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AN IN-DEPTH INQUIRY INTO THE TRANSFORMATIVE POTENTIAL OF GAMIFICATION STRATEGIES

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ABSTRACT

This descriptive study aimed to investigate the concept of gamification and its potential applications in education. This involves the level of gamification strategies for learning enhancement; level of students' engagement; mean performance of students after using gamification strategies; level of gamification strategies for learner's performance; utilization of gamification strategies effect students' sustainable engagement; and contribution of gamification strategies to the engagement of learning in Earth Science within the STEM students.

On the other hand, mixed method of research was utilized in this study. Checklist questionnaire was formulated and given to eighty-nine (89) respondents, who were selected purposively as the Grade 11 STEM students at Philippine Women's University – CDCEC Sta. Cruz Campus, Sta. Cruz, Laguna. The researcher also conducted an interview to four (4) selected students from the mentioned school. Statistical analysis, including measures such as the mean average, standard deviation, and paired t-test, was employed in the course of this research endeavor.

The findings revealed that the effectiveness of various gamification strategies for sustaining student engagement. "Gamified Assessment" emerged as the most effective, closely followed by "Interactive Simulation" and "Real-world Case," all achieving very high scores. Despite a slightly lower score, "Collaborative Game" also showed considerable effectiveness. As a whole, gamification strategies significantly enhance student engagement to a very high degree. The interpretation of "very great extent" further emphasizes the widespread recognition of the effectiveness of gamification in fostering sustained student engagement. The students performed better after utilizing gamification strategies. Their level of student's performance has significantly improved from low to very high.

Gamification strategies greatly and extremely raise student engagement. The degree of gamification strategies for sustainable engagement attained a high mean score with respect to students' sense of fulfillment, sense of belonging, active participation, and collaboration, demonstrating broad acceptance of their efficacy. After applying gamification techniques, students also demonstrated higher performance in analytical, critical, and problem-solving abilities, showing a notable improvement. A significant relationship between gamification techniques and long-term involvement is supported by the regression analysis, and key components include gamified assessment, mission challenge, interactive simulation, collaborative game, and real-world case.

It is highly suggested that teachers may utilize a variety of gamification techniques. Teachers may keep using gamification strategies to raise enthusiasm and participation levels among students in class that meet the interests and preferences of a wide range of students. A study is recommended to compare traditional and gamified instructional approaches in various academic settings to understand their effectiveness in enhancing student performance. Educational researchers may investigate the role of teacher training and support in implementing effective gamification strategies for problem-solving instruction. Educators may incorporate influential factors into educational interventions. This will enhance student engagement and promote sustained learning. Teachers may design gamified activities that encourage students to apply, analyze, evaluate, and synthesize information within meaningful contexts, thereby facilitating the development of advanced cognitive skills essential for success in academic and professional endeavors.

KEYWORDS: *Gamification Strategies; Transformative Potential; learning enhancement*

1. INTRODUCTION

Teachers take an active part in the teaching and learning process as a result of the new route that globalization has created for education globally. In this sense, pedagogy is placing greater emphasis on the roles that students play during learning sessions, particularly how this is in line with 21st century learning strategies (Amran et al., 2019). When the standard technique is used, Kamarudin et al. (2019) found that student engagement in teaching and learning is poor. To become a teacher who can convey information to their students utilizing a range of engaging approaches and strategies, it is therefore imperative to have an in-depth knowledge of teaching methods and procedures. The best strategy for information transfer must be used by teachers.

The utilization of gamification strategies in the field of STEM (Science, Technology, Engineering, and Mathematics) education has become a focal point of innovation and inquiry in contemporary educational practices. In recent years, educators and researchers have increasingly turned their gaze toward the application of gamified techniques, drawn from the world of gaming and interactive technologies, as a means to

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revolutionize traditional classroom experiences. This paradigm shift is fueled by the recognition of gamification's immense potential to engage, inspire, and, ultimately, empower students within the multifaceted domain of STEM education.

Within this vibrant landscape of pedagogical innovation, Earth Science emerges as a particularly intriguing and challenging subject of study. The Earth Sciences, encompassing disciplines like geology, meteorology, oceanography, and environmental science, offer a profound and holistic understanding of our planet and its intricate systems. However, these very complexities often render Earth Science education daunting and demanding, eliciting apprehension among students who must navigate its intricacies.

Against this backdrop, the present research embarks on a noble quest—to explore the profound impact of gamification within the niche domain of Earth Science education. It seeks to delve deeply into the effectiveness of gamification strategies in motivating students to engage with this captivating yet intricate subject matter. Moreover, it endeavors to ascertain whether gamification can serve as a catalyst for the improvement of learning outcomes, ultimately dismantling the barriers that often hinder students from realizing their full potential in Earth Science.

This research aims to revitalize Earth Science education and reshape STEM pedagogy by incorporating gamification. By pushing conventional instruction boundaries, gamification can create an engaging, transformative, and sustainable education. This intellectual journey aims to uncover the transformative potential of gamification in Earth Science, paving the way for a more enlightened generation of Earth Science enthusiasts and scholars.

1.1 Statement of the Problem

Specifically, it sought to answer the following questions:

1. What is the level of gamification strategies for learning enhancement in Earth Science:
   - 1.1 Interactive Simulation;
   - 1.2 Mission Challenge;
   - 1.3 Collaborative Game;
   - 1.4 Real-world Case; and
   - 1.5 Gamified Assessment?
2. What is the level of students' engagement in terms of:
   - 2.1 sense of fulfillment;
   - 2.2 sense of belonging;
   - 2.3 active participation; and
   - 2.4 collaboration?
3. What is the mean performance of students after using gamification strategies in terms of:
   - 3.1 analytical;
   - 3.2 critical; and
   - 3.3 problem-solving?
4. Is there a significant difference on the student's performance before and after utilizing gamification strategies?
5. Do the utilization of gamification strategies effect students' sustainable engagement?
6. How do gamification strategies contribute to the engagement of learning in Earth Science within the STEM students?

2. METHODOLOGY

The research method used in this study was descriptive method of research to examine the transformative potential of gamification strategies for sustainable engagement in Earth Science. The descriptive design was appropriate for this study, which assessed the STEM students' engagement and performance.

Voxco (2021) suggested that the goal of a descriptive study design is to gather data that may be used to systematically characterize a phenomena, circumstance, or population. It especially aids in addressing the study problem's what, when, where, and how questions as opposed to its why.

The descriptive method of research allows for the investigation of the target variables using a wide range of research techniques. Although occasionally qualitative data is employed for descriptive purposes, it primarily uses quantitative data.

Descriptive survey research extends beyond simple data collection and tabulation, encompassing interpretation to derive meaning or significance from the findings. The researcher advocates for the descriptive method as the most suitable research approach for this study.

3. RESULTS AND DISCUSSION

This chapter presents the results of a study on gamification strategies for learning enhancement in Earth Science, focusing on student engagement, performance after and after use. It discusses the significant effect of gamification strategies on sustainable engagement, and the significant difference in student performance before and after gamification. The data collected from the study is presented in tabular presentations.

Level of Utilizing Gamification Strategies for Students' Sustainable Engagement

This section evaluates the level of gamification strategies utilized for enhancing learning in Earth Science. These strategies encompass Interactive Simulation, Mission Challenge, Collaborative Game, Real-world Case, and Gamified Assessment.

The following table shows the statement, mean, standard deviation and the verbal interpretation. Mean score and standard deviation obtained from the points given by the respondents for each statement can be remarked as strongly agree, agree, moderately agree, disagree and strongly disagree. Moreover, from the remarks given, the verbal interpretation can be determined as very high, high, moderately high, low and very low.

The level of students' learning engagement in Earth Science is analyzed and determined. It presents the statements, mean, standard deviation and verbal interpretation in terms of

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instructions.

Table 1 illustrates the level of utilizing gamification strategies for students' sustainable engagement in Earth Science in terms of Interactive Simulation. With a weighted mean of 4.80 and a standard deviation of 0.26, the level of gamification strategies for promoting sustained student engagement through Interactive Simulation is assessed as very high.

Table 1. *Level of utilizing gamification strategies for students' sustainable engagement in terms of Interactive Simulation*

STATEMENTS	***MEAN***	***SD***	***REMARKS***
1. The use of interactive simulation makes the classes enjoyable and dynamic.	4.78	0.44	Strongly Agree
2. The use of interactive simulation allows active discussion of misconceptions to build knowledge.	4.78	0.41	Strongly Agree
3. The use of interactive simulation improves my learning performance in Earth Science.	4.86	0.35	Strongly Agree
4. The use of interactive simulation evaluates my comprehensive knowledge of each topic covered during the classes.	4.83	0.38	Agree
5. The use of interactive simulation helps me more focused during the Earth Science classes.	4.74	0.44	Strongly Agree
Weighted Mean		*4.80*	
SD		*0.26*	
Verbal Interpretation		*Very High*	

Students strongly agree that utilizing gamification strategies particularly interactive simulation enhance their performance *(M=4.86, SD=0.35)*. Moreover, interactive simulation have been instrumental in fostering student engagement and focus during each Science class *(M=4.74, SD=0.44)*.

The level of gamification strategies for students' sustainable engagement in terms of Interactive Simulation attained a weighted mean score of 4.80 and a standard deviation of 0.26 and was Very High among the respondents.

The data in Table 1 showcases the effectiveness of gamification strategies, particularly through Interactive Simulation, in enhancing students' engagement. The result shows that interactive simulations, when paired with effective teaching, can be highly effective tools.

Table 2 illustrates the level of utilizing gamification strategies for students' sustainable engagement in terms of Mission Challenge. The calculated weighted mean of 4.69, along with a standard deviation of 0.35, indicates an exceptionally high level of gamification strategies aimed at fostering sustained student engagement via Mission Challenges.

Table 2. Level of utilizing gamification strategies for students' sustainable engagement in terms of Mission Challenge

STATEMENTS	***MEAN***	***SD***	***REMARKS***
1. Mission challenges allow me to voice my ideas effectively to the class.	4.58	0.52	Strongly Agree
2. Mission challenges allow me to build interactions that enhanced my learning.	4.76	0.45	Strongly Agree
3. Mission challenges motivate me to think critically.	4.63	0.57	Strongly Agree
4. Mission challenges improve my participation in class behind anonymity.	4.68	0.54	Strongly Agree
5. Mission challenges allow active discussion of misconceptions to build my knowledge.	4.78	0.44	Strongly Agree
Weighted Mean		*4.69*	
SD		*0.35*	
Verbal Interpretation		*Very High*	

The statement indicating that mission challenges facilitate active discussions of misconceptions to enhance knowledge garnered the highest mean score *(M=4.78, SD=0.44)* and was strongly agreed upon. Conversely, the statement regarding the effectiveness of voicing ideas during mission challenges received the lowest mean score *(M=4.58, SD=0.52)*, despite also being strongly agreed upon.

Integrating mission challenges as a gamification strategy in teaching and learning revolutionizes the educational experience, enhancing student engagement and improving learning outcomes. By framing learning objectives as missions, educators tap into students' intrinsic motivation, turning learning into an adventure.

This approach fosters greater retention, creative application of knowledge, and deeper understanding of the subject matter. Ultimately, integrating mission challenges harnesses the power of gamification to make learning more enjoyable, meaningful, and effective.

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The level of gamification strategies for students' sustainable engagement in terms of Mission Challenge attained a weighted mean score of 4.69 and a standard deviation of 0.35 and was Very High among the respondents.

Understanding how different student characteristics interact with gamified learning environments can inform personalized instructional design and intervention strategies. Mission challenges captivate students' interest by presenting learning goals as quests or missions. This framework gives tasks meaning, motivating students to embark on educational adventures. As students utilize challenges, they actively participate in learning, driven by intrinsic motivation to succeed. Research shows that gamified learning significantly boosts student engagement and motivation, fostering a positive attitude toward learning.

Beyond motivation, mission challenges facilitate the development of a wide range of cognitive and socio-emotional skills. Students engage in problem-solving, critical thinking, decision-making, and creativity as they tackle obstacles and achieve mission objectives. Collaborative missions promote teamwork, communication, and leadership skills, preparing students for success in collaborative work environments.

Furthermore, the immediate feedback provided in gamified platforms allows for timely adjustments and scaffolding, leading to improved learning outcomes and knowledge retention.

Table 3 illustrates the level of utilizing gamification strategies for students' sustainable engagement in terms of Collaborative Game. The weighted mean of 4.76 with a standard deviation of 0.29 indicates a very high level of gamification strategies for fostering sustainable engagement among students in collaborative games.

Table 3. Level of utilizing gamification strategies for students' sustainable engagement in terms of Collaborative Game

STATEMENTS	***MEAN***	***SD***	***REMARKS***
1. Collaborative gaming motivates me to engage in the course discussions.	4.80	0.41	Strongly Agree
2. Collaborative gaming enhances my ability to engage in lifelong learning.	4.75	0.44	Strongly Agree
3. Collaborative gaming improves my participation in classes behind anonymity.	4.75	0.46	Strongly Agree
4. Collaborative gaming helps me learn more due to my participation in the discussions.	4.75	0.46	Strongly Agree
5. Collaborative gaming makes me feel confident about posting to the discussion forums after observing my classmates	4.75	0.49	Strongly Agree
Weighted Mean		*4.76*	
SD		*0.29*	
Verbal Interpretation		*Very High*	

The examination of responses revealed that the statement suggesting that collaborative gaming serves as motivation for participating in course discussions received the highest mean score *(M=4.80, SD=0.41)*, with strong agreement. In contrast, the statement indicating that collaborative gaming contributes to enhancing lifelong learning skills received the lowest mean score *(M=4.75, SD=0.44)*, despite still being strongly agreed upon. These results imply that collaborative gaming effectively encourages engagement in course discussions and also positively influences students' abilities for lifelong learning.

Students' strongly agreed (M=4.80, SD=0.41) that collaborative gaming serves as motivation for participating in course discussions. This suggests a widespread consensus among students that engaging in collaborative gaming activities significantly enhances their enthusiasm and willingness to actively contribute to discussions within the course. Such findings underscore the potential of collaborative gaming as an effective tool for not only fostering engagement but also promoting meaningful interaction and learning experiences among students.

Through collaborative gaming experiences, students are empowered to take ownership of their learning journey, develop mastery of subject matter, and establish meaningful connections with peers. These intrinsic motivators not only drive sustained engagement but also foster a deeper sense of fulfillment and satisfaction in the learning process.

Furthermore, collaborative gaming offers a multitude of benefits beyond mere motivation for participation in course discussions. It promotes the development of essential 21st-century skills, such as critical thinking, communication, collaboration, and problem-solving, which are increasingly valued in today's rapidly evolving society. By immersing students in immersive and interactive learning experiences, collaborative gaming nurtures their ability to think creatively, adapt to challenges, and work effectively in diverse team settings.

Collaborative gaming has the potential to democratize learning by providing equal opportunities for participation and engagement among students of varying backgrounds and abilities. In a collaborative gaming environment, all students have a voice and can contribute meaningfully to the collective learning experience, irrespective of their academic proficiency or socio-economic status. This inclusivity fosters a sense of belonging and empowers students to embrace their unique

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strengths and perspectives.

This suggests that Collaborative Game approaches not only enhance motivation for course discussions but also contribute to students' long-term learning capabilities, aligning well with the goals of promoting sustained engagement and fostering lifelong learning habits.

Table 4 illustrates the level of gamification strategies for students' sustainable engagement in terms of Real-world Case. The analysis reveals that the level of utilizing gamification strategies employed to enhance students' sustained engagement through Real-world Cases is exceptionally high, with a weighted mean of 4.80 and a standard deviation of 0.25.

Table 4. Level of utilizing gamification strategies for students' sustainable engagement in terms of Real-world Case

STATEMENTS	***MEAN***	***SD***	***REMARKS***
1. Real-world application allows me to formulate and implement solutions to real-life problems.	4.78	0.41	Agree
2. Real-world application motivates me to engage more with the subject.	4.82	0.39	Strongly Agree
3. Real-world application gives me more time exploring the topics due to the real-world application in a gamified approach.	4.82	0.39	Strongly Agree
4. Real-world application is an effective way to teach earth science.	4.78	0.44	Strongly Agree
5. Real-world application provides valuable information to improve my learning process.	4.77	0.45	Strongly Agree
Weighted Mean		*4.80*	
SD		*0.25*	
Verbal Interpretation		*Very High*	

Students highly value the incorporation of real-world application into their learning experiences. Real-world application for students serves as a motivation for deeper engagement with the subject and provides opportunities for extended exploration within a gamified context received the highest mean score *(M=4.82, SD=0.39)*, indicating strong agreement among respondents.

These results emphasize the significance of incorporating immersive and real-world elements into education to improve student engagement, learning outcomes, and overall satisfaction with the educational experience.

Despite slightly lower scores *(M=4.77, SD=0.45)*, the statement emphasizing the valuable information gained from real-world application for enhancing the learning process still received strong agreement. Overall, these findings highlight the significant positive impact of integrating real-world application into educational approaches, particularly within a gamified framework, on students' motivation and learning experiences.

The significant benefits of incorporating real-world application into educational methods, especially within a gamified structure, on students' motivation and learning encounters cannot be overstated. This approach not only enhances students' enthusiasm for learning but also enriches their understanding by connecting theoretical concepts to real-world scenarios. By immersing students in practical contexts, such as simulations or problem-solving tasks based on real-world situations, educators can foster deeper engagement and facilitate a more profound grasp of the subject matter.

Furthermore, within a gamified framework, where elements of competition, collaboration, and achievement are integrated, students are not only motivated to actively participate but also encouraged to explore and experiment, thereby promoting a more dynamic and interactive learning environment. This holistic approach not only enhances students' academic performance but also cultivates essential skills such as critical thinking, problem-solving, and decision-making, which are crucial for success in today's complex world.

Table 5 illustrates the level of utilizing gamification strategies for students' sustainable engagement in terms of Gamified Assessment. The assessment of gamification strategies aimed at fostering sustainable student engagement through Gamified Assessment indicates a remarkably high level, with a weighted mean of 4.84 and a standard deviation of 0.22, categorizing it as very high.

Table 5. Level of utilizing gamification strategies for students' sustainable engagement in terms of Gamified Assessment

STATEMENTS	***MEAN***	***SD***	***REMARKS***
1. Gamified assessment enhances my engagement in learning the subject matter.	4.84	0.37	Agree
2. Gamified assessment motivates me to study and participate actively in lessons.	4.83	0.38	Strongly Agree
3. Gamified assessment encourages me to explore and comprehend complex concepts.	4.80	0.41	Strongly Agree
4. Gamified assessment contributes to my sense of	4.82	0.39	Strongly Agree

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achievement and progress in lifelong learning.			
5. Gamified assessment enhances my academic progress and understanding of the lessons.	4.91	0.29	Strongly Agree
Weighted Mean		*4.84*	
SD		*0.22*	
Verbal Interpretation		*Very High*	

The gamified assessment that enhances academic progress and understanding of the lessons received the highest mean score (M=4.91, SD=0.29) from the students and was strongly agreed upon. The overwhelmingly positive response from students regarding the gamified assessment that enhances academic progress and understanding underscores its effectiveness in facilitating learning. With the highest mean score and strong agreement, it is clear that students perceive this form of assessment as highly beneficial for their educational journey.

Conversely, the gamified assessment that encourages exploration and comprehension of complex concepts received the lowest mean score (M=4.80, SD=0.41), yet it was still strongly agreed upon. Despite receiving the lowest mean score, the fact that the gamified assessment also encourages exploration and comprehension of complex concepts, and was still strongly agreed upon, highlights its multifaceted impact on student learning. These findings affirm the value of integrating gamified assessment into educational practices, not only for enhancing academic progress and understanding but also for promoting active exploration and comprehension of challenging topics.

Utilizing gamified techniques into assessments not only enhances student engagement but also deepens their understanding of complex concepts. By incorporating game elements such as points, levels, and challenges into assessments, educators can create a more interactive and immersive learning experience. This approach not only motivates students to actively participate but also provides them with immediate feedback, allowing for continuous improvement.

Table 6 verifies the composite table of gamification strategies for students' sustainable engagement. The compilation of gamification strategies for fostering students' sustained engagement shows an overall mean of 4.78, with a standard deviation of 0.27, suggesting a highly effective level across the board.

Level of Students' Sustainable Engagement

The study examines students' engagement in Earth Science, focusing on sense of fulfillment, belonging, active participation, and collaboration. The mean score and standard deviation are categorized as strongly agree, moderately agree, disagree, and strongly disagree. The verbal interpretation is categorized as very high, high, moderately high, low, and very low. The analysis provides insights into students' learning engagement in Earth Science.

Table 6 illustrates the level of gamification strategies for students' sustainable engagement in terms of sense of fulfillment. Students' sustained engagement, as measured by their sense of fulfillment, is rated as very high, with a weighted mean of 4.78 and a standard deviation of 0.27.

Table 6. Level of students' sustainable engagement in terms of sense of fulfillment

STATEMENTS	***MEAN***	***SD***	***REMARKS***
1. Gamification strategies give greater fulfillment when successfully applying gamified knowledge to real-world scenarios.	4.80	0.41	Strongly Agree
2. Gamification strategies contribute to a more fulfilling learning experience.	4.76	0.43	Strongly Agree
3. Gamification strategies give me a sense of accomplishment when completing gamified learning tasks.	4.72	0.45	Agree
4. Gamification strategies made the learning experience more enjoyable for me.	4.78	0.41	Strongly Agree
5. Gamification strategies make me experience a positive emotional response, such as joy or satisfaction.	4.84	0.37	Strongly Agree
Weighted Mean		*4.78*	
SD		*0.27*	
Verbal Interpretation		*Very High*	

The gamification strategies lead to a positive emotional response, such as joy or satisfaction, garnered the highest mean score *(M=4.84, SD=0.37)*, strongly agreed upon by students.

This highlights the significance it is to apply gamification strategies in educational settings to encourage students' positive emotional experiences and sense of fulfillment.

Charles (2023) delves into students' motivation to learn using gamification, revealing that satisfaction plays a significant role in driving engagement.

On the flip side, the gamification strategies provide a sense of accomplishment when completing gamified learning tasks received the lowest mean score *(M=4.72, SD=0.45)*, although

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it was still considered agreeable.

Table 8 illustrates the level of gamification strategies for students' sustainable engagement in terms of sense of belonging. Students' sustained engagement, gauged through their sense of belonging, is notably high, with a weighted mean of 4.76 and a standard deviation of 0.31, indicating a strong sense of connection and inclusion.

Table 8. Level of Students' Sustainable Engagement in terms of sense of belonging

STATEMENTS	*MEAN*	*SD*	*REMARKS*
1. Gamification strategies enhance my connection to Earth Science concepts and content.	4.85	0.36	Strongly Agree
2. Gamification strategies facilitate participants' shared understanding and engagement with Earth Science topics.	4.72	0.45	Strongly Agree
3. Gamification strategies foster a supportive and encouraging learning environment.	4.74	0.49	Agree
4. Gamification strategies give a sense of camaraderie and support from my peers and instructor.	4.69	0.55	Strongly Agree
5. Gamification strategies make me perceive a sense of belonging to a shared purpose in advancing Earth Science education.	4.78	0.44	Strongly Agree
Weighted Mean		*4.76*	
SD		*0.31*	
Verbal Interpretation		*Very High*	

The gamification strategies deepen students' understanding of Earth Science concepts and content and achieved the highest mean score *(M=4.85, SD=0.36)*, strongly agreed upon by students. This implies that students view gamification as a successful approach for improving their understanding of Earth Science subjects. Moreover, the substantial mean score indicates widespread agreement among students regarding the beneficial influence of gamification on their learning journey in this field.

Also, this shows that students strongly agreed that the gamification strategies foster a sense of camaraderie and support from peers and instructors, despite this aspect obtaining the lowest mean score *(M=4.69, SD=0.55)*.

Gamification strategies notably enhance students' sense of belonging in Earth Science education, with strong agreement seen in both fostering connections to concepts and content and promoting camaraderie and support from peers and teachers.

The strong agreement across gamification strategies facilitates students' shared understanding and engagement with Earth Science topics, fostering a collaborative learning environment. Lastly, the perception of a shared purpose in advancing Earth Science education highlights the alignment of gamification strategies with broader educational goals, promoting a sense of belonging and motivation among students. Overall, these implications underscore the multifaceted benefits of incorporating gamification techniques in Earth Science education, enhancing both individual learning experiences and collective engagement with the subject matter.

From the results, it indicates their significant effectiveness in cultivating a sense of belonging within the educational context. This highlights the importance of integrating gamification approaches to foster connection and support among students and instructors in Earth Science education.

Table 9 illustrates the level of gamification strategies for students' sustainable engagement in terms of active participation. The level of students' sustained engagement, as assessed by their active participation, is categorized as very high, with a weighted mean of 4.80 and a standard deviation of 0.27, indicating robust and consistent involvement in activities.

Table 9. Level of Students' Sustainable Engagement in terms of Active Participation

STATEMENTS	*MEAN*	*SD*	*REMARKS*
1. Gamification strategies motivate me to participate actively in class activities.	4.90	0.30	Strongly Agree
2. Gamification strategies make me consistently engaged and involved throughout the session.	4.75	0.44	Strongly Agree
3. Gamification strategies give me a sense of excitement and eagerness to participate in activities that incorporated gamification elements.	4.85	0.36	Agree
4. Gamification strategies foster valuable techniques for improving my overall learning experience.	4.73	0.47	Strongly Agree
5. Gamification strategies make me feel more confident answering the class questions.	4.76	0.50	Strongly Agree
Weighted Mean		*4.80*	
SD		*0.27*	

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Verbal Interpretation	*Very High*

It was discovered that the gamification strategies effectively encouraged respondents to engage actively in class activities, receiving the highest mean score *(M=4.90, SD=0.30)* and strong agreement.

These implications highlight the broader impact of gamification on student engagement across various learning contexts and underscore its potential to promote active participation and involvement in educational settings.

Gamification strategies were observed to foster valuable techniques for improving my overall learning experience, despite receiving the lowest mean score of responses *(M=4.73, SD=0.47)*. Nevertheless, it was strongly agreed upon. Despite receiving a low mean score, the strong agreement suggests that students find gamification strategies valuable for their learning experience.

Despite receiving a low mean score, the strong agreement among students regarding the value of gamification strategies stresses their significance in enhancing learning experiences. Furthermore, research indicating increased student participation and engagement due to gamification reinforces its effectiveness as an educational approach. Utilization of gamification strategies into teaching practices promote active learning and foster student engagement.

This indicates that gamification strategies effectively promote a strong active participation among respondents highlighting the consensus among students regarding the effectiveness of these strategies in fostering a supportive and inclusive learning environment.

Table 10 evaluates gamification strategies for sustainable student engagement, focusing on collaboration. Results show high engagement, consistent participation, and effective teamwork, with a mean score of 4.80 and a low standard deviation of 0.28.

Table 10. Level of students' sustainable engagement in terms of collaboration

STATEMENTS	***MEAN***	***SD***	***REMARKS***
1. Gamification strategies facilitate meaningful interactions and collaboration with my peers.	4.86	0.35	Strongly Agree
2. Gamification strategies encourage collaborative problem-solving and teamwork with my classmates	4.76	0.43	Strongly Agree
3. Gamification strategies positively influence group dynamics, fostering a sense of cohesion and shared purpose among participants.	4.75	0.46	Agree
4. Gamification strategies promote effective communication and collaboration within my learning group.	4.85	0.36	Strongly Agree
5. Gamification strategies will positively impact my future STEM-related collaborations.	4.78	0.44	Strongly Agree
Weighted Mean		*4.80*	
SD		*0.28*	
Verbal Interpretation		*Very High*	

The result indicates a widespread agreement among students regarding the effectiveness of gamification strategies in enhancing students' collaboration. It was noted that the gamification strategies facilitate meaningful interactions and collaboration with my peers which received the highest mean score *(M=4.86, SD=0.35)* and was strongly agreed upon. Gamification effectively promotes peer interaction and collaboration, enhancing the overall learning experience. Such findings underline the importance of encompassing interactive elements into educational practices to foster student engagement and collaboration, ultimately leading to more enriched learning outcomes.

Based from the findings, gamification strategies positively influence group dynamics, fostering a sense of cohesion and shared purpose among participants which received the lowest mean score of responses *(M=4.75, SD=0.46)*, yet it was still strongly agreed upon.

The ability of gamification to promote a sense of unity among group members is particularly noteworthy. By assimilating elements of competition, cooperation, and reward, gamification creates a shared context that encourages students to work together towards a common goal. This collaborative aspect of gamification fosters stronger interpersonal connections and builds trust among group members, laying the foundation for effective teamwork and collaboration.

Table 11 verifies the composite table of gamification strategies for students' sustainable engagement. The composite table of students' sustainable engagement reveals an overall mean of 4.79, with a standard deviation of 0.28, indicating a very high level of sustained engagement across various dimensions.

Mean Performance of Students After Using Gamification Strategies

The mean performance of students subsequent to the implementation of gamification strategies within the framework of analytical, critical, and problem-solving skills assessment has been formally calculated.

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The mean (average) score of students on the pre-test and post-test calculated separately. This can be done by summing up all individual scores and dividing by the total number of students.

Comparing the mean score of students on the pre-test with the mean score on the post-test, this comparison indicates whether there has been an improvement in students' analytical performance after utilizing gamification strategies. Statistical analysis such as a paired t-test was conducted to determine if the difference in mean scores before and after implementing gamification strategies is statistically significant.

Table 11 verifies the mean performance of students before and after using gamification strategies in terms of analytical. The comparative analysis of students' performance before and after the utilization of gamification strategies, focusing on analytical skills, demonstrates a notable improvement.

Table 11. Mean performance of students before and after using gamification strategies in terms of analytical

Score	Before		After		Descriptive Equivalent
	f	%	f	%	
13 - 15	0	*0.00*	66	*74.16*	Outstanding
10 - 12	43	*48.31*	22	*24.72*	Very Satisfactory
7 - 9	55	*61.80*	1	*1.12*	Satisfactory
4 - 6	1	*1.12*	0	*0.00*	Fairly Satisfactory
0 - 3	0	*0.00*	0	*0.00*	Did not meet Expectation
Total	**89**	***100***	**89**	***100***	
Weighted Mean	*8.90*		*12.88*		
SD	*1.24*		*0.95*		
Verbal Interpretation	*Satisfactory*		*Outstanding*		

Prior to implementation, the weighted mean was 8.90 with a standard deviation of 1.24, indicating a satisfactory level. Subsequent to implementation, there was a considerable enhancement, with the mean rising to 12.88 and the standard deviation decreasing to 0.95, reflecting an outstanding level of performance.

Table 11 proves the mean performance of students before using gamification strategies in terms of analytical. Out of total number of eighty-nine respondents *"7 to 9*" received the highest frequency of fifty-five (55) or 61.80% of the total population with descriptive equivalent of *Satisfactory*.

The scores *"10 to 12"* received the frequency of forty-three (43) or 48.31% of the total population with descriptive equivalent of *Very Satisfactory*.

While the scores *"4 to 6"* received the lowest frequency of one (1) or 1.12% of the total population with descriptive equivalent of *Fairly Satisfactory*.

With a *(Weighted Mean = 8.90, SD = 1.24)* it shows that the mean performance of students before using gamification strategies in terms of analytical has a descriptive equivalent of *Satisfactory*.

This indicates that, on average, students demonstrated a satisfactory level of proficiency in analytical skills before the integration of gamification techniques. This finding suggests a baseline level of competence among students in this domain, providing valuable context for evaluating the effectiveness of gamification interventions in enhancing analytical abilities. Additionally, the relatively low standard deviation indicates a moderate level of variability in individual performance scores, implying a degree of consistency in the pre-gamification assessment of analytical skills among the student cohort.

The mean performance of students after employing gamification strategies in terms of analytical skills resulted in the category *"13 to 15"* receiving the highest frequency, with sixty-six (66) respondents, comprising 74.16% of the total population. This category was described as *"Outstanding"*.The scores *"10 to 12"* received the frequency of twenty-two (22) or 24.72% of the total population with descriptive equivalent of *Very Satisfactory*. While the scores *"7 to 9"* received the lowest frequency of one (1) or 1.12% of the total population with descriptive equivalent of *Satisfactory*.

With a *(Weighted Mean = 12.88, SD = 0.95)* it shows that the mean performance of students after using gamification strategies in terms of analytical has a descriptive equivalent of *Outstanding.*

This significant elevation from a baseline of "Satisfactory" to "Outstanding" shows the remarkable improvement in students' analytical competencies following engagement with gamified learning methodologies. The descriptive label of "Outstanding" indicates that, on average, students demonstrated exceptionally high levels of proficiency in analytical skills post-implementation of gamification interventions.

This transformative enhancement not only validates the efficacy of gamification strategies in fostering analytical thinking but also higlights their potential to drive substantial skill development among students. The reduced standard deviation of 0.95 suggests a high degree of consistency in performance across the student cohort, indicating that the observed improvement is not an isolated occurrence but rather a widespread outcome.

These findings highlight the transformative impact of

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gamification on analytical skill acquisition and suggest its potential as a powerful tool for enhancing academic outcomes. It emphasizes the significance of incorporating gamification techniques into educational practices to enhance students' analytical skills and prepare them for a dynamic and complex world.

The data presented reveals that, prior to implementing gamification strategies, students' mean performance on analytical tasks was deemed "Satisfactory," with a weighted mean of 8.90 and a standard deviation of 1.24. The weighted mean performance was rated as "Outstanding," with a standard deviation of 0.95 and a weighted mean of 12.88, following the implementation of gamification strategies.

This shows that the use of gamification techniques improved students' performance on analytical tasks and produced noticeable improvements in their results.

This improvement shows that gamification strategies effectively enhance students' analytical skills and contribute to notable advancements in their academic outcomes. Hence, educators and designers could integrate gamification techniques to enhance student performance in analytical tasks.

Table 12 proves the mean performance of students before using gamification strategies in terms of critical. This data serves as a foundational reference point for assessing the effectiveness of integrating gamification techniques in enhancing students' critical thinking skills.

Table 12. Mean performance of students before and after using gamification strategies in terms of critical

Score	Before		After		Descriptive Equivalent
	f	%	f	%	
13 - 15	0	*0.00*	39	*43.82*	Outstanding
10 - 12	19	*21.35*	49	*55.06*	Very Satisfactory
7 - 9	66	*74.16*	1	*1.12*	Satisfactory
4 - 6	4	*4.49*	0	*0.00*	Fairly Satisfactory
0 - 3	0	*0.00*	0	*0.00*	Did not meet Expectation
Total	**89**	***100***	**89**	***100***	
Weighted Mean	*8.54*		*12.17*		
SD	*1.26*		*3.81*		
Verbal Interpretation	*Satisfactory*		*Very Satisfactory*		

Before the implementation of gamification strategies, the weighted mean performance of students in terms of critical skills was 8.54, with a standard deviation of 1.26, indicating a satisfactory level. After the utilization of gamification strategies, there was a notable improvement, with the mean increasing to 12.17. Although the standard deviation also increased to 3.81, the overall performance was classified as very satisfactory.

Out of total number of eighty-nine respondents *"7 to 9*" received the highest frequency of sixty-six (66) or 74.16% of the total population with descriptive equivalent of *Satisfactory*.

The scores *"10 to 12"* received the frequency of nineteen (19) or 21.35% of the total population with descriptive equivalent of *Very Satisfactory***.** While the scores *"4 to 6"* received the lowest frequency of four (4) or 4.49% of the total population with descriptive equivalent of *Fairly Satisfactory*.

With a *(Weighted Mean = 8.54, SD = 1.26)* it shows that the mean performance of students before using gamification strategies in terms of analytical has a descriptive equivalent of *Satisfactory*.

The mean performance of students after using gamification strategies in terms of analytical skills resulted in the category *"10 to 12"* receiving the highest frequency, with forty-nine (49) respondents, comprising 55.06% of the total population. This category was described as *"Very Satisfactory"*. The scores *"13 to 15"* received the frequency of thirty-nine (39) or 43.82% of the total population with descriptive equivalent of *Outstanding***.** While the scores *"7 to 9"* received the lowest frequency of one (1) or 1.12% of the total population with descriptive equivalent of *Satisfactory*. With a *(Weighted Mean = 12.17, SD = 3.81)* it shows that the mean performance of students after using gamification strategies in terms of analytical has a descriptive equivalent of *Very Satisfactory*.

Before using gamification strategies, the mean performance of students in critical tasks was described as "Satisfactory," with a weighted mean of 8.54. After implementing gamification strategies, the mean performance significantly improved and was described as "Very Satisfactory," with a weighted mean of 12.17. This indicates a notable enhancement in students' critical performance following the implementation of gamification strategies.

The shift from a "Satisfactory" to a "Very Satisfactory" rating underscores the effectiveness of gamification techniques in fostering deeper critical thinking skills among students. It shows that gamification interventions not only engage students more effectively but also facilitate a more profound understanding and application of critical concepts.

Gamified activities often require students to solve problems, make decisions, and strategize, thereby promoting critical thinking skills (Brown & Johnson, 2024).

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This improvement is crucial as critical thinking is a foundational skill necessary for academic success and real-world problem-solving.

Table 13 presents the mean performance of students before using gamification strategies in terms of problem-solving. This data offers valuable insights into students' baseline proficiency in problem-solving skills, providing a foundation for evaluating the effectiveness of gamification interventions in enhancing these abilities.

Table 13. Mean performance of students before and after using gamification strategies in terms of problem-solving

Score	Before		After		Descriptive Equivalent
	f	%	f	%	
13 - 15	0	*0.00*	62	*69.66*	Outstanding
10 - 12	1	*1.12*	21	*23.60*	Very Satisfactory
7 - 9	63	*70.79*	6	*6.74*	Satisfactory
4 - 6	25	*28.09*	0	*0.00*	Fairly Satisfactory
0 - 3	0	*0.00*	0	*0.00*	Did not meet Expectation
Total	**89**	***100***	**89**	***100***	
Weighted Mean	*7.13*		*11.06*		
SD	*1.14*		*1.36*		
Verbal Interpretation	*Satisfactory*		*Very Satisfactory*		

Before the implementation of gamification strategies, the weighted mean performance of students in terms of problem-solving was 7.13, with a standard deviation of 1.14, indicating a satisfactory level. After the utilization of gamification strategies, there was a significant improvement, with the mean increasing to 11.06. Despite a slight increase in the standard deviation to 1.36, the overall performance was classified as very satisfactory.

Out of total number of eighty-nine respondents *"7 to 9*" received the highest frequency of sixty-three (63) or 70.79% of the total population with descriptive equivalent of *Satisfactory*. The scores *"4 to 6"* received the frequency of twenty-five (25) or 28.09% of the total population with descriptive equivalent of *Fairly Satisfactory***.** While the scores *"10 to 12"* received the lowest frequency of one (1) or 1.12% of the total population with descriptive equivalent of *Very Satisfactory*. With a *(Weighted Mean = 7.13, SD = 1.14)* it shows that the mean performance of students before using gamification strategies in terms of problem-solving has a descriptive equivalent of *Satisfactory.*

The mean performance of students after using gamification strategies in terms of analytical skills resulted in the category *"13 to 15*" received the highest frequency of sixty-two (62) or 69.66% of the total population with descriptive equivalent of *Outstanding*. The scores *"10 to 12"* received the frequency of twenty-one (21) or 23.60% of the total population with descriptive equivalent of *Very Satisfactory***.** While the scores *"7 to 9"* received the lowest frequency of six (6) or 6.74% of the total population with descriptive equivalent of *Satisfactory*. With a *(Weighted Mean = 11.06, SD = 1.36)* it shows that the mean performance of students after using gamification strategies in terms of problem-solving has a descriptive equivalent of *Very Satisfactory.*

Prior to implementing gamification techniques, students average performance on problem-solving assignments was rated as "Satisfactory," with a weighted mean of 7.13. With a weighted mean of 11.06, the mean performance dramatically increased and was deemed "Very Satisfactory" following the use of gamification strategies. The findings indicate that when methods of gamification were used, students problem-solving abilities significantly improved.

This improvement suggests that gamification strategies not only capture students' interest but also facilitate a more thorough understanding and application of problem-solving principles. Such proficiency in problem-solving is crucial for academic success and prepares students for the challenges they will face in various professional and real-world contexts.

Difference on the Student's Performance Before and After Utilizing Gamification Strategies

The study investigates the significant difference in student performance before and after gamification strategies using a paired t-test, comparing mean differences to zero to determine statistical significance.

Revealed in Table 14 is the test of difference between the student's performance before and after utilizing gamification strategies, providing valuable insights into the effectiveness of these techniques in enhancing student outcomes.

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Table 14. Test of Difference between the student's performance before and after utilizing gamification strategies

Student's performance	Before		After		Mean Difference	95% Confidence Interval of Difference		t	df	Sig (2-tailed)
	Mn	SD	Mn	SD		L	U			
analytical	8.90	1.24	12.88	0.95	-3.98	8.609	11.46	13.99	87	0.000
critical	8.54	1.26	12.17	3.81	-3.63	9.801	12.57	16.06	87	0.000
problem-solving	7.13	1.14	11.06	1.36	-3.93	8.731	18.60	5.505	87	0.000

*Legend: *Significant at 0.05*

Data obtained through a paired t-test indicated that the increase in the scores in *performance* is significant ($p < 0.05$). This implies that the students performed better after utilizing gamification strategies. Their level of student's performance has significantly improved from low to very high.

The test of difference between student performance before and after utilizing gamification strategies reveals a significant improvement. This is evidenced by a paired t-test indicating a significant increase in scores implying that students performed better after the implementation of gamification strategies.

Level of Utilizing Gamification Strategies and Students' Sustainable Engagement

This section investigates the relationship between gamification strategies and students' sustainable engagement, using regression analysis to identify significant associations or predictive factors and examine the impact of changes in gamification strategies.

This table provides important insights into the link between gamification strategies and sustained engagement in education by looking at the prevalence of gamification features and their impact on student participation.

Table 15. Regression Analysis on the level of utilizing gamification strategies and students' sustainable engagement

Sense of fulfillment	B	SE	β	t	p
Constant	.846	.591		1.432	.156
Interactive Simulation		.138	.404	2.919*	.005
Mission Challenge		.092	.044	0.471	.639
Collaborative Game		.119	-.05	-0.422	.674
Real-world Case		.123	-.017	-0.134	.894
Gamified Assessment		.14	.436	3.121*	.002
R-squared			.373		
Adjusted R-squared			.335		
Standard Error of the Estimate		.224			
F(4, 136)				9.766	.000
Sense of belonging	**B**	**SE**	**β**	**t**	**p**
Constant	.3	.625		-.479	.633
Interactive Simulation		.147	.434	2.962*	.004
Mission Challenge		.098	.066	.677	.5
Collaborative Game		.126	-.135	-1.071	.287
Real-world Case		.131	.211	1.618	.109
Gamified Assessment		.148	.474	3.206*	.002
R-squared			.459		
Adjusted R-squared			.426		
Standard Error of the Estimate		.237			
F(4, 136)				13.92	.000
Active participation	**B**	**SE**	**β**	**t**	**p**
Constant	.74	.543		1.363	.177
Interactive Simulation		.127	.397	3.119*	.003
Mission Challenge		.085	-.052	-.61	.543
Collaborative Game		.11	.141	1.289	.201
Real-world Case		.113	.078	.686	.495
Gamified Assessment		.128	.279	2.176*	.032
R-squared			.433		
Adjusted R-squared			.398		
Standard Error of the Estimate		.206			
F(4, 136)				12.51	.000

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Collaboration	B	SE	β	t	p
Constant	-.132	.517		-.256	.799
Interactive Simulation		.121	.292	2.412*	.018
Mission Challenge		.081	-.034	-.425	.672
Collaborative Game		.104	-.028	-.272	.786
Real-world Case		.108	.21	1.949	.055
Gamified Assessment		.122	.582	4.768*	.000
R-squared			.528		
Adjusted R-squared			.5		
Standard Error of the Estimate		.196			
F(4, 136)				18.38	.000

*p < 0.05

The table presents the results of a multiple regression analysis examining the effect of utilizing gamification strategies and students' sustainable engagement. The *Interactive Simulation, Mission Challenge, Collaborative Game, Real-world Case and Gamified Assessment* have significant effect to the students' sustainable engagement. The F-test of the overall model is significant (F5, 84) with, $p < 0.05$), indicating that the regression model is a good fit for the data.

The regression analysis indicates a significant relationship between the utilization of gamification strategies and students' sustainable engagement. Specifically, factors such as Interactive Simulation, Mission Challenge, Collaborative Game, Real-world Case, and Gamified Assessment significantly influence students' sustainable engagement. The significant regression analysis further validates the model's effectiveness in explaining this effect, rejecting the null hypothesis and confirming the substantial impact of gamification strategies on students' sustainable engagement.

The significant relationship identified between gamification strategies and students' sustainable engagement highlights the potential of gamified approaches to promote continuous involvement and participation in the learning process. This implies that educators can utilize gamification strategies such as Interactive Simulation, Mission Challenge, Collaborative Game, Real-world Case, and Gamified Assessment to cultivate a learning environment that fosters active student engagement over time.

Gamification Strategies Contribute to the Engagement of Learning

The use of gamification strategies into educational environments has been the subject of great interest in the past several years as a way to improve learning outcomes and student engagement. The use of game principles and aspects in non-gaming environments, or "gamification," presents a viable strategy for increasing learning's interactivity, immersion, and enjoyment. This study looks at how gamification strategies influence student engagement during the learning process, with an emphasis on how they work in STEM education. This study intends to shed light on the transformational potential of gamification in encouraging successful and long-lasting learning experiences through a thorough analysis of various gamification strategies and their impact on student engagement.

Collaborative Learning Gamification

With the goal of engaging students and improving their educational experience, collaborative learning gamification is a powerful teaching approach that combines game design aspects with the fundamentals of collaborative learning.

To improve the learning process, collaborative learning gamification incorporates gamification and collaboration components. It entails adding aspects of games to cooperative learning tasks. Making learning more interesting, participatory, and pleasurable for participants is the aim, since this can boost motivation, involvement, and information retention. When gamified components are used, students are frequently more inclined to devote time and energy to the learning process. Gamification of collaborative learning may be used in a number of ways, including online, through mobile applications, or through in-person events. It pushes students to collaborate, solve issues as a group, and either compete or cooperate with their classmates. Collaborative learning gamification, when done well, may improve overall learning results, create a good learning atmosphere, and encourage teamwork and cooperation. It is especially helpful in corporate training programs, educational settings, and online learning platforms as stated by Azmi et al. (2020).
R1 mentioned that *"...it fosters proper socialization since group settings often involve interacting with a variety of individuals, whether familiar or new acquaintances" which garnered consensus from the other participants."*

R2 shared that "*I struggled to make friends and I was shy at first. Now, I no longer feel ashamed or hesitant because the games create a light vibe and comfortable atmosphere*."

R3 uttered that, *"It felt like we were all connected, forming a circle of friends at the forefront, sharing a common bond."*

In line with Christopher, et al. (2023), through the integration of gamification and collaboration, Circuit Smart games offer an engaging and dynamic learning environment where students may explore and advance at their own speed. Students of many ages, genders, backgrounds, places, and times can benefit from this method. An engaging learning environment is produced when technology and physical exercise are combined in the classroom. The aims and goals of the games describe the advantages for each player. Participants handle learning issues more successfully when they have mutual trust and good communication.

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R1 added that *"...you figure out how to express what you want to say that you've never said before."*
Emphasized by R3, *"It promotes cooperation."*

This means that by tapping into humans' natural tendencies for competition, accomplishment, and social engagement, this approach aims to render learning more pleasurable, impactful, and stimulating.

Engagement Dynamics leads to Students' Active Participation

As reiterated by R3, *"Unlike traditional activities that involve straightforward reports and presentations, gamification offers a unique approach that fosters participation, particularly among those who may feel hesitant or shy."* Additionally, *"enabling us to effortlessly engage with the material while at the same time enjoying the learning experience."*

This statement from R3 highlights that gamification offers a unique approach to promoting engagement, particularly for students who might be reluctant or uneasy in more conventional learning activities that mostly consist of simple reports and presentations. A strategy that is more participatory and captivating, gamification can encourage a wider variety of students to actively participate in the learning process. Learners can seamlessly interact with the educational content while simultaneously finding enjoyment in the learning process. It implies that gamified learning experiences make learning more enjoyable and accessible, thereby facilitating deeper engagement and understanding of the material.

Moreover, R3 shared that *"In essence, it promotes inclusivity by inviting everyone to participate and be part of the experience."*
Furthermore, R2 added that *"What I especially liked about Kahoot was how everyone seemed to be actively involved, chatting, and sharing laughter throughout,"* which is also supported by R3's statement that *"our excitement soared when we saw our names featured on the Kahoot game shown on TV."*

This quotes from R2 and R3 emphasizes the good experience that was had while using Kahoot, as one of the gamified assessment used in the session, suggesting that learners are encouraged to participate actively since the platform is engaging. The idea that everyone is conversing, laughing, and actively participating points to the vibrant and interesting environment that Kahoot's features generate. It suggests that Kahoot facilitates pleasure, engagement, and communication among users in an efficient manner, creating a more lively and cooperative learning environment. R4 mentioned that *"I become more invested in the project you assigned, which in turn motivates me to study harder."*

More than half of both reflective and active learners stressed that the gamification process gave them a fun and engaging learning environment, in line with Topu's (2023) "Challenge and Competition" concept. On top of that, almost one-third of them said that the setting for learning allowed for higher both in terms of performance and involvement.

Positive Experience Design

As R2 expressed that *"It's actually fun because it adds an extra layer of fun to the experience."*
This statement suggests that according to R2, conveyed that the activity becomes more enjoyable due to the presence of an added element of fun, contributing to a richer and more fulfilling experience overall.

Congruent with Delnevo, et al.'s (2022) use of gamification to boost student engagement in university web technology courses. favorable effects on students' five years of academic experience. The authors came to the conclusion that, within the parameters set out, the gamification techniques used improved the educational experience for the pupils.

R3 stated that *"I initially felt pressured, but that feeling turned into happiness when it became a group effort."* R3 also added that "…it's a completely new experience."

From the experience of R3, the pressure turned into a positive emotion due to the collaborative nature of the activity. As they are experiencing this for the first time, R3's comment implies that the current circumstance or action is something completely new or unknown to them. Gamification is the practice of bringing elements of gaming into non-gaming situations to make learning more engaging and fun. Iruela, et al. (2022) adopted gamification, thus, provides sufficient answers to the educational requirements of the younger generation of learners. The writers provide evidence of a particular, positive relationship between motivation, satisfaction, and engagement. It is noteworthy that all of the students that participated in this experience and approach acquired positive benefits from this kind of training.

R1 reported that *"This positive atmosphere not only makes learning more fun also motivates them to perform better."*

R4 remarked that *"It appeared that everyone found pleasure in this improvised setup making the activity thoroughly enjoyable for all of us".*
R4 observed that everyone seemed to derive enjoyment from the impromptu arrangement, resulting in a highly enjoyable experience for all participants involved in the activity. Beatriz and Martinez (2022) presented gamification as an innovative teaching method. Because to gamification, students reported being more motivated and involved in class. Additionally, gamification enhanced the learning process and positively impacted the students' ultimate performance.

Sense of Belonging among Peers as a Result of Gamification Strategies

In modern educational and professional settings, fostering a sense of belonging among peers is paramount for collaboration and productivity. Gamification strategies have emerged as effective tools in achieving this goal. In the article of Bowen (2021) echoed the sentiments of Gray (2021), suggesting that teachers can cultivate a sense of belonging among students by forging ties between the classroom and the community. This sense of belonging is associated with various positive outcomes, including enhanced academic performance and

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motivation. This is particularly crucial for historically marginalized students, as they derive significant benefit from encountering their cultural heritage and community reflected in the classroom.

As reiterated by R2 *"I was a new student. Participating in them on my first day helped me feel a sense of closeness and connection with my classmates."*

This means that participating in certain activities on their first day of school helped them feel a sense of closeness and connection with their classmates. This suggests that engaging in these activities played a significant role in helping the student integrate into the peer group and establish a feeling of belongingness early on in their school experience.

This statement was agreed upon by R1 that *"Having peers to consult with gives me confidence in the subject, making me more actively engaged."*

R1 mentioned that *"The use of gamification has played a crucial role in my personal development, particularly in enhancing my ability to socialize with my classmates."*

This indicates that the incorporation of gamification has been highly significant to their personal growth, namely in terms of improving their social skills and fostering peer connections. This implies that gamification strategies have improved R1's ability to engage with peers and positively contribute to a more fulfilling social experience in their academic or professional context.

In the manner stated by R1 that *"Previously, I struggled with interacting with unfamiliar peers, but through gamified activities, I've learned to communicate with people I didn't know before, whether they are classmates or group members."* Also, supported by R2 that *"My classmates and I have become more socially connected, with individuals I previously didn't interact with now engaging in conversations because of the games.*

In addition, the institution wants to make sure that students who are deemed to be at "risk" have access to help, and they have already reaped benefits from taking part in it. R1's and R2's statement indicate that they used to encounter difficulties in engaging with new peers. However, through participating in gamified activities, they have developed the ability to communicate effectively with unfamiliar individuals, regardless of whether they are classmates or members of a group. This signifies the fact that gamification have helped R1 and R2 overcome social challenges and become more adept at interacting with a diverse range of people in various contexts.

As stated by R1 that *"I was motivated by the camaraderie among you and your friends."*

Deep Sense of Fulfillment Through Gamification Strategy

R1 executed that *"The factors that caught my attention were the happy memories we had that even when we make mistakes."*

This claim made by R1 demonstrates that even in the face of errors or disappointments, the good memories made throughout the event are what stick in their minds. This emphasizes a profound sense of fulfilment that goes beyond accomplishment or perfection and is obtained from the connections and shared experiences with people. It emphasizes the idea that connections, resiliency in the face of adversity, and the capacity to discover joy and significance in the midst of faults are frequently the foundations of fulfillment. Essentially, the depth of these shared experiences adds to a deep sense of contentment that transcends accomplishments or results that are only visible.

As explained by R2 that *"I feel like I have satisfaction especially when my score is high, when I am the one who wins it seems like it inspires me to study especially when my score is low in games."*

Based on R2's feedback it appears to feel satisfied, especially when they win or get a high score in gamified activities. When their performance in the games is not as good as they would like it to be, this sense of accomplishment motivates them to study. In other words, students are motivated to work more and achieve better academically because they find gamified activities enjoyable and successful.

Added by R2 that *"I particularly enjoyed the Kahoot sessions and activities like multiple-choice quizzes and the lab exercises where we folded fine paper."*

The fact that R2 enjoyed these activities denotes that they felt satisfaction in participating in practical, interactive learning opportunities. The diversity of activities indicated offers a wide range of interesting learning opportunities, from tactile lab exercises to digital quizzes. R2 probably had a sense of satisfaction and success from these encounters since R2 engaged and actively participated in the material. A stronger sense of satisfaction is also implied by the statement of enjoyment in these activities, which suggests a good emotional connection. In the end, R2's admiration for these exercises emphasizes how crucial fulfilling learning experiences are to developing a feeling of fulfillment in academic endeavors.

R3 mentioned that *"I'm grateful for the understanding I've gained from this simulation."*

R2's positive experience with gamified activities illustrates how they enhance learning and foster fulfillment. Interactive quizzes and hands-on exercises contribute to enjoyment, active participation, and immediate feedback, boosting engagement and motivation. R2's sense of achievement suggests that fulfillment stems from the learning process, not just the outcome.

Students' Experiences With Gamification Strategies that Enhance their Academic Performance

New strategies to improve learning outcomes and student performance have come to light, including gamification, as the field of education continues to change. Gamification is a promising approach to meaningfully engage students and inspire them to succeed academically. It involves incorporating

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game components into educational activities. In order to improve academic achievement, this study explores how students interact with gamification strategies.

Learning Enhancement through Gamification Dealing with Cognitive Skill Development

R4 mentioned that *"…helps us learn more from what you are teaching us."*

R4's affirmation highlights the efficacy of gamified approaches in enhancing cognitive skill acquisition and knowledge. This underscores the potential of incorporating gamification techniques into education to foster engaging and effective learning experiences, ultimately promoting cognitive skill development.

As enunciated by R4 that *"I understand better the process and progress of landslides and how they happen."*

R4's remark highlights how gamified learning experiences can facilitate comprehension and mastery of complex topics, such as the processes of landslides. Based from the statement above it underscores the potential of gamification to enhance learning by providing engaging and interactive experiences that facilitate the development of cognitive skills and understanding of complex concepts. Eleftheria et al. (2020) claim that in order to evaluate and broaden their knowledge, users engage with a virtual laboratory, conduct experiments, and finish tasks through gaming. The goal is to engage students and make studying more enjoyable while also providing a more thorough comprehension of the subject matter through the use of gamification and augmented reality techniques. By involving students in cultural subjects, the cultural legacy is preserved and passed on to future generations.

R3 mentioned that "…our logical and critical thinking abilities have seen notable improvement."

Added by R1 that *"Indeed, the gamification technique contributes significantly to improving scores due to the heightened excitement it generates."* In addition to this R1 specified that *"I've noticed a significant improvement in their learning performance because of gamification."*

Therefore, R1's assertion reinforces the relevance of gamification in promoting cognitive skill enhancement, as discussed in the study on learning enhancement through gamification dealing with cognitive skill development.

R3 specified that "*With the help of gamification, the things we do are imprinted on our minds."* R2 further indicated that *"…creating a dynamic environment where everyone contributes to problem-solving."*

Both R3 and R2 underscore the potential of gamification in enhancing learning experiences and cognitive skill development. R3's discovery of increased memory retention aligns with the aim of improving cognitive skills through gamification, while R2 highlights how gamification fosters active participation and critical thinking. R3 asserted that *"Winning took us by surprise, given the abundance of participants, making the victory even more satisfying."*

The claim made by R3 on the surprise of winning in spite of many competitors emphasizes the increased happiness that results from unanticipated achieving success.

4. CONCLUSION AND RECOMMENDATIONS

The results show that, in the final analysis, gamification strategies greatly and extremely raise student engagement. The degree of gamification strategies for sustainable engagement attained a high mean score with respect to students' sense of fulfillment, sense of belonging, active participation, and collaboration, demonstrating broad acceptance of their efficacy.

After applying gamification techniques, students also demonstrated higher performance in analytical, critical, and problem-solving abilities, showing a notable improvement. A significant relationship between gamification techniques and long-term involvement is supported by the regression analysis, and key components include gamified assessment, mission challenge, interactive simulation, collaborative game, and real-world case.

The hypothesis stating that there are no significant effects of gamification strategies in Earth Science on student engagement at Philippine Women's University is rejected, given the substantial improvements observed in student engagement.

Similarly, the hypothesis asserting that there is no significant difference in student performance before and after utilizing gamification strategies is also rejected, as evidenced by the notable enhancement in analytical, critical, and problem-solving abilities post-implementation.

Taken together, these findings highlight how much gamification strategies may improve students' long-term engagement and performance.

Based on the drawn findings and conclusions, the following were hereby recommended:

1. It is highly suggested that teachers may utilize a variety of gamification techniques, including Interactive Simulation, Mission Challenge, Collaborative Game, Real-world Case, and Gamified Assessment, into their lesson plans, since gamification has a substantial effect on student engagement and outcome. Overall effectiveness may be increased by this diversity, which can accommodate various learning preferences and methods.
2. Teachers may keep using gamification strategies to raise enthusiasm and participation levels among students in class that meet the interests and preferences of a wide range of students.
3. A study is recommended to compare traditional and gamified instructional approaches in various academic settings to understand their effectiveness in enhancing student performance. This would involve collecting quantitative data on student performance metrics and qualitative feedback from students and instructors.

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