Examining the Impact of Gamification on Science Academic Performance of Grade 3 Learners: A Quasi-Experimental Study

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DOI: 10.29322/IJSRP.15.05.2025.p16123
https://dx.doi.org/10.29322/IJSRP.15.05.2025.p16123

Paper Received Date: 21st April 2025
Paper Acceptance Date: 17th May 2025
Paper Publication Date: 26th May 2025

Abstract

This study investigated the impact of a gamification intervention on the academic performance of Grade 3 learners in science at Obrero Central Elementary School in Butuan City. Utilizing a quasi-experimental design, the research compared the science performance of an experimental group, encompassing all Grade 3 learners in Sections Durian (n=32), who underwent the gamification intervention, against a control group, made up of all Grade 3 learners in Section Mango (n=32), who received standard instruction. The findings revealed that the pretest performance of the Grade 3 learners in both groups was predominantly at the "Beginning" level in science. Most pupils in both groups demonstrated scores below 60%, indicating a similar baseline understanding of the subject matter, with very few learners exhibiting high proficiency levels. A gamification strategy was designed by structuring lesson plans to incorporate game-like elements, such as Kahoot, to engage learners and create a dynamic learning environment. The posttest performance of the two groups showed a divergence. In the control group, the highest concentration of learners reached the "Approaching Proficiency" level, while in the experimental group, more pupils attained the "Proficient" level. The experimental group also exhibited fewer learners at the "Beginning" level than the control group. The gain scores revealed that the experimental group exhibited a higher average increase in scores (experimental group mean gain score = 10.963; control group mean gain score = 9.1250) compared to the control group. The independent t-test revealed a statistically significant difference in the mean gain scores between the two groups ($t = -2.414$, $p = .019$), indicating that the learning strategy employed with the experimental group led to a greater enhancement in pupil achievement. Consequently, the null hypothesis, which posited no significant difference in gain scores, was rejected.These provide insights into the effectiveness of gamification as a pedagogical strategy within the local educational context. The findings suggested that a gamified approach can lead to more substantial and consistent learning gains, warranting consideration for its broader application in educational materials and pedagogical strategies.

Index Terms: Academic Performance, Gamification Strategy, Gamification Intervention

I.INTRODUCTION

In today's diverse educational landscape, there is a growing emphasis on adopting innovative teaching strategies to better engage learners and improve academic outcomes. This is especially relevant in science education, where conventional methods such as textbook-based instruction and rote memorization often fail to spark curiosity or sustain student interest particularly at the elementary level. At Obrero Central Elementary School, Grade 3 learners have demonstrated a noticeable decline in enthusiasm and performance in science, as evidenced by consistently low scores in formative and summative assessments. These challenges are compounded by

limited access to interactive educational tools and hands-on learning experiences. As a result, there is a pressing need for pedagogical approaches that are engaging and effective in promoting deep learning and critical thinking in young learners.

International and national assessments continue to highlight the learning crisis in science education. The 2022 Programmed for International Student Assessment (PISA) reported that Filipino students scored significantly below the OECD average in reading (347 vs. 476), mathematics (355 vs. 472), and science (356 vs. 485), indicating persistent underachievement in key academic areas (Philstar, 2023). Scholars have argued that traditional teaching methods are inadequate in capturing student interest or fostering conceptual understanding, particularly in science. In response, the Department of Education (DepEd) issued Memorandum No. 021, s. 2019, promoting learner-centered and innovative strategies, such as gamification, to address these educational gaps. Gamification integrates game-like elements—such as points, rewards, and interactive challenges—into the learning process, encouraging active participation, collaboration, and student motivation. Studies show that gamified learning can enhance academic performance, support critical thinking, and make complex subjects more accessible and enjoyable (Department of Education, 2019; Namoco et al., 2023).

Despite the growing interest in gamification as a pedagogical tool, there is limited empirical research examining its impact on elementary-level science education within the Philippine context. Most existing studies focus on higher education or general subjects, leaving a gap in localized evidence on how gamification affects science learning outcomes among younger learners. In resource-constrained public schools like Obrero Central Elementary, where instructional materials and technology are limited, gamification's practical application and effectiveness remain underexplored. There was few published research on how gamification influences essential academic skills in science, such as knowledge retention, critical thinking, and problem-solving, especially among Grade 3 students at a formative stage of cognitive development.

This quasi-experimental study filled the identified research gap by investigating the impact of gamification on the science academic performance of Grade 3 learners at Obrero Central Elementary School. The study aims to determine whether gamification can significantly enhance student engagement, conceptual understanding, and academic achievement by incorporating game elements such as points, badges, and interactive activities into science instruction. Using a mixed-methods approach, the research integrates quantitative data (test scores) and qualitative insights (student and teacher feedback) to comprehensively understand gamification’s effects. The findings will contribute valuable knowledge to educational innovation, particularly in low-resource settings, and offer evidence-based recommendations for educators and policymakers seeking to improve science education outcomes among Filipino learners.

II. RESEARCH ELABORATIONS

This study was anchored on Jean Piaget's Constructivist Theory (1952). It posited that learner actively constructed knowledge through interaction with their environment. Unlike passive recipients, individuals assimilated new experiences into existing mental structures (schemas) or accommodated schemas to accommodate new information. This process of assimilation and accommodation drove cognitive development, characterized by stages: sensorimotor, preoperational, concrete operational and formal operational. Active exploration, experimentation and reflection processes ensured that meaningful learning took place as learners integrated new concepts into their existing knowledge frameworks. Gamification aligned with constructivism by providing learners with interactive experiences where they actively constructed knowledge through exploration and engagement with game elements. Incorporating challenges, feedback mechanisms, and opportunities for iterative attempts mirrored the constructivist principles of active learning, allowing students to assimilate new scientific concepts into their existing schemas or accommodate their understanding based on the outcomes of their in-game actions and reflections. This active participation fostered a deeper and more meaningful understanding of science, consistent with Piaget's emphasis on learners as active knowledge builders. This theory guided the investigation of how gamification facilitated the construction of knowledge and understanding in science students..

III.RESEARCH METHODOLOGY

This study employed a quasi-experimental design to investigate the efficacy of a gamification intervention on the academic performance in science among Grade 3 learners at Obrero Central Elementary School, Butuan City, Philippines. This design allowed for the comparison of science achievement between a pre-existing experimental group exposed to the gamification intervention and a pre-existing control group receiving traditional, worksheet-based instruction, thereby maintaining the integrity of the natural classroom environment. Intact classes were utilized as the experimental and control groups: Section Durian (n=32; 17 male, 15 female) served as the experimental group, and Section Mango (n=32; 18 male, 14 female) constituted the control group. The selection of intact classes was a pragmatic decision to minimize disruption to the school's existing organizational structure. The third-quarter quarterly assessment questionnaire designed for Grade 3 learners measured academic performance in science. This instrument aligns this study with the

Essential Learning Competencies (MELCs) prescribed by the Department of Education, Caraga Region, and was developed based on a Table of Specifications. The content validity and appropriateness of the assessment were ensured through a review process involving the school/district science coordinator and the principal of Obrero Central Elementary School. This standardized assessment was administered as both a pre-test and a post-test to gauge changes in academic performance. Before the intervention, a pre-test was administered to the experimental and control groups to establish a baseline understanding of their existing science knowledge aligned with the Grade 3 curriculum. A homogeneity of variance test was conducted on the pre-test scores to ascertain the comparability of the groups at the outset.

The data from the pre-test informed the subsequent design of the instructional interventions. For the experimental group, contextually relevant lesson plans incorporating gamification elements and mechanics were developed. Concurrently, worksheet-based instructional materials were planned for the control group, representing the conventional teaching approach. The researcher developed the gamified lesson plans, integrating game design principles to enhance learner engagement and active participation. These plans underwent a validation process involving expert review from the research adviser, experienced educators, and subject matter specialists to ensure pedagogical soundness and alignment with learning objectives. The worksheet-based materials for the control group were also finalized during this stage. The experimental group received science instruction during the third academic quarter through the newly developed gamification intervention-based lesson plans. Conversely, the control group received traditional worksheet-based science instruction, covering the duplicate learning content.

The interventions were implemented by the respective groups' classroom teachers under the researcher's guidance. Upon completion of the intervention period, a post-test, identical to the pre-test, was administered to the experimental and control groups under similar conditions. The post-test scores served as the primary data for evaluating the effectiveness of the gamification intervention. Frequency and Percentage descriptive statistics were used to characterize the demographic profile of the participants (e.g., gender distribution). The mean pre-test and post-test scores were calculated for the experimental and control groups to determine the average performance levels. Independent Samples t-tests ascertain if a statistically significant difference existed in the learning gains between the experimental and control groups, and an independent samples t-test was employed. This inferential statistic compared the mean post-test scores of the two groups, controlling for any potential initial differences identified in the pre-test scores, to determine the impact of the gamification intervention on science academic performance. The significance level was set at $\alpha=0.05$.

III. RESULTS AND DISCUSSION

This section presents the study's findings through a structured presentation of the data. First, it establishes the pretest science performance of the Grade 3 learners within the experimental and control groups, providing a baseline for subsequent comparisons. Following this, the posttest science performance of the learners in each group is presented to illustrate the outcomes after the respective interventions. The mean gain scores in science for both the experimental and control groups are then calculated and reported to quantify the learning achieved. Finally, the section culminates in the statistical test of the significant difference in the gain **scores** between the two groups. This analysis determines whether the observed improvements in science achievement are statistically attributable to the gamification intervention or occurred by chance.

. Pretest Performance of the Grade 3 Learners in Both Groups

Table 1 shows the pretest performance of Grade 3 learners in both the control and experimental groups, indicating that the majority of pupils in both groups fell within the "Beginning" descriptive level before the intervention.

Table 1 Pretest Performances of the Grade 3 Learners in both groups

Score Ranges	GROUP		Total	Descriptive Level
	Control Group	Experimental Group		
90-100%	0	0	0	Highly Proficient
80-89%	0	1	1	Proficient
70-79%	2	3	5	Approaching Proficiency
60-69%	2	3	5	Developing
Below 60%	28	25	53	Beginning
Total	32	32	64	

Table 1 presents the pretest performances of the Grade 3 learners in both the control and experimental groups. In the control group, most pupils (28 out of 32) scored below 60%, indicating a "Beginning" descriptive level. Likewise, the experimental group had the highest number of learners (25 out of 32) in the "Beginning" category, scoring below 60%. Conversely, the "Proficient" (80-89%) and "Highly Proficient" (90-100%) levels had the fewest learners in the control group, with zero pupils in each range. Similarly, the experimental group had no learners in the "Highly Proficient" range, and only one scored in the "Proficient" range. This initial distribution shows that most pupils in both the control and experimental groups performed at a "Beginning" level before the interventions, with minimal representation in the "Proficient" and "Highly Proficient" levels. The pretest data demonstrated that the control and experimental groups began with a significant proportion of learners performing at the "Beginning" level, with minimal representation in the higher proficiency categories. This baseline homogeneity between the groups was crucial for evaluating the impact of any subsequent intervention (Alshammari, 2020). The initial low performance across both groups underscored the need for effective instructional strategies to enhance the learners' understanding.

Posttest Performance of the Grade 3 Learners in Both Groups

Table 2 shows the posttest performance of Grade 3 learners in both control and experimental groups, indicating that the majority of pupils in the control group fell within the “Approaching Proficiency” descriptive level while the majority of pupils in the experimental group fell within the “Proficient” descriptive level after the intervention.

Table 2 Posttest Performances of the Grade 3 Learners in both groups

Score Ranges	GROUP		Total	Descriptive Level
	Control Group	Experimental Group		
90-100%	4	9	13	Highly Proficient
80-89%	10	13	23	Proficient
70-79%	13	7	20	Approaching Proficiency
60-69%	0	1	1	Developing
Below 60%	5	2	7	Beginning
Total	32	32	64	

As shown in Table 2, the posttest performances of the Grade 3 learners in both the control and experimental groups show an upward shift compared to the pretest. In the control group, the highest number of pupils (13 out of 32) scored within the 70-79% range, categorized as "Approaching Proficiency." The lowest score is 5 pupils (5 out of 32), scoring below 60% and remaining at the "Beginning" level. For the experimental group, the highest number of pupils (13 out of 32) achieved scores in the 80-89% range, indicating "Proficient" performance, and the lowest score has 2 pupils (2 out of 32) scoring below 60%, remaining in the "Beginning" level. This posttest distribution reveals a potential difference in outcomes between the two groups, with the experimental group showing a higher concentration of pupils in the "Proficient" level and a smaller proportion of pupils with the lowest scores ("Beginning") compared to the control group.

The posttest results reveal an apparent disparity in performance between the groups. Specifically, the experimental group exhibited a greater density of pupils reaching "Proficient" levels, accompanied by a reduced representation at the lowest performance tier. This pattern implies a possible beneficial effect of the gamification intervention on the learning achievements of the experimental group, especially when juxtaposed with the control group's larger segment of pupils with the lowest scores.
The study by Blancaflor et al. (2022) further supports these findings. Their research also observed that implementing gamification strategies led to enhanced learning outcomes in the experimental group compared to the control group. This corroborates the initial observation of a positive influence, specifically highlighting the capacity of gamification to elevate pupil performance to higher proficiency levels and mitigate the number of pupils struggling at the foundational levels. The consistency between the posttest results and the broader findings of Blancaflor et al. (2022) strengthens the assertion that gamification can be an effective pedagogical tool.

Mean Gain Score of the Grade 3 Learners in Both Groups

Table 3 Mean Gain Scores of the Grade 3 Learners in both Groups

GROUP	N	Mean	Std. Deviation	Std. Error Mean
Control Group	32	9.1250	2.959	.52315

Experimental Group	32	10.9063	2.944	.52047

As shown in Table 3, the control group had a lower mean gain score (m=9.1250) than the experimental group (m=10.963). It can also be noted that the learners' scores in the control group had a slightly higher divergence from the mean (SD=2.959) than the scores in the experimental group (SD=2.944). This indicates that the learners' scores in the control group were more diverse because many were still left in the lower performance levels, with a few scattered along three high levels. On the other hand, the scores of the learners in the experimental group were less diverse because many of them had now been able to improve their performance at the higher levels, potentially due to the engaging and motivating elements inherent in gamification, which could have fostered greater learning and retention compared to the traditional methods experienced by the control group.The observed higher mean gain score and reduced score divergence in the experimental group strongly suggest that the integration of gamification fostered a more consistent and substantial improvement in learning outcomes compared to the control group. This aligns with the principles of the Motivation-Exploration-Implementation Theory, where gamified elements are theorized to enhance engagement and facilitate deeper learning (Cabello et al., 2021). The findings underscore the potential advantage of gamification to positively impact pupil performance and create a more focused distribution of learning gains.

Test on Significant Difference in the Gain Scores of the Learners in Science 3 in Both Groups

Table 4 Independent t-test on the Mean Gain Scores of the Grade 3 Learners in both groups

Group	Mean Gain Score	Mean Difference	t-value	p-value	Decision on H_o	Interpretation
Control Group	9.1250					
Experimental Group	10.9063	-1.78	-2.414*	.019	Reject H_o	Significant

*significant @ p< .05

Table 4 shows the result of the independent t-test, which was employed to determine if there was a significant difference in the gain scores between the learners in the two groups. The analysis yielded a t-value of -2.414 at p=.019, indicating a significant difference. This led to the rejection of the null hypothesis, signifying that the learners in the experimental group performed significantly better in the posttest than the learners in the control group. This superior performance in the experimental group could be attributed to increased learner engagement and motivation observed during the implementation period, where the interactive and rewarding elements of the gamified learning strategy likely fostered a more active and sustained participation in the learning process compared to the traditional methods used with the control group. The statistically significant t-test result (t = -2.414, p = .019) confirms that the experimental group demonstrated a significantly greater performance improvement than the control group. This provides strong evidence for the effectiveness of the learning strategy implemented with the experimental group in enhancing pupil outcomes. These findings align with the research findings of Grabner-Hagen & Kingsley (2023), further substantiating the positive impact of the gamification strategy. Their study also reported a statistically significant difference in performance favoring the group that received the gamification intervention, indicating a similar enhancement of pupil outcomes. These results from the t-test and the broader study of Grabner et al., 2023 and Flores et al., 2023) reinforces the conclusion that the implemented learning strategy effectively improves pupil interest and performance.

IV. CONCLUSIONS AND RECOMMENDATIONS

The homogeneity in the pretest performance of both groups established a reliable foundation for evaluating the impact of the gamification intervention, mitigating concerns that pre-existing differences in academic ability confound the assessment of the gamification strategy's effectiveness. The gamification strategy effectively structured lesson plans using game-like elements, notably Kahoot, to promote learner engagement within a dynamic learning environment. This design incorporated clear content and performance standards, diverse learning resources, and activity-based learning to make science concepts fun and accessible. The post-intervention results revealed a difference in learning outcomes between the groups, with the gamification strategy appearing to facilitate a more substantial improvement in performance levels for the experimental group. The gamified learning environment was more conducive to academic advancement in science than the control group. The mean gain scores indicated a difference in the effectiveness of the instructional approaches, with the experimental group showing a significantly larger average gain. The gamification elements effectively promoted greater learning increments and a more consistent academic growth across the experimental group compared to the control group.

The statistical significance of the t-test confirmed that the difference in mean gain scores between the groups was not due to chance. The rejection of the null hypothesis affirmed that the gamification intervention improved science learning outcomes, validating its effectiveness over traditional instruction. Curriculum developers may explore the potential of integrating gamification principles into the design of science curricula for elementary grades. The findings suggest that a gamified approach can lead to more substantial and consistent learning gains, warranting consideration for its broader application in educational materials and pedagogical strategies. School administrators are encouraged to support the professional development of Grade 3 teachers in effectively designing and implementing gamified learning activities in science. Providing training and resources can equip educators with the necessary skills to leverage the motivational aspects of gamification to enhance pupil learning outcomes across the grade level. It is recommended that Grade 3 teachers consider incorporating gamified elements into their science instruction. Given learners' initial comparable performance levels and the subsequent significant improvement observed in the experimental group, integrating game-based mechanics can create a more engaging and effective learning environment for all pupils, regardless of their initial proficiency. Future research amy investigate the gamification elements that were most effective in enhancing science performance among Grade 3 learners in this context. Exploring the optimal types of game mechanics, levels of challenge and integration strategies could provide more nuanced insights into maximizing the benefits of gamification in elementary science education.

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