Students' Concept Retention on the Use of Gamification in Biology

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Article

Students' Concept Retention on the Use of Gamification in Biology

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Abstract

Conventional teaching methods in biology often result in student disinterest and difficulty in understanding complex concepts, leading to limited long-term retention. This study addresses this issue by comparing the effectiveness of gamification with traditional teaching methods among Grade 10 Biology students using a quasi-experimental design. The intervention group experienced gamified learning, while the conventional group received standard lecture-based instruction. Results showed that the gamification group achieved significantly higher retention scores (mean = 57.29) compared to the conventional group (mean = 37.62), with statistical significance ($p = 0.00$). The mean scores of intervention group increased notably from pre-test to post-test by 22.58 points and further improved by 12.33 points from post-test to retention test, both with moderate effect sizes (Cohen's $d = 0.69$). Students reported that gamification made learning more enjoyable and engaging, which enhanced their focus, motivation, and confidence. Additionally, gamified lessons promoted better social interaction and collaboration among students. These findings provide evidence that gamification not only improves direct learning outcomes but also supports retention and a more motivating learning environment. The study recommends integrating gamified elements thoughtfully into biology instruction to enhance student engagement, motivation, and academic performance while ensuring alignment with curriculum goals and equitable access to technology.

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Introduction

Gamification has emerged as a promising pedagogical strategy that applies game design elements in non-game contexts, with growing evidence supporting its application to enhance learning engagement and motivation (Costello, 2020; Chans and Portuguez Castro, 2021). It has been shown to effectively promote intrinsic motivation and academic retention (Bouchrika et al., 2021; Putz et al., 2020). As Dichev and Dicheva (2017) argue, the purpose of gamification in education is to enhance student engagement by incorporating game aspects into the learning environment. This, in turn, influences learners' behavior, making them more likely to participate actively and sustain their involvement.

Poor academic performance among students has often been linked to several factors, with motivation and involvement playing critical roles (Gute & Wainman, 2019; Qureshi et al., 2023). Despite the continuous efforts of teachers to employ innovative educational approaches, these factors must remain central. Instructional games, in particular, have been identified as highly effective strategies for teaching and enhancing conceptual understanding. By embedding domain-specific learning elements, these games promote persistence and commitment among students (Winget & Persky, 2022; Guskey, 2022). They also encourage creative thinking and conceptual understanding through interactive technologies (Suchyadi and Suharyati, 2021; Dewi and Primayana, 2019). Consequently, these innovations contribute to effective learning environments that strengthen problem-solving skills and encourage consistency across various educational contexts (Liu et al.,

 doi:10.20944/preprints202601.1058.v1

2020; Owoc et al., 2019; Abdelrahman and Wang, 2019; Yuliansyah & Ayu, 2021). While games can motivate learners by offering enjoyment and healthy competition, the development of engaging educational games requires significant time and resources.

In the context of biology education, simplifying complex concepts is essential to set commitment and interest while addressing students' perceptions of the subject as difficult or overwhelming. Incorporating active learning techniques has been shown to significantly improve participation (Hodges, 2020). For instance, tools such as Kahoot! have been found to increase interaction and make biology learning more enjoyable (Jones et al., 2019; Cameron and Bizo, 2019) and teaching models such as design thinking improves student performance and self-efficacy (Mangintay et al., 2025). Similarly, visual aids, including instructional videos and animations, make abstract concepts more tangible (Liu and Elms, 2019). The integration of emerging technologies, such as virtual reality, provides immersive experiences that deepen experiential learning and enhance commitment (Fitrianto and Saif, 2024). Ethnopedagogical approaches further enrich biology instruction by linking content tocultural contexts of students, thus, enhancing relevance and engagement (Rahmawati et al., 2020). Collectively, these strategies contribute to making biology more accessible and meaningful (Fowler et al., 2024; Skinner et al., 2022).

Recent studies on gamification in education consistently show its positive influence on student engagement, motivation, and academic performance across science and non-science disciplines (Lampropoulos & Sidiropoulos, 2024; Li et al., 2024; Nguyen-Viet et al., 2025). In biology education specifically, gamified tools and interactive strategies have been demonstrated to make abstract and complex concepts more accessible, enjoyable, and meaningful for learners (Felszeghy et al., 2019; Varol Selçuk & Özer Keskin, 2024). However, much of the existing literature remains concentrated on short-term achievement, engagement, or affective outcomes, with comparatively limited empirical attention given to deferred concept retention, particularly among secondary-level learners. Further, several gamification studies report outcomes without grounding instructional implementation in an established learning theory, making it difficult for practitioners to replicate or systematically apply the approach in classroom settings. Addressing these gaps, the present study integrates gamification within Gagne's Nine Events of Instruction and empirically examines its effects on both direct and deferred concept retention in Grade 10 Biology, specifically focusing on the endocrine and reproductive systems. Through a theory-driven instructional design with quantitative retention measures and qualitative data for learner experiences, this study provides an original contribution that strengthens both the empirical and practical foundations of gamification in biology education.

Specifically, this study sought to 1) determine the level of performance between the intervention and conventional groups in pre-test, post-test, retention test; 2) examine the difference in their test performance; 3) evaluate the effect of gamification on students' concept retention in biology compared to conventional teaching; and 4) explore students' perceptions of how gamification shapes their learning experiences in Biology.

Methodology

Research Design

The study employed a quasi-experimental design complemented by qualitative analysis to examine the effect of gamification on students' concept retention in Biology. Two comparable groups of Grade 10 students were assigned to different instructional approaches: one group received traditional standard lecture-based instruction (Conventional group), while the other participated in gamification (Intervention group). Both groups underwent a pre-test, post-test, and retention test to measure their conceptual understanding and long-term retention of biological concepts. In addition, students' perceptions of gamification were gathered through qualitative feedback to capture their affective learning experiences. The combination of quantitative and qualitative data allowed a more comprehensive understanding of both cognitive outcomes and learner experiences.

 doi:10.20944/preprints202601.1058.v1

Respondents of the Study

Ninety (90) participants were involved and grouped into two sections of grade 10 science classes from Pilot Provincial Science High School and Technology, BARMM, Philippines. The first group was assigned as the conventional group while the second group functioned as the intervention group. The researchers ensured that both groups were comparable through analysis of pretest scores, which confirmed equivalence in prior knowledge and abilities. The learning environment, instructional time, and curricular content were identical across both groups, ensuring that the only variable manipulated was the mode of instruction.

Research Instrument

The quantitative data were collected using a validated researcher-made acheivment test consisting of 80 multiple-choice items equally distributed across the two biology topics. All items were aligned with the competencies and standards stipulated in the curriculum guide of the K to 12 curriculum. The test instrument's Table of Specifications (TOS) ensured content validity by mapping each item to specific lerning outcomes. Expert validators from the Cotabato City Schools Division, including the Subject Area Coordinator and the School Principal reviewed the test for clarity, relevance, and difficulty. The Pilot run of the test yielded a Cronbach's alpha coefficient of 0.843, indicating high internal consistency. In addition to achievement testing, a student perception survey and open-ended interviews were conducted to gather qualitative insights on engagement, motivation, and attitudes toward gamified learning. These responses were thematically analyzed to identify common perceptions and experiences, triangulating the quantitative results with students' reflections.

Gamification

Gamification, when implemented by a teacher as an instructional intervention, transforms traditional teaching methods by incorporating game elements to enhance student engagement (Raju et al, 2021) and learning outcomes, and promoting teamwork (Rivera & Garden, 2021). Unlike the standard lecture approach, which primarily relies on verbal explanations and passive reception of information, gamification actively involves learners through interactive challenges, immediate feedback, and motivational rewards. By integrating interactive components such as quizzes and games, teachers can cultivate a dynamic classroom atmosphere that captures and maintains students' interest (Duggal et al, 2021). As shown in Table 1 is the comparative sequence or flow of instruction between the two groups in the study uisng Gagne's 9 events of instruction.

Table 1. Comparative Flow of Instruction between Conventional and Intervention Groups.

Gagne's 9 Events of Instruction	Conventional Group (Standard Lecture)	Time Allotment	Intervention Group (Gamification)
Gain Attention	Teacher starts with a brief question (prompt), or visual aid to stimulate curiosity.	**3 minutes**	Leaners are introduced through a gem teaser or short challenge (Game Ka Na Ba? buzzer round) that reveals the objectives of the day.
Inform Learners of the Objectives	Teacher states learning objectives verbally	**2 minutes**	Objectives presented as game goals or mission objectives
Stimulate Recall of Prior Learning	Teacher asks review questions about previous topic using Q and A or a short recitation.	**5 minutes**	Interactive scenarios or problem-solving tasks are explored to to recall prior knowledge
Present the Content (Stimulus Material)	Teacher discusses new lesson with slides	**15 minutes**	Students further explore examples through digital or

 doi:10.20944/preprints202601.1058.v1

	explaining Biology concepts and direct explanations.		board-based games that unlock content as they answer correctly.
Provide Learning Guidance	Teacher explains key points, uses diagrams, and more examples	**8 minutes**	Students perform team-based tasks and earn nadges or tokens as they take hints, tips, and feedback embedded in the game environment
Elicit Performance (Practice)	Students answer questions or take notes, label diagrams or answer seat works.	**7 minutes**	Students complete game tasks or engage in level-up or cooperative missions (e.g. Hormone Hero Role-Play).
Provide Feedback	Teacher reviews answers, clarifies misconceptions, and summarizes the lesson.	**5 minutes**	Students generalize concepts through peer discussion supported by leaderbaord feedback from game system; they interpret their game performance and derive key ideas.
Assess Performance	Students answer written exercises, short quizzes, or textbook-based problems.	**8 minutes**	Game level completion or score-based assessment; students complete timed quizzes.
Enhance Retention and Transfer	Teacher facilitates a short dicussion on real-life applications; or homework assignment	**7 minutes**	Unlocking bonus levels or real-world scenario challenges; Students reflect on the lesson through scenario-based games (What Would You Do? cards) connecting biological concepts to real-life behavior and health.

Course Implementation

The implementation of the course was based on Gagne's Nine Events of Instruction, ensuring that the lessons flowed consistently for both groups. Both the control (traditional) and experimental (gamified) groups studied the same materials focused on the endocrine and reproductive systems, aligned with the Grade 10 Biology curriculum. Over the course of three weeks, they received instruction in two 50-minute sessions per week, for a total of 10 contact hours. Each session adhered to Gagne's Nine Events of Instruction. The gamified condition substituted conventional and structured drills and recitations with interactive challenges such as 'Hormone Relay Race,' 'Game Ka Na Ba?,' 'Hormone Hero Scenarios', among others.

Lessons in the conventional group were taught using a standard lecture-discussion that included teacher-led discussion, with PowerPoint presentations, and diagrams. Students paid attention, made notes, and finished assignments and follow-up tests. The intervention group, on the other hand, was given the same material through gamified activities designed to increase motivation and engagement. These included team-based competitions that rewarded accuracy and cooperation, point-based challenges, badge systems, and interactive digital games. The integration of gamification in the plan follows a clear sequence: (1) introduce the game and set goals; (2) explore the content through interactive challenges; (3) provide immediate feedback and reinforcement through rewards; and (4) have a reflective discussion to link gameplay to concept understanding and application.

The same teacher-researcher, who had previously received training in incorporating game-based principles and effectively utilizing digital platforms, taught both groups. This arrangement

 doi:10.20944/preprints202601.1058.v1

ensured consistency in the pace, instructional style, and content delivery. Throughout the implementation period, the subject area coordinator closely oversaw and monitored the researcher to make sure that every instructional strategy was carried out faithfully in accordance with its intended goals and flow. Lesson plans, TOS, and tests were checked and approved by science education heads and school administrators. Game-based activities and materials were also examined.

Data Gathering Procedure

The researchers obtained ethical clearance from the Office of the Vice Chancellor for Research and Extension at Mindanao State University- Maguindanao before initiating the actual conduct of the study, with the ERC Code OVCRE-ERC-004 released January 29, 2025. Figure 1 shows the flow chart of the data gathering procedure.

Following this approval, permission was sought from the school division superintendent and the school principal of the Pilot Provincial Science High School and Technology, BARMM, Philippines. After receiving the necessary permissions, a pre-test was administered to both groups. Over a three-week instructional period, the intervention group engaged in lessons that integrated games, while the conventioanl group followed traditional teaching methods. Subsequent post-tests and retention tests were conducted, and the collected data were analyzed.

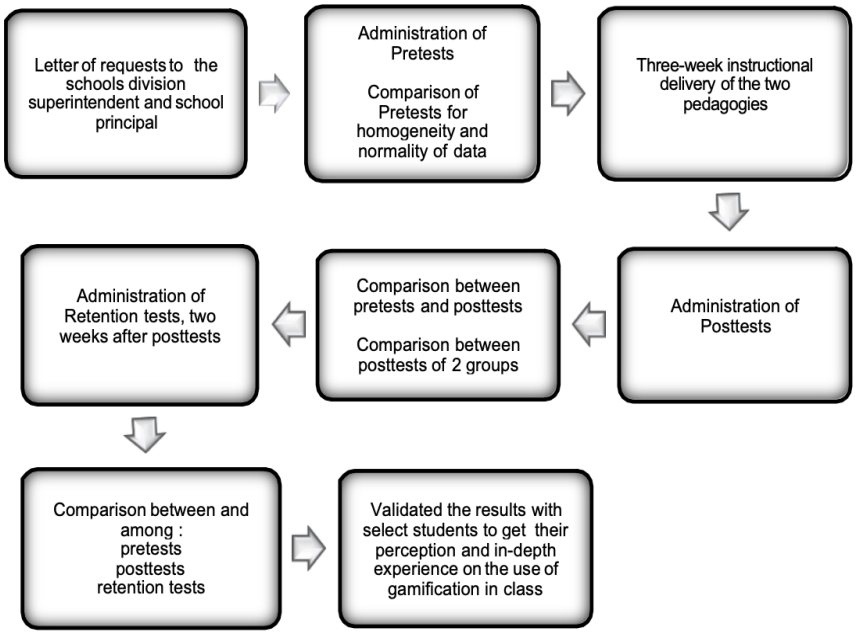

Figure 1. Flow chart for Gathering of Data.

Data Analysis Procedure

The data collected were organized and analyzed using descriptive statistics, including the mean scores and standard deviations, and inferential statistics using t-tests to compare the performance of between groups and types of tests, assessing the concept concept retention, and Cohen's d for the effect sizes. Test score improvements which were categorized using a scale ranging from "Very Low" to "Very High," and effect sizes were calculated to evaluate the effectiveness of the gamification intervention; while test performance was interpreted from "Weak Effect" to "Strong Effect".

Results and Discussions

Level of Performance Between Conventional and Intervention Groups

 doi:10.20944/preprints202601.1058.v1

Table 2 shows that both the conventional group and the intervention group had low average scores at the beginning, with means of 20.96 and 22.38. This means that participants in both groups had a low level of knowledge, skills, or performance related to the topic before any treatment or intervention was given.

Table 2. The mean scores of interventions and conventional groups in pre-test, post-test, and retention-test.

Test Type	Group	Mean Score	Description
Pre-test	Conventional	20.96	Low
	Intervention	22.38	Low
Post-test	Conventional	43.84	Moderate
	Intervention	44.96	Moderate
Retention-test	Conventional	37.62	Moderate
	Intervention	57.29	High

These low scores set a baseline for comparing later results. After the intervention, the post-test scores improved. The intervention group, which was taught using gamification, had an average score of 44.96, which falls in the Moderate range. The conventional group scored 43.84, also in the Moderate range. Even though the gamification group scored slightly higher by 1.12 points, both groups are still in the same performance category. This matches what other studies have found such as Jo et al (2018), which showed that gamification helps students improve their learning. Similarly, Lampropoulos and Sidiropoulos (2024) suggest that gamification engages students more effectively than traditional teaching methods. These studies support the idea that gamification can make learning more effective, even if the difference in scores here is small.

Regarding retention, the intervention group achieved a mean score of 57.29, which indicates a high level of retention. This shows that the intervention group performed significantly better at retaining information compared to the conventional group. The comparison of these scores clearly demonstrates that the intervention had a positive and meaningful effect on learners' ability to remember what they learned. The improvement from a moderate to a high retention level highlights how effective the intervention strategy was in helping students retain and recall the material.

This finding is supported by Zainuddin (2018) and Ortiz-Rojas et al (2019), explaining that gamification enriches the learning experience by adding game elements to education. Additionally, research shows that gamified workshops improve both short-term memory and long-term recall. For example, in a controlled trial comparing gamified and non-gamified workshops, participants in the gamified group performed much better on tests right after the workshops and kept higher knowledge levels over time (Putz & Treiblmaier, 2019). This suggests that gamification not only boosts immediate engagement but also helps students remember scientific concepts longer, especially in subjects like biology.

Many studies, including those by Huang et al. (2020) and Lai et al. (2020), have found that gamification greatly increases students' commitment and learning effectiveness. Furthermore, Zhan et al. (2022) and Mula-Falcón et al. (2022) emphasize that gamified educational strategies lead to significant improvements in motivation and academic performance.

Comparison of Test Performance of the Conventional Group

Traditional teaching methods usually rely on passive, lecture-based approaches that may not encourage deep thinking or active participation during class discussions. Such methods often lead to surface-level learning and lower retention rates, resulting in weaker long-term understanding, as explained by the forgetting curve (Eze et al., 2021). Because of this, students tend to memorize information just enough to perform well in the short term, rather than developing a deeper understanding that supports long-term retention.

As shown in Table 3, the average scores of conventional group dropped from 43.84 in the post-test to 37.62 in the retention test given two weeks later. In traditional teaching, once a lesson is over,

 doi:10.20944/preprints202601.1058.v1

students often do not review the material, which causes their memory to fade over time. This pattern matches the Ebbinghaus forgetting curve, which shows how quickly information is lost, especially soon after learning.

Table 3. The improvement in test scores of the Conventional group.

Test Comparison	Mean difference	SD	*t*- value	*p*- value	Cohen's d	Interpretation
Pre-test vs. Post-test	22.88	7.68	13.04	0.00*	0.78	Moderate effect
Pre-test vs. Retention-test	16.66	5.86	10.76	0.00*	0.52	Moderate effect
Post-test vs. Retention-test	6.22	11.83	3.98	0.00*	0.18	Weak effect

Note: * significant at 0.05 level > 1.00 (Strong effect); 0.50 – 1.00 (Moderate effect); 0.21 – 0.50 (Modest effect); 0 – 0.20 (Weak effect).

The retention tests also show that although the conventional group's scores improve somewhat, there remains a gap when compared to innovative teaching methods that encourage deeper learning and engagement, as noted by Ehsanpur and Razavi (2020) and Cheng (2023). However, Omeh and Olelewe (2021) suggest that student involvement and teaching methods together play an important role in learning outcomes for conventional groups, since greater involvement can lead to higher post-test scores. Additionally, some studies argue that while conventional groups do show improvements in pre-tests, post-tests, and retention tests, their learning is more effective when combined with other educational strategies (Lee et al., 2024; James, 2024; Ugwoke et al., 2020).

Comparison of Test Performance of the Intervention Group

Table 4 shows that the gamification intervention had a statistically significant and moderately large effect on learners' performance right after it was applied. The biggest change was seen when comparing the pre-test and the retention test, with an average increase of 34.91 points. From the pre-test to the post-test, there was also a significant increase of 22.58 points.

This improvement was statistically significant, with a t-value of 13.45 and a p-value of 0.00, and it showed a moderate effect size (Cohen's d = 0.80). The difference between the post-test and retention test was also statistically significant (t = 23.30, p = 0.00) with a moderate effect size (Cohen's d = 0.69). These results clearly show that the intervention had a significant and lasting impact on learners' performance after just a few days. Supporting this, a study by Putz et al. (2020) found similar results, with an average increase of 22.58 points from pre-test to post-test, and an even larger improvement of 34.91 points in retention test scores. This highlights the benefits of gamified learning experiences.

Table 4. The improvement in test scores of the intervention group.

Test Comparison	Mean difference	SD	*t*- value	*p*- value	Cohen's d	Interpretation
Pre-test vs. Post-test	22.58	7.80	13.45	0.00*	0.80	Moderate effect
Pre-test vs. Retention-test	34.91	6.66	23.30	0.00*	0.69	Moderate effect
Post-test vs. Retention-test	12.33	10.36	5.81	0.00*	0.24	Modest effect

Note: * significant at 0.05 level > 1.00 (Strong effect); 0.50 – 1.00 (Moderate effect); 0.21 – 0.50 (Modest effect); 0 – 0.20 (Weak effect).

When comparing the post-test to the retention test, the scores improved further by 12.33 points. Although the effect size was modest (Cohen's d = 0.24), this improvement was still statistically significant (t = 5.81, p = 0.00). This suggests that learners not only retained their knowledge over time

 doi:10.20944/preprints202601.1058.v1

but also built on it slightly, even though the gain was smaller than the initial improvement seen after the post-test.

Similar findings were reported by Salama and Daraghmi (2025), who noted that gamified classes not only increased student motivation but also improved performance (Taghipour et al., 2023) and interaction among students. This supports the idea that gamification offers multiple benefits.

Supporting this, Gündüz and Akkoyunlu (2020) found that adding gamification to flipped learning increased student engagement and understanding, showing that gamified methods work well across different academic subjects. Abed Khasawneh et al. (2024) further explored how skills gained in gamified environments last over time, indicating that the educational benefits continue well beyond the immediate intervention. This is important for educators who want to create lasting learning effects through innovative teaching methods.

Comparison of Concept Retention between the Conventional and Intervention Groups

The results in Table 5 show a statistically significant difference in concept retention scores between the conventional and intervention groups. The intervention group had a higher average score of 57.29, while the conventional group scored lower, with a mean of 37.62. Their standard deviations were 9.13 and 6.06, respectively. The t-value of 11.95 and a p-value of 0.00 confirm that this difference is statistically significant at the 0.05 level.

Gambari et al. (2024) found that gamification had a positive effect on both achievement and retention among secondary biology students. The use of game elements like competitive scoring and immediate feedback appears to encourage greater participation and improve concept retention (Felszeghy et al., 2019; Rai et al., 2019; Babicz, 2025) compared to traditional teaching methods.

Table 5. The comparison of concept retention scores between conventional and intervention groups.

Group	Mean	SD	t-value	p-value	Interpretation
Conventional	37.62	6.06	11.95	0.00*	significant
Intervention	57.29	9.13			

Note: * significant at 0.05 level.

Several studies have shown that innovative teaching strategies, such as gamified approaches, effectively improve students' participation and retention of biological concepts (Sionillo, 2024; Thongmak, 2019). The study found that students who learned through gamification scored significantly higher (M = 57.29) than those who attended traditional lectures (M = 37.62), clearly showing the benefits of gamified learning environments (Oliveira et al., 2025). This is further supported by Varol Selçuk and Özer Keskin (2024), whose systematic review highlights how gamification in biology education improves motivation and promotes deeper learning experiences.

Perception of Students on the Use of Gamification

Figure 2 shows the four (4) different themes that emerged from the data which elucidate the the different students' perception on the use of gamification in teaching biology.

 doi:10.20944/preprints202601.1058.v1

Figure 2. Simulacrum of Themes on the Use of Gamification as Perceived by Students.

Students perceive gamification as a valuable teaching approach that makes learning enjoyable, improves understanding and retention, gives motivation and confidence, and promotes social interaction. While the benefits are clear, the effectiveness of gamification depends on thoughtful integration with educational goals, access to technology, and careful facilitation to ensure inclusive and meaningful learning experiences. Educators should consider these factors to fully harness the potential of gamification in creating engaging and supportive classrooms.

Increased Engagement and Enjoyment

Students consistently expressed that gamification made learning more fun and exciting, often describing it as "playing while learning," which helped them stay focused and motivated. For example, Student 1 (Male) said, "*Gamification made the lesson more fun and exciting. It felt like playing while learning, which kept me more focused."* Similarly, Student 6 (Female) shared, *"I enjoyed very much when gamification was used in our class… Nagiging kakaiba rin po ang atmosphere ng klase, mas masigla, mas cooperative, at mas nakakaengganyo."* These statements highlight how gamification can transform the classroom atmosphere into a lively and enjoyable environment that encourages active participation. However, despite these positive effects, challenges remain in implementing gamification effectively, especially in online settings. Almusharraf (2023) notes that limited access to technology and students' unfamiliarity with digital platforms can hinder the full potential of gamified learning. This suggests that while gamification can boost engagement, its success depends on addressing infrastructural and digital literacy barriers.

Improved Understanding and Retention of Lessons

Students reported that gamification helped them understand and remember lessons better than traditional methods. The interactive nature of games made concepts clearer and more memorable. For instance, Student 4 (Female) explained, *"Mas nagiging memorable po yung lesson kasi nagfufunction yung utak ko… isa potalagasiyang epektibong paraan para mas maintindihan at maalala namin 'yung mga itinuturo."* Student 3 (Female) also noted, *"Gamification can easily help you retain information about our certain lesson… while you are enjoying the game you can also learn and gain knowledge."* These reflections suggest that gamification supports deeper learning by making lessons more engaging and easier to recall. Supporting this, Nguyen-Viet et al. (2025) found that gamified learning increases students' commitment, making education both enjoyable and rewarding. Still, it is important to ensure that gamification aligns with learning objectives to avoid superficial engagement that does not translate into meaningful understanding.

Motivation and Confidence Boost

 doi:10.20944/preprints202601.1058.v1

Gamification appeared to increase the motivation of students and reduce their fear of making mistakes. Student 3 (Female) said, *"Mas nagkaroon ako ng motivation na galingan, hindi lang para manalo, kundi para matuto talaga."* Student 5 (Female) added, *"Hindi na ako natatakot magkamali kasi lahat kami ay natututo habang nag-e-enjoy."* These comments show how gamification's competitive and rewarding elements, such as points and rankings, encourage students to participate more actively and build confidence in their learning. Research supports these observations, showing that gamification enhances intrinsic motivation by cultivating autonomy and social connection (Li et al., 2024). Huang and Wang (2025) also highlight how gamification influences emotional responses that affect cognitive engagement and learning success. However, as Gaurina et al. (2025) caution, motivation gains must be balanced with curriculum goals to ensure that gamification supports educational outcomes rather than distracting from them.

Social Interaction and Collaboration

Gamified lessons encouraged better social interaction and collaboration among students, making learning a shared and cooperative experience. Student 2 (Female) remarked, *"It can improve my behavior and performance by having a good socialize with my classmates."* Student 6 (Female) also noted, *"Kapag may games nagkakatawanan din, hindi na naiiwasan, kaya sobrang na enjoy ko."* These insights show that gamification not only enhances academic learning but also builds positive relationships and teamwork skills. This aligns with Candel et al. (2024), who argue that gamification transforms learning tasks into more interactive and attractive experiences by incorporating game-like elements. However, the quality of social interaction depends on how gamification is designed and facilitated. Poorly structured gamified activities may render unhealthy competition or exclude some students, limiting social benefits.

Conclusion

This study shows that both conventional and gamified teaching methods started with students having low knowledge and skills related to the topic. After the lessons, both groups improved to a moderate level, with the gamification group scoring slightly higher. More importantly, the gamification group demonstrated a significantly better ability to retain information over time, reaching a high retention level compared to the conventional group. The results confirm that gamification not only helps students learn but also supports longer-lasting understanding and recall. Students also reported that gamified lessons were more enjoyable, motivating, and encouraged better social interaction. These findings align with previous research showing that gamification enhances engagement, motivation, and academic performance, especially in subjects like biology.

Recommendations

Educators should consider incorporating gamified elements into their lessons to boost student engagement, motivation, and retention of knowledge. Moreover, schools and institutions need to ensure students have access to the necessary technology and digital skills to fully benefit from gamified learning, especially in online settings. Gamified activities should be carefully designed by educators to support curriculum objectives and promote meaningful learning rather than just competition or entertainment. Further, educators should cultivate an inclusive environment where all students feel motivated and confident to participate without fear of mistakes. The use of gamification enhances social interaction and teamwork, but there must be monitoring to avoid unhealthy competition or exclusion.

Implications

This study highlights the potential of gamification as an effective teaching strategy that can transform traditional classrooms into more interactive, enjoyable, and productive learning environments. By improving not only immediate learning outcomes but also long-term retention,

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gamification offers a promising approach to address challenges in student motivation and engagement. For educators and policymakers, investing in gamified learning tools and training can lead to better academic performance and deeper understanding among students. However, successful implementation requires attention to technology access, thoughtful instructional design, and balancing motivational elements with educational goals to maximize benefits for all learners.

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