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Collaborative Learning and Gamification Strategies in Relation to Learners' Mathematics Performance

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***Abstract*—** Effective classroom strategies, such as collaborative learning and structured feedback, play a vital role in enhancing student proficiency and performance. This study explored the extent of Mathematics teachers' use of collaborative learning and gamification strategies on learners' mathematics performance in selected private schools under the Archdiocesan Commission on Education in Misamis Occidental during SY 2024-2025. A total of 120 Grade 9 students from private secondary schools, selected through a random sampling method, served as respondents. Using a descriptive-correlational design, data were gathered through survey questionnaires and analyzed using Mean, Standard Deviation, Pearson Product-Moment Correlation, and Stepwise Multiple Regression. Results showed that teachers applied collaborative learning and gamification strategies to a great extent, while students' mathematics performance was at a satisfactory level. A significant relationship was found between structured cooperative learning, particularly assessment and feedback, and learners' performance. Gamification showed no significant relationship, though game-based learning emerged as a predictor of performance. Structured collaborative learning strategies are more strongly linked to student performance than gamification. Math teachers may focus on enhancing collaborative learning with effective assessment and feedback to support student achievement.

***Keywords*—** assessment and feedback, classroom strategies, game-based integrated lessons, learning outcomes, student engagement.

I. INTRODUCTION

Mathematics, as one of the core subjects in education, has always been perceived negatively by the learners (Chand et al., 2021), though some students perceived it positively amidst its difficulty, which is due to its essential use in their daily life (Hagan et.al, 2020). Learners had inconsistent beliefs and seldom think critically about Mathematics and its learning process (Sachdeva & Eggen, 2021). This belief brings anxiety to the learners towards Mathematics and causes a negative bearing towards their Mathematics performance (Dumlao, et.al, 2019), however if the learners are motivated to think critically about mathematics education, there is a visibility of their contribution of their improvement towards Mathematics (Sachdeva & Eggen, 2021).

In OECD countries, an average of 65% of students express concern about receiving poor grades in mathematics, highlighting the significant pressure they feel in this subject. Around 55% of students experience anxiety over the possibility of failing, reflecting the challenges they face in coping with academic expectations in mathematics. About 40% of students report feeling nervous, helpless, or anxious when solving mathematics problems or completing homework. This demonstrates the emotional strain that math-related tasks can create, emphasizing the importance of fostering supportive learning environments to address these challenges (Atienza, 2024). According to the current result of the conducted test by the Programme for International Student Assessment (PISA, 2022), the Philippines ranked at the bottom among the 64 countries. According to Rep. Roman Romulo, a congressman in Pasig City and the Chairperson of the House of the Basic Education Committee, this result indicates the need to improve students' understanding of the core competencies in reading, mathematics, and science. The challenge falls to the Educational system, where the ineffective curriculum and the instructor's competencies are seen as the possible factors behind the poor performance in Mathematics (Chand et al., 2021), thus, different teaching strategies are introduced to address the necessary concerns relating to this issue.

Collaborative learning, as one of the strategies in teaching Mathematics, was found to have a great impact on Learners' Academic Learning (cognitive), Collaborative Skills (affective) and least on Skills development (psychomotor) (Sotto, 2021), whereas learners perceived that collaborative learning had positively contributed to their learning motivation, cognitive development, emotional awareness and broad-mindedness (Warsah, et al., 2021). Collaborative strategy increases the critical thinking skills of the learners, which brings a profound impact on the learners' academic and personal growth (Viado & Espiritu, 2023). These skills help students analyze information more thoughtfully, make well-informed decisions, and tackle difficult problems with greater self-assurance.

High levels of critical thinking also allow them to express their ideas more clearly, adjust to new situations with ease, and find creative solutions to challenges. Beyond improving academic performance, these abilities empower students to navigate real-world situations successfully, giving them the confidence and tools they need for lifelong learning and to thrive in their future careers (Hafeez, 2021). Although using this strategy in instruction may require the teacher's skills in organizing group tasks, learning materials, and establishing an engaging and inclusive environment, it provides a deeper approach to learning as the learners have a positive experience in their collective work (Boakye, 2024). Learners believe that collaborative learning enhances socialization among their co-learners (Ghavifekr, 2020), which leads to the acquisition of mathematical problem-solving skills, but friendships and social acceptance may greatly impact the students' mathematical performance (Klang et al., 2021).

Moreover, this interaction aids students in exercising their reasoning, clarifying doubts, and refining their understanding, which shows that active participation enhances conceptual understanding and retention of mathematical knowledge (Prieto-Saborit et al., 2022). Communication, teamwork, and conflict resolution are among the enumerated skills that are developed when collaborative learning is effectively implemented, where these skills are particularly essential in diverse classrooms as they foster inclusivity and mutual respect (Bassachs, 2022). With the integration of technology, Collaborative learning can also be conducted through online platforms, where learners indicated that they truly enjoyed working with a partner, explaining that it gave them a chance to exchange ideas and collaborate in a meaningful way.

The learners found that discussing concepts with someone else helped them understand the topic on a deeper level, as they could see things from different perspectives and clarify their thoughts through conversation. This process made learning more engaging and allowed them to build stronger connections with each other while improving their communication and teamwork skills (Owens, 2022). The learners liked being able to work on the same document at the same time, which made the process feel smooth and efficient. Being able to stay within one tool for editing and communicating meant they didn't have to jump between apps, which saved time and kept things simple. For the learners, this approach to working together made the experience not only productive but also enjoyable (Gaad, 2021). Learners in collaborative settings are bound to effectively explain their reasoning and reflect on their approaches, leading to improved outcomes and deeper understanding in Mathematics.

Another strategy in Mathematics instruction is gamification, which has proven to be a highly effective approach for boosting student performance and motivation. By incorporating elements such as rewards, leaderboards, and avatars, it transforms the classroom into a dynamic and interactive learning environment (Chans, 2021). This method not only makes mathematics more engaging but also addresses challenges like math anxiety and a lack of interest. Incorporating lessons in games increases learners' active participation, which highlights the increase of understanding, and its rewards enhance learners' attitudes towards math and reduce anxiety (Rodriguez et al., 2023).

As teachers integrate mathematics quizzes and assessments into the game, it helps students develop confidence, which is translated into higher scores on the test (Rincon-Flores et al., 2022), and a gamified learning environment fosters a better understanding of problem-solving techniques (Rosen, 2020). Using technology to create gamified or game-based learning experiences has proven to be beneficial, helping to foster an environment where students are more motivated to participate. This approach encourages students to collaborate with their peers, dive deeper into the content, and stay interested in the subject matter. With features like leaderboards and badges, gamification makes learning more enjoyable and interactive, allowing students to feel more connected to their studies.

In addition, gamification and game-based learning have been shown to increase students' engagement, boost their confidence, and make learning more enjoyable overall. These methods not only add an element of fun to the learning process but also give students a sense of achievement, helping them feel more capable and motivated to continue their educational journey. Ultimately, this approach creates a more positive and rewarding experience for students (May, A., 2021).

Furthermore, tasks incorporated through gamification strategy encourage learners to communicate, collaborate and explain their reasoning and further reinforcing their mathematical skills (Alioto, 2022) and it appears to have a favorable impact to learners, as evidenced by increased engagement in the teaching and learning process, increased motivation and comprehension (Raouf, 2020). Gamification also fosters differentiated instruction, which allows the learners to learn at their own pace and preferences (Rincon-Flores, 2022).

It has been identified that the challenges in implementing this strategy center on the design and implementation complexity, sustainability of engagement, equity and inclusivity issues, ethical concerns, and teacher preparedness and workload. Developing an effective gamification strategy needs careful planning to ensure that the game elements align with the learning objectives, since a poorly prepared gamification can lead to a mismatch between game activities and educational goals, including confusion and lack of engagement (Jaramillo-Mediavilla et al., 2024). The strategy may initially increase motivation, but the long-term engagement depends on the intrinsic values of the learning content and how well the game mechanics support it.

Despite the existing studies of the implementation, the impact, and the challenges in using these teaching strategies, there needs to be more exploration on their longitudinal impact, such as the analysis of long-term retention, application of mathematical concepts, and problem-solving skills. Studies centered on gamification strategies often highlight region-specific which means that fewer studies focus on developing countries such as the Philippines. These studies often highlight the benefits of both learners and teachers from using the strategy, but do not mention the preparations and the necessary skills in implementing the strategy. Furthermore, there are lesser number of studies that highlight the effects of the combination of these strategies, thus, this study will focus on the effects/ impacts of the implementation of both collaborative and gamification strategies on the learner's mathematical performance.

The researcher identified an apparent knowledge gap in the prior research concerning strategies in the Mathematics instruction where it is conducted in a controlled environment, such as laboratories and pilot programs, which may not reflect the complexities of real-world classrooms. In addition, the prior research did not address the subject of the implementation in the actual classroom settings, where variables such as collaborative learning and gamification strategy come into play. This encompasses several unexplored dimensions that lately have attracted research attention in other disciplines where collaborative learning emphasizes the necessity of crafting activities that encourage reflective learning (Saikia, 2023) and that a gamified learning environment brings a better understanding of problem-solving techniques (Rosen, 2020; Miles, 2017).

The findings of this study will serve as a resource for educational institutions, teachers, and curriculum planners in implementing a collaborative and gamification strategy in teaching mathematics. Curriculum planners and developers can incorporate these strategies in the education curriculum, specifically in the Mathematics instruction, to cater to the needs of the teachers, specifically adapting to the learners' generation, and to diminish the idea that mathematics is a difficult subject. Educational institutions can provide training to their teachers on the proper implementation of these strategies, specifically that one of the elements of the gamification strategy is technology.

II. RESEARCH METHODOLOGY

A. Design

This quantitative study used the descriptive-correlational design. The descriptive correlational design combined descriptive and correlational methods to describe variables as they naturally exist and identified relationships among them without doing any manipulation to the variables (Creswell, 2014). This design was deemed appropriate in this study as it explored the extent of teachers' usage of Collaborative Learning and Gamification Strategy in relation to the learners' mathematical performance

B. Setting

This study was conducted in selected private junior high schools in Misamis Occidental, specifically within the first district. These schools were managed by the Archdiocesan Commission on Education (ACE) under the supervision of the Archbishop of the Archdiocese. The ACE schools were primarily parochial, as their directors were parish priests. These private institutions mainly offered elementary and secondary education, following a curriculum aligned with the guidelines set by the Department of Education (DepEd).

C. Respondents

The respondents of the study included 120 Grade 9 students who were drawn from the total population, specifically representing each school. They were selected using a stratified random sampling technique. The respondents were enrolled in one of the private schools under ACE and were willing to participate in the study.

D. Instruments

The researcher used the following instruments as data gathering tools:

A. Collaborative Learning Practices Survey (CLPS). This was a researcher-made tool used to measure teachers' perceptions of collaborative learning strategies based on the following categories: group work and peer interaction, structured cooperative learning models, use of hands-on and interactive activities, real-world problem solving and applications, and assessment and feedback in collaborative learning. The questionnaire consisted of twenty-five statements, with five items per category, rated using a 4-point Likert scale. Respondents indicated their level of agreement with each statement, ranging from "Very Great Extent" (4) to "Less Extent" (1). This instrument was pilot tested by 5 experts and also pilot tested with selected students who were not included in the study with a Cronbach Alpha (0.97 - Excellent reliability). To determine the teachers' extent of use of collaborative learning, the following scale was used to interpret the results:

Responses	Range	Interpretation
4	3.50 – 4.00	Very Great Extent
3	2.50 – 3.49	Great Extent
2	1.50 – 2.49	Less Extent
1	1.00 – 1.49	Least Extent

B. Gamification Strategies Assessment (GSA). It is a researcher made tool used to measure teachers' perceptions of collaborative learning strategies based on three categories: game-based learning integration, reward and achievement system, competitive learning, engagement and motivation strategies, assessment and performance tracking. The questionnaire will consist of twenty five statements, with five items per category, rated using a 4-point Likert scale. Respondents will indicate their level of agreement with each statement, ranging from " Very Great Extent " (4) to " Less Extent " (1). This instrument will be pilot tested to 5 experts and will be pilot tested to selected students not included in the study with a Cronbach Alpha (0.98 - Excellent reliability)To determine the teachers' extent of use of collaborative learning, the following scale will be used to interpret the results:

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2	1.50 – 2.49	Less Extent
1	1.00 – 1.49	Least Extent

C. Learners' Mathematics Performance. The learners' academic performance was evaluated using their average grades in Mathematics, as detailed in DepEd Order No. 8, s. 2015, titled "Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program." This evaluation was based on their second quarter grade in Math. Grades were used and interpreted using the following scale:

Rating	Interpretation
90 – 100	Outstanding
85 – 89	Very Satisfactory
80 – 84	Satisfactory
75 – 79	Fairly Satisfactory
74 and below	Did not Meet Expectations

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E. Data Gathering Procedures

Before the researcher gathered the data, certification and approval to conduct the study were secured from the Office of the Dean of the Graduate School at Misamis University. The researcher then presented a formal request letter addressed to the Superintendent of the ACE schools, outlining the intent and importance of conducting the study. Additionally, upon receiving the required permissions, the researcher informed and coordinated with the ACE Supervisor and the principals of the ACE schools for the dissemination of the necessary documents for data gathering.

Furthermore, the research instruments were administered to the respondents with the help of the ACE Communication Committee via Google Forms to facilitate easy data collection. Detailed instructions were placed before the survey questionnaires to ensure accurate responses. Mathematics grades of the students were also requested from the offices of the school registrars of the chosen schools. The gathered data were tallied, analyzed, and interpreted using statistical software to ensure accuracy and confidentiality.

F. Ethical Considerations

The researcher of this study ensured the priority of the rights and well-being of the respondents throughout the entire research process. Informed consent was obtained with a detailed explanation of the study's purpose, goals, potential benefits, and any minimal risks involved. It was emphasized that participation in the study was completely voluntary, and respondents could withdraw at any time without facing any consequences or penalties. The researcher took all necessary steps to keep the data private and secure.

Questionnaires were distributed and collected directly by the researcher to avoid unauthorized access, and a number-coding system was used when organizing and analyzing the data to maintain anonymity. If participants had any concerns or questions, they were provided with the researcher's contact details, including a phone number and email address. All questions were answered promptly to ensure participants felt comfortable and supported throughout the study. All completed questionnaires were stored securely in a locked cabinet accessible only to the researcher. Six months after the completion of the study, all data were safely destroyed by shredding. Even if the findings were published, participants' identities remained completely confidential, and no personal details were ever shared.

G. Data Analysis

- The researcher used several statistical tools and software to analyze the data and produce meaningful conclusions.
- Mean and Standard Deviation were used in assessing the teachers' extent of usage of collaborative learning and gamification strategies.
- Frequency and Percent were also applied to evaluate the learners' mathematics performance.
- The Pearson Product-Moment Correlation Coefficient was used to examine whether there was a significant relationship between collaborative learning and gamification strategies and the learners' mathematics performance.
- Stepwise multiple regression analysis was used to identify the predictors of the learners' performance in mathematics.

III. RESULTS AND DISCUSSIONS

Extent of Teacher's Usage of Collaborative Learning

Table 1 presents the extent of Mathematics teachers' use of collaborative learning strategies based on responses from 120 participants. Overall, the teachers reported a "Great Extent" of use ($M = 3.11$, $SD = 0.58$), suggesting that collaborative learning is a common practice in their instructional approach. However, the moderate variability indicated by the standard deviation also points to inconsistency in how these strategies are applied across different classrooms or situations. This implies that while most teachers value and apply collaborative learning, the depth, frequency, and fidelity of implementation may vary depending on classroom conditions or teacher preparedness. As such, there is room to strengthen how collaborative learning is embedded consistently across diverse teaching contexts.

Specifically, the structured cooperative learning model was utilized to a great extent ($M = 3.18$, $SD = 0.71$). This result implies that teachers are familiar with and frequently implement well-known cooperative learning structures such as jigsaw, think-pair-share, and numbered heads together. These formalized strategies support accountability, equal participation, and content understanding within student groups. However, the relatively higher standard deviation in this area indicates that while some teachers may be consistent in implementing these models, others may use them only occasionally or in less structured ways. It highlights the potential need for sustained professional development to ensure all teachers apply cooperative learning models with fidelity and effectiveness.

In terms of assessment and feedback within collaborative learning, the results also revealed a “Great Extent” of use (M = 3.16, SD = 0.53). This suggests that Mathematics teachers recognize the importance of evaluating group dynamics and providing timely, constructive feedback during collaborative activities. Teachers appear to actively monitor group processes and offer feedback to support learning outcomes and encourage reflection. This finding reinforces the idea that feedback is a critical part of making collaborative learning effective—not just in terms of academic performance, but also in improving student accountability and group cohesion. Consequently, assessment and feedback mechanisms are key levers in ensuring that collaborative efforts translate into meaningful learning experiences.

Regarding real-world problem solving and applications, teachers also reported using this strategy to a great extent (M = 3.11, SD = 0.58). This suggests that collaborative learning is not limited to routine academic tasks but is also integrated into authentic problem-solving contexts. Teachers are making efforts to connect mathematical concepts with real-life situations, thereby improving students' ability to apply what they learn in practical scenarios. This integration helps promote critical thinking, creativity, and relevance in mathematics instruction. Despite this, consistent and effective implementation may still be influenced by factors such as curriculum design and time constraints, which could affect the depth and frequency of real-world applications.

Lastly, both group work and peer interaction (M = 3.06, SD = 0.51) and the use of hands-on and interactive activities (M = 3.06, SD = 0.57) were also rated to a great extent, although slightly lower than other components. These findings indicate that while these elements are part of collaborative learning, they may pose more practical challenges for teachers. Implementing hands-on and interactive group activities often requires more time, resources, and classroom management skills. Additionally, peer interaction can vary in effectiveness depending on student dynamics and group composition. Therefore, these components may benefit from additional support in terms of planning strategies, classroom structures, and resource provision to enhance their implementation and effectiveness.

The slightly higher usage of structured cooperative learning and assessment practices implies a teacher preference for clear, organized methods and measurable outcomes within group settings. This may reflect confidence in evidence-based models and the increasing accountability measures tied to student performance. Meanwhile, the relatively lower scores in group work, peer interaction, and hands-on activities might indicate potential challenges in classroom management, time constraints, or limited access to materials that support interactive learning. Additionally, while real-world problem solving is moderately used, its mean suggests variability in how effectively it is integrated across different subjects or grade levels.

Moreover, while both group work and peer interaction and the use of hands-on and interactive activities yielded slightly lower yet still strong ratings, they still have an impact on the collaborative environment. Collaborative strategies such as group work enable students to construct knowledge actively, develop critical thinking skills, and foster communication and teamwork, essential skills for succeeding in mathematics (Gillies et al. 2023),.

However, the practical implementation of these strategies often encounters challenges related to classroom management, time constraints, and resource availability, as observed in rural school settings (Boakye , 2024). These limitations might explain the comparatively lower ratings, despite the known pedagogical value of these activities.

The importance of these strategies is further supported by educational theories. The use of group work and interactive activities allows students to engage with peers, share perspectives, and collaboratively build deeper mathematical understanding (Nasir et al., 2021; Lee & Yang, 2023).

Through hands-on activities, learners anchor abstract mathematical concepts into tangible experiences, thereby enhancing conceptual understanding (Malik & Zhu, 2023).

The findings show a strong use of collaborative teaching but reveal areas needing improvement, especially in peer interaction and hands-on learning. School leaders should provide professional development on advanced collaborative strategies and classroom management for group tasks.

Organizing peer coaching, lesson study groups, and providing necessary materials and tools can help address these gaps. Regular reflection and student feedback should also be encouraged to improve practice.

Table 1

Extent of Teacher's Usage of Collaborative Learning
(n=120)

Constructs	Mean	SD	Interpretation
Group Work and Peer Interaction	3.06	0.51	Great Extent
Structured Cooperative Learning Models	3.18	0.71	Great Extent
Use of Hands-On and Interactive Activities	3.06	0.57	Great Extent
Real-World Problem Solving and Applications	3.11	0.58	Great Extent
Assessment and Feedback in Collaborative Learning	3.16	0.53	Great Extent
Overall Extent of Teacher's Usage of Collaborative Learning	3.11	0.58	Great Extent

Note: Scale: 3.25-4.0(Very Great Extent); 2.50-3.24(Great Extent); 1.75-2.49 (Less Extent); 1.0-1.74 (Least Competent)

Extent of Teacher's Usage of Gamification Strategy

Table 2 presents the extent of Mathematics teachers' utilization of gamification strategies among a sample of 120 teachers. Overall, the usage of gamification strategies was reported to a "Great Extent" (M = 2.94, SD = 0.63). This indicates that while gamification is integrated into instructional practices, its application may be somewhat limited or inconsistent across different teaching contexts. The moderate mean score suggests that teachers are incorporating gamification elements, but perhaps not with strong frequency or intensity. This variability could be attributed to factors such as differing levels of familiarity with gamification techniques, resource availability, or varying perceptions of its effectiveness in enhancing student learning.

In terms of specific strategies, teachers reported using assessment and performance tracking to a "Great Extent" (M = 3.10, SD = 0.55). This highlights that Mathematics teachers are keen on monitoring learners' development and progress through gamified methods such as badges, levels, or points. Such practices not only provide visibility into student performance but also serve to motivate learners by acknowledging their achievements. The relatively low standard deviation indicates a consistent application of this strategy among the teachers surveyed.

Teachers also utilized engagement and motivation strategies to a "Great Extent" (M = 2.96, SD = 0.61). This suggests that Mathematics teachers often employ personalized activities such as puzzles, games, and simulations to maintain student engagement in the classroom. These methods encourage intrinsic motivation, prompting learners to participate actively in mathematics activities without perceiving them solely as competitive tasks. However, the standard deviation implies some variation in the implementation of these strategies, possibly due to differences in classroom dynamics or teacher preferences.

The integration of game-based learning was also reported at a "Great Extent" (M = 2.89, SD = 0.67). This indicates that Mathematics teachers incorporate tools like board games or card games (e.g., Math Bingo, Math Monopoly) to reinforce concepts and cater to diverse learning styles. While the usage is notable, the higher standard deviation suggests that the effectiveness and frequency of these activities may vary, potentially influenced by factors such as resource availability or time constraints. Further support and training may be necessary to optimize the implementation of game-based learning.

Competitive learning strategies were also utilized to a "Great Extent" (M = 2.88, SD = 0.66). This reflects positively on the use of team-based challenges to promote cooperative learning in Mathematics. However, the slightly lower mean score and higher variability may indicate hesitancy among some teachers to fully embrace competitive elements, possibly due to concerns about fairness or managing competitiveness among students. Balancing competition with collaboration is essential to ensure a positive learning environment.

Lastly, the implementation of reward and achievement systems was reported at a "Great Extent" (M = 2.86, SD = 0.68). This suggests that extrinsic reinforcements such as prizes, badges, or certificates are integrated into Mathematics classes to recognize student achievements. While these rewards can motivate students, the relatively higher standard deviation indicates variability in their use. It's important for educators to balance extrinsic rewards with intrinsic motivation to foster sustained engagement and a deeper appreciation for learning.

When used thoughtfully, competitive learning strategies build teamwork, accountability, and encourage peer reinforcement—outcomes also supported by Social Learning Theory (Bandura, 1963), which highlights the importance of modeling successful behaviors within social contexts (Adams, 2023). Thus, the Mathematics teachers' selective use of competitive activities demonstrates a strategic balance between encouraging student effort and nurturing collaborative spirit in solving mathematical challenges.

Mathematics teachers' moderate application of rewards shows a deeper understanding of the need to balance extrinsic motivation with fostering students' internal drive to engage with and master mathematical concepts (Christopoulos & Mystakidis, 2023). Furthermore, by promoting personalized and meaningful gamified learning experiences, teachers also follow the principles of Constructivist Learning Theory (Piaget, 1936; Vygotsky, 1978), wherein learners construct knowledge through engaging, authentic experiences rather than relying solely on external incentives (Nasir et al., 2021).

The findings suggest that Mathematics teachers are effectively using gamification strategies but still have room to deepen their integration. School leaders should support training focused on designing balanced gamified activities that combine both intrinsic and extrinsic motivation. Providing resources such as educational games, digital tools, and classroom incentives can further enhance engagement. Encouraging reflective practice will help teachers fine-tune these strategies to better support diverse learners.

Table 2

Extent of Teacher's Usage of Gamification Strategy
(n=120)

Constructs	Mean	SD	Interpretation
Game-Based Learning Integration	2.89	0.67	Great Extent
Reward and Achievement System	2.86	0.68	Great Extent
Competitive Learning	2.88	0.66	Great Extent
Engagement and Motivation Strategies	2.96	0.61	Great Extent
Assessment and Performance Tracking	3.10	0.55	Great Extent
Overall Extent of Teacher's Usage of Gamification Strategy	2.94	0.63	Great Extent

Note: Scale: 3.25-4.0(Very Great Extent); 2.50-3.24(Great Extent); 1.75-2.49 (Less Extent); 1.0-1.74 (Least Competent)

Mathematics Performance of the Learners

Table 3 presents the level of Mathematics performance among the learners (n = 120). The overall mean performance (M = 83.44), which corresponds to a Satisfactory level based on the established grading scale. This indicates that, on average, students are meeting the expected academic standards in Mathematics but are not yet achieving beyond the basic proficiency level. While this performance suggests a foundational understanding of key mathematical concepts, it also points to opportunities for growth. Strategic instructional interventions, enrichment programs, or differentiated support may be necessary to help more students progress toward Very Satisfactory (85–89) or Outstanding (90–100) performance levels.

This reflects findings from the Programme for International Student Assessment (PISA, 2022), where the Philippines ranked among the bottom in mathematics performance, emphasizing persistent difficulties among Filipino learners in developing critical problem-solving skills (Atienza, 2024; OECD, 2025). The results align with the identified systemic instructional challenges—including insufficient engagement strategies—as major contributors to students' underachievement in mathematics (Chand et al. 2021). From the theoretical standpoint, Constructivist Learning Theory (Piaget, 1936; Vygotsky, 1978) advocates that students build deeper understanding through active, meaningful engagement rather than rote memorization. Thus, the moderately satisfactory performances suggest the need for more constructivist-aligned teaching strategies, such as problem-based learning, collaborative problem-solving tasks, and gamified experiences, which would allow students to actively construct mathematical knowledge (Nasir et al., 2021; Lee & Yang, 2023).

Table 3

Table 3

Level of the Mathematics Performance of the Learners
(n=120)

Interpretation	Frequency	Percentage
Outstanding		
Very Satisfactory	29	24.2
Satisfactory	39	32.5
Fairly Satisfactory	33	37.5
Did not Meet the Expectations	19	15.8
Mean Performance	83.44 – Satisfactory	

Note: Scale: 90-100(Outstanding); 85-89 (Very Satisfactory); 80-84 (Satisfactory); 75-79 (Fairly Satisfactory); Below 75 (Did not Meet the Expectations)

Relationship between the Extent of Teacher's Usage of Collaborative Learning and the Level of the Mathematics Performance of the Learners

Table 4 presents the relationship between the extent of teachers' usage of collaborative learning strategies and the level of mathematics performance among learners. Significant relationships were identified for variables with p-values less than .05.

Structured cooperative learning models and learners' mathematics performance showed a significant negative relationship (r = -0.29, p = .001). This suggests that as mathematics teachers frequently implement cooperative learning strategies, learners' mathematics performance slightly decreases. The frequent use of collaborative learning strategies may not always effectively enhance mathematical skills, particularly when learners are not consistently engaged in the activity or when the implemented collaborative activity is not appropriate to the topic. This finding aligns with research indicating that the effectiveness of cooperative learning depends on factors such as group composition and task structure .

Assessment and feedback in collaborative learning and learners' mathematics performance also showed a significant negative relationship (r = -0.23, p = .01). This finding suggests that the frequent use of collaborative assessments and feedback correlates with lower mathematics performance. One possible explanation is that feedback within collaborative settings may be targeted more on group-level outcomes rather than on individual accountability, potentially overlooking individual learners' needs in mathematics. Ensuring that assessments address both group dynamics and individual understanding is crucial for effective learning.

Group work and peer interaction and learners' mathematics performance showed no significant relationship (r = -0.12, p = .19). This suggests that general group activities and peer interactions may not strongly influence individual mathematical achievement, possibly due to variations in group dynamics or unequal participation among students. Effective group work requires careful planning to ensure that all students are actively engaged and that tasks are designed to promote meaningful collaboration. Research has shown that structured group work can enhance learning outcomes when implemented thoughtfully .

Similarly, the use of hands-on and interactive activities and learners' mathematics performance was found to be non-significant (r = -0.04, p = .66). This indicates that incorporating hands-on or interactive activities, while beneficial for engagement, may not directly translate to higher mathematics scores, especially if such activities lack sufficient cognitive demand or direct application to tested mathematics skills. To maximize the effectiveness of interactive activities, educators should align them closely with learning objectives and ensure they challenge students appropriately. Integrating movement and physical engagement in math lessons has been shown to improve retention and motivation.

Lastly, real-world problem-solving applications and learners' mathematics performance also did not show a significant relationship (r = -0.16, p = .08). Although real-world problems can enhance relevance and motivation, their complexity might initially hinder performance if students struggle to transfer theoretical mathematical knowledge to practical scenarios without sufficient scaffolding. Providing students with the necessary support and gradually increasing problem complexity can help bridge the gap between theoretical understanding and practical application. Educators are encouraged to design real-world tasks that are accessible and build upon students' existing knowledge .

The significant negative relationship between structured cooperative learning models and learners' mathematics performance suggests that while collaboration is generally beneficial, improper implementation may limit its effectiveness. Collaborative learning significantly enhances cognitive, affective, and social skills, but it demands careful structuring, clear accountability, and active engagement from each member (Sotto ,2021). In cases where cooperative learning becomes unstructured or students are not equally participating, the instructional benefits diminish, leading to lower academic outcomes. This is supported by Constructivist Learning Theory (Piaget, 1936; Vygotsky, 1978), which emphasizes that learning must be actively constructed by the learner through meaningful engagement (Nasir et al., 2021). Without proper scaffolding, collaborative activities might become passive rather than active learning experiences. Furthermore, friendships and group dynamics significantly affect the success of peer learning; when dynamics are poor, mathematical performance can be negatively impacted even when collaboration is intended (Klang et al. (2021).

The findings suggest that collaborative strategies must be carefully planned to positively impact mathematics performance. School leaders should train teachers to structure group activities with clear roles, accountability, and alignment to learning goals. Teachers should balance group and individual assessments to ensure each student's progress is monitored. Enhancing group dynamics and providing scaffolding can help prevent passive participation and improve learning outcomes.

Table 4

Relationship between the Extent of Teacher's Usage of Collaborative Learning and the Level of the Mathematics Performance of the Learners

Construct/Variable	*r* value	*p-value*	Decision
Group work and peer interaction and performance	-0.12	0.19	Do not Reject Ho
Structured cooperative learning models and performance	-0.29**	0.001	Reject Ho
Use of hand-on and interactive activities and performance	-0.04	0.66	Do not Reject Ho
Real world problem solving application and performance	-0.16	0.08	Do not Reject Ho
Assessment and feedback in collaborative learning and performance	-0.23*	0.01	Reject Ho

Ho: There is no significant relationship between collaborative learning and learners' mathematics performance.

*Note: Probability Value Scale: **p<0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not significant)*

Extent of Teacher's Usage of Gamification Strategy and the Learners' Performance in Mathematics

Table 5 presents the test of the significant relationship between teachers' technological skills, specifically the use of gamification strategies, and learners' performance in mathematics. The results showed that none of the variables had a statistically significant relationship with learners' mathematics performance, as all p-values were greater than .05.

Game-based learning integration and learners' mathematics performance showed a very weak positive correlation ($r = 0.06$, $p = .53$). The data indicates no significant relationship. This suggests that although teachers may integrate games into instruction, such strategies do not directly influence improvements in students' mathematics performance. This may possibly due to issues in aligning game content with learning objectives.

Similarly, the reward and achievement system and learners' mathematics performance revealed a very weak negative correlation ($r = -0.03$, $p = .77$), indicating no significant association. This suggests that the use of extrinsic motivators such as badges, points, or tangible rewards in a gamified setting does not necessarily contribute to improved performance in mathematics. While these mechanisms may boost short-term participation or engagement, they may fall short in promoting intrinsic motivation—an essential factor for deep and sustained learning. The findings align with Deci and Ryan's Self-Determination Theory, which posits that overreliance on extrinsic rewards can undermine students' internal drive to learn. In subjects like mathematics, where understanding requires logical reasoning and conceptual mastery, extrinsic motivators may not foster the perseverance and critical thinking needed for problem-solving. Therefore, educators should be cautious in using rewards as a primary motivational tool without embedding them in a broader pedagogical framework that encourages self-regulation and mastery-oriented goals.

Competitive learning strategies and learners' mathematics performance also showed a negligible correlation ($r = 0.02$, $p = .85$), suggesting no significant impact. Competition, though often assumed to stimulate engagement and motivation, can have mixed effects on learning outcomes. In the context of mathematics education, the pressure to outperform peers may induce anxiety, lower self-confidence, or discourage participation among students who are already struggling. These emotional barriers may inhibit cognitive functioning and hinder the ability to focus on complex problem-solving tasks. Moreover, excessive emphasis on winning can shift learners' focus from understanding concepts to merely outperforming others, which contradicts the formative nature of learning. These findings highlight the importance of fostering a collaborative learning environment where peer support, rather than rivalry, is emphasized—especially in high-cognitive-demand subjects like mathematics.

In addition, engagement and motivation strategies demonstrated a near-zero correlation with learners' mathematics performance ($r = 0.01$, $p = .92$), again suggesting no meaningful connection. While engaging activities such as interactive games, storytelling, or digital simulations are often effective in capturing attention, their educational value depends largely on their instructional design. If such activities are not strategically aligned with learning objectives and content standards, they may serve as distractions rather than learning enablers. For mathematics, which involves cumulative knowledge and precision, instructional strategies must go beyond surface-level engagement. They should integrate scaffolding, guided practice, and opportunities for metacognitive reflection. The data imply that engagement, though necessary, is insufficient on its own to produce measurable academic gains without being embedded in structured and cognitively challenging tasks that promote meaningful learning.

Lastly, assessment and performance tracking showed a weak positive correlation ($r = 0.06$, $p = .56$), indicating no statistically significant relationship with learners' mathematics performance. While formative assessment and progress monitoring are widely recognized as best practices in instruction, their effectiveness hinges on the quality and use of the feedback generated. Gamified tracking tools, such as leaderboards or point systems, may fall short in providing individualized, constructive feedback that helps students understand their errors and improve their strategies. Furthermore, if performance tracking is not accompanied by timely intervention or targeted support, students may not use the data to enhance their learning. These findings point to the need for assessment practices that are formative in nature—providing clear, actionable insights that inform instruction and promote learner self-awareness and autonomy in mathematics.

The absence of statistically significant relationships between the extent of teachers' usage of gamification strategies and learners' mathematics performance indicates important considerations for instructional practice. Although game-based learning integration shows a weak positive trend, gamified learning environments enhance engagement, they do not guarantee academic mastery unless the gaming elements

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are purposefully aligned with cognitive learning goals (Rodriguez et al. 2023). This situation reflects a critical insight from Constructivist Learning Theory (Piaget, 1936; Vygotsky, 1978), which asserts that true learning requires active construction of knowledge, not merely interaction with engaging content. Without proper cognitive scaffolding, gamified activities risk promoting surface-level engagement rather than deep conceptual understanding (Nasir et al., 2021; Lee & Yang, 2023). Therefore, while game-based learning holds promise for enhancing classroom experiences, its effectiveness depends largely on the thoughtful integration of game mechanics that reinforce mathematical thinking and problem-solving.

Similarly, the non-significant relationship between reward and achievement systems and mathematics performance highlights the potential limitations of relying on extrinsic motivation. Rooted in Operant Conditioning Theory (Skinner, 1938), rewards can effectively reinforce desired behaviors (Lambert et al., 2024), but overreliance on badges, points, or prizes without fostering intrinsic motivation can lead to superficial participation rather than true skill acquisition (Saleem et al., 2022; Schneider & Sanguinetti, 2021).

The findings resonate that gamification may initially boost motivation but does not automatically sustain long-term learning unless intrinsic goals are nurtured (Jaramillo-Mediavilla et al. 2024),.

In the context of mathematics—a discipline demanding critical and sustained cognitive effort—extrinsic rewards must be coupled with strategies that foster mastery-oriented mindsets to produce lasting academic gains.

The findings imply that gamification strategies alone do not significantly improve mathematics performance without strong alignment to learning goals. School leaders should guide teachers to integrate game elements that directly support mathematical reasoning and problem-solving.

Professional development should emphasize designing gamified activities that balance engagement with deep cognitive challenge.

Additionally, teachers should focus on fostering intrinsic motivation alongside rewards to promote meaningful and lasting learning outcomes.

Table 5

Test of Significant Relationship between Teachers' Technological Skills and the Learners' Performance in Mathematics

Variables	*r* value	*p-value*	Decision
Game-based learning integration and performance	0.06	0.53	Do not reject Ho
Reward and Achievement System and performance	-0.03	0.77	Do not reject Ho
Competitive Learning and performance	0.02	0.85	Do not reject Ho
Engagement and Motivation Strategies and performance	0.01	0.92	Do not reject Ho
Assessment and Performance Tracking and performance	0.06	0.56	Do not reject Ho

Ho: There is no significant relationship between the gamification strategy and learners' mathematics performance.

*Note: Probability Value Scale: **p<0.01 (Highly Significant); *p<0.05 (Significant); p>0.05 (Not significant)*

Predictors of the Learners' Performance in Mathematics

The regression analysis in Table 6 identified three significant predictors of learners' mathematics performance: structured cooperative learning models, assessment and feedback in collaborative learning, and game-based learning integration. A multiple linear regression analysis was conducted to determine whether Structured Cooperative Learning Models, Assessment and Feedback in Collaborative Learning, and Game-Based Learning Integration significantly predicted learners' mathematics performance. The overall regression model was statistically significant, F(3, N–4) = 6.42, $p < .01$, suggesting that the predictor variables collectively accounted for 14.2% of the variance in learners' performance in mathematics ($R^2 = .142$).

Taken together, the regression model accounted for 14.2% of the variance in learners' mathematics performance ($R^2 = .142$), which, while modest, is statistically significant ($F = 6.42$, $p < .01$). This suggests that instructional strategies related to collaboration, assessment, and gamification do influence student outcomes, though other unmeasured factors also play a significant role. The findings illuminate a key principle in education: not all pedagogical innovations uniformly benefit all learners. Cooperative and collaborative practices, though theoretically sound, require careful design and execution to avoid unintended consequences, such as diluted individual accountability or generic feedback. Meanwhile, game-based learning, when thoughtfully integrated, appears to offer more promise in enhancing mathematics achievement. These insights reinforce the need for intentional instructional planning, where methods are aligned not only with content standards but also with learners' developmental and motivational needs.

Notably, both structured cooperative learning ($\beta = -0.34$, $p = .02$) and assessment and feedback ($\beta = -$

0.48, p = .02) were negative predictors, indicating that excessive or improperly implemented collaborative practices may hinder rather than help mathematics achievement. Higher reliance on these models was associated with a reduction in learners' mathematics performance. This outcome may reflect the possibility that overly structured or rigid group work frameworks could inadvertently reduce individual accountability or promote uneven participation.

This supports earlier findings that unstructured or poorly aligned collaborative methods can limit cognitive gains if students are not held individually accountable (Sotto, 2021). Klang et al. (2021) also emphasized the influence of group dynamics and student relationships, which, when unfavorable, can diminish the benefits of peer-based instruction. Such findings affirm that while collaboration is valuable, it requires thoughtful design and execution to be effective in cognitively demanding subjects like mathematics.

Assessment and Feedback in Collaborative Learning also negatively predicted mathematics performance (β = –0.48, t = 2.24, p = .02). While feedback is a cornerstone of effective learning , the data suggest that collaborative feedback mechanisms may not be sufficiently individualized to meet each student's needs. Group assessments or collective feedback, though efficient, may dilute the precision and personalization needed to address specific mathematical misconceptions. Furthermore, the possibility exists that students might not always perceive group feedback as relevant to their individual learning progress.

Conversely, game-based learning integration emerged as a positive predictor (β = 0.39, p = .01), uggesting that effective integration of educational games into the teaching-learning process can enhance students' mathematics performance. This finding is consistent with research that supports the role of game-based strategies in increasing learner motivation, engagement, and active problem-solving. Grounded in constructivist theory, such learning environments allow students to explore and interact with mathematical concepts dynamically. However, it is essential that the games be well-aligned with curricular goals and provide meaningful feedback for this positive effect to manifest.

This is consistent with Rodriguez et al. (2023), who argued that gamified content can foster active participation and reduce anxiety, especially when used to support problem-solving and conceptual mastery. Furthermore, Constructivist Learning Theory underpins this effect, asserting that learners best acquire knowledge through meaningful, interactive experiences (Nasir et al., 2021; Lee & Yang, 2023). These results imply that integrating well-designed educational games can provide students with both motivation and deep cognitive engagement, making it a promising avenue for improving mathematical performance when implemented with pedagogical intent.

The findings imply that collaborative strategies must be carefully structured to avoid negatively affecting mathematics performance. Teachers should receive training on implementing cooperative learning with clear individual accountability and aligned objectives. Game-based learning should be encouraged, as it shows positive potential when integrated meaningfully into instruction.

School leaders must support the thoughtful design of educational games that reinforce mathematical concepts. Overall, effective implementation of both strategies requires balancing engagement with cognitive rigor to enhance learning outcomes.

Table 6

Predictors of the Learners' Mathematics Performance

Predictors	Coef (β)	SE Coef	t- value	p-value
(Constant)	4.13	0.56	7.37	.000
Structured Cooperative Learning Models	-0.34	0.14	2.42	0.02
Assessment and Feedback in Collaborative Learning	-0.48	0.22	2.24	0.02
Game-Based Learning Integration	0.39	0.15	2.52	0.01

R^2 = 0.142 or 14.2 %
F- value = 6.42

Dependent Variable:
Performance = 4.13 – 0.34 Structured Cooperative Learning Models – 0.48 *Assessment and Feedback in Collaborative Learning +0.39 *Game-Based Learning Integration*

IV. SUMMARY

This study explored the collaborative learning and gamification strategies in relation to learners' mathematics performance. It employed a descriptive-correlational research design. It was conducted on a total of 120 Grade 9 students who were enrolled in the private secondary schools under the Archdiocesan Commission on Education (ACE).

Survey Questionnaires were utilized to gather the necessary data for the study. They were analyzed and interpreted using Mean, Standard Deviation, Pearson Product-Moment Correlation Coefficient, and the Stepwise Multiple Regression Analysis.

V. FINDINGS

The following are the findings of the study:

1. Teachers used collaborative learning strategies to a great extent, particularly structured cooperative learning models.
2. Gamification strategies were also used to a great extent, especially in the area of assessment and performance tracking, showing a strong focus on monitoring learner progress through gamified tools.
3. Most learners performed at satisfactory to very satisfactory levels in mathematics, while a few did not meet expectations.
4. Structured cooperative learning and assessment with feedback were negatively associated with performance. Other collaborative strategies showed no significant relationship.
5. No gamification component showed a significant relationship with learners' mathematics performance.
6. Game-based learning positively predicted mathematics performance, while structured cooperative learning and assessment with feedback were negative predictors

VI. CONCLUSIONS

Based on the findings of the study, the following are the conclusions drawn:

1. Teachers extensively implement collaborative learning strategies, with a strong emphasis on structured cooperative learning models to enhance student engagement and participation.
2. Gamification strategies are widely applied, particularly in assessment and performance tracking, highlighting a focused effort on using gamified tools to monitor and motivate learners.
3. Learners' performance in mathematics could be improved with targeted interventions.
4. Structured cooperative learning models and collaborative assessment and feedback significantly impact learners' mathematics performance, suggesting their effectiveness in improving mathematical understanding and achievement.
5. The motivational benefits of gamification strategies may not directly enhance academic outcomes in mathematics.
6. Game based activities in Math play a vital role in instruction as they positively influence learning outcomes.

VII. RECOMMENDATION

Based on the findings and conclusions of the study, the following are the recommendations:

1. Math teachers diversify their collaborative learning approaches by incorporating methods such as peer tutoring or group-based problem-solving tasks to further enhance student engagement and critical thinking skills in mathematics.
2. Math coordinators might explore the integration of more diverse gamified tools and resources, ensuring that they go beyond just assessments to stimulate student engagement and motivation throughout the learning process.
3. School administrators could implement additional academic support systems, such as after-school tutoring or peer mentoring programs, to help struggling students improve their mathematics skills.
4. Teacher trainers could provide professional development workshops focused on refining collaborative learning practices and feedback strategies, ensuring they align with students' needs and foster deeper mathematical understanding.
5. Curriculum developers might reassess the role of gamification in mathematics teaching, ensuring that it is strategically aligned with the content and objectives, and not just used as an engagement tool.
6. Math coordinators may consider expanding the use of game-based learning in mathematics, while revisiting collaborative learning models and feedback methods to better support student outcomes.
7. Future researchers could explore the long-term effects of integrating game-based learning and structured cooperative learning on mathematics performance, examining how different types of feedback and gamification techniques influence various student groups and learning environments.

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