi.org/10.1016/j.compedu.2005.11.026.

Gentile, D. A., Bailey, K., Bavelier, D., Brockmyer, J. F., Cash, H., Coyne, S. M., Doan, A., Grant, D. S., Green, C. S., Griffiths, M., Markle, T., Petry, N. M., Prot, S., Rae, C. D., Rehbein, F., Rich, M., Sullivan, D., Woolley, E., & Young, K. (2017). Internet gaming disorder in children and adolescents. Pediatrics, 140(Suppl 2), S81–S85. https://doi.org/10.1542/peds.2016-1758H

Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? — A literature review of empirical studies on gamification. Proceedings of the Annual Hawaii International Conference on System Sciences. https://doi.org/10.1109/HICSS.2014.377

Ibanez, M. B., Di-Serio, A., & Delgado-Kloos, C. (2014). Gamification for engaging computer science students in learning activities: A case study. IEEE Transactions on Learning Technologies, 7(3), 291–301. https://doi.org/10.1109/TLT.2014.2329293

Iwamoto, D. H., Hargis, J., Taitano, E. J., & Vuong, K. (2017). Analyzing the efficacy of the testing effect using Kahoot™ on student performance. Turkish Online Journal of Distance Education-TOJDE, 18(2), 7. https://files.eric.ed.gov/fulltext/EJ1145220.pdf

Kapp, K. (2012). The gamification of learning and instruction: Game-based methods and strategies for training and education. San Francisco, CA: Pfeiffer.

Karamert, Ö. & Kuyumcu Vardar, A. (2021). The effect of gamification on young mathematics learners' achievements and attitudes. Journal of Educational Technology & Online Learning, 4(2), 96-114. https://doi.org/10.31681/jetol.904704.

Lister, M. C. (2015). Gamification: The effect on student motivation and performance at the post-secondary level. Issues and Trends in Educational Technology, 3(2). https://doi.org/10.2458/azu_itet_v3i2_lister

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook (2nd ed.). Sage Publications, Inc.

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2020). TIMSS 2019 International Results in Mathematics and Science. Retrieved from https://tinyurl.com/5d2at4r9

Nacional, R. (2024). Gamifying education: Enhancing student engagement and motivation. Puissant, 5, 716-729. https://tinyurl.com/2m9dw5xf

Nicholson, S. (2012). A user-centered theoretical framework for meaningful gamification. Retrieved from https://tinyurl.com/yc2a3meu

O'Donovan, S., Gain, J.E., & Marais, P.C. (2013). A case study in the gamification of a university-level games development course. Research Conference of the South African Institute of Computer Scientists and Information Technologists. https://doi.org/10.1145/2513456.25134

Perttula, A., & Tuomi, P. (2017). Gamification at School. EDULEARN17 Proceedings, 9334-9340. https://doi.org/10.21125/EDULEARN.2017.0756

Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., Flores, P., Grau, V., Lagos, F., López, X., López, V., Rodriguez, P., & Salinas, M. (2003). Beyond Nintendo: Design and assessment of educational video games for first and second grade students. Computers & Education, 40(1), 71-94. https://doi.org/10.1016/S0360-1315(02)00099-4

Sooknanan, J., & Seemungal, T. (2023). Mathematics education in the time of COVID-19: A public health emergency exacerbated by misinterpretation of data. Teaching Mathematics and Its Applications: An International Journal of the IMA, 42(4), 375–383. https://doi.org/10.1093/teamat/hrac025

Su, C-H., & Cheng, C-H. (2015). A mobile gamification learning system for improving the learning motivation and achievements. Journal of Computer Assisted Learning, 31(3), 268–286. https://doi.org/10.1111/jcal.12088

Tomaro, Q.P. (2018). ICT integration in the educational system of Philippines. Journal of Governance and Public Policy, 5. https://doi.org/10.18196/jgpp.5399

Tondello, G. F., Wehbe, R. R., Orji, R., Ribeiro, G., & Nacke, L. E. (2017). A framework and taxonomy of videogame playing preferences. Proceedings of the Annual Symposium on Computer-Human Interaction in Play, 329–340. https://doi.org/10.1145/3116595.3116629

Torres, R. (2021). Addressing the learning gaps in the distance learning modalities. International Journal of Academic and Applied Research, 5(6), 76-79. https://tinyurl.com/2292zncn

Turan, Z., Avinc, Z., Kara, K., & Goktas, Y. (2016). Gamification and education: Achievements, cognitive loads, and views of students. International Journal of Emerging Technologies in Learning, 11, 64-69. https://doi.org/10.3991/ijet.v11i07.5455

Uzunboylu, H., Galimova, E.G., Kurbanov, R.A., Belyalova, A.M., Deberdeeva, N., & Timofeeva, M. (2020). The views of the teacher candidates on the use of Kahoot as a gaming tool. International Journal of Emerging Technologies in Learning, 15, 158-168. https://doi.org/10.3991/ijet.v15i23.18811

Vidad, D., & Quimbo, M. (2021). Students' problem-solving difficulties and coping strategies in mathematics: A model-building study. International Journal of Learning, Teaching and Educational Research, 20, 136-173. https://doi.org/10.26803/ijlter.20.9.9

Wang, A. I. (2015). The wear out effect of a game-based student response system. Computers & Education, 82, 217–227. https://doi.org/10.1016/j.compedu.2014.11.004

Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. Educational Research Review, 30, 100326. https://doi.org/10.1016/j.edurev.2020.100326

Zamora-Polo, F., Corrales-Serrano, M., Sanchez-Martin, J., & Espejo-Antunez, L. (2019). Nonscientific university students training in general science using an active-learning merged pedagogy: Gamification in a flipped classroom. Education Sciences, 9(4), 297-315. https://doi.org/10.3390/educsci9040297