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# Students' Perceptions and Experiences with Gamified Learning, Open-Ended Mathematical Tasks, and Self-Directed Learning via Video Lessons in Mathematics

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**Abstract.** While mathematics is essential for developing critical thinking and problem-solving skills, traditional teacher-centered approaches often fall short in fostering deep understanding, student engagement, and autonomous learning, highlighting a gap for more innovative, student-centered instructional strategies. This study explored students' perceptions and experiences with mathematics lessons that integrated gamified elements, open-ended tasks, and video-based learning. Using a census approach, participants were 120 Grade 10 students from Northern Mindanao, Philippines. The study employed a descriptive explanatory mixed-method approach and sought to gain more profound insights into how learners engage with mathematics through gamification, problem-solving with multiple strategies, and self-directed video lessons. Data analysis encompasses descriptive statistics for quantitative data and content and thematic analysis for qualitative data. Results from the perception questionnaire showed an average rating of 4.24, indicating generally positive views toward this learning approach. Thematic analysis led to the development of a proposed pathway to motivation and engagement in mathematics. The findings suggest that by emphasizing creativity, independence, and enjoyment alongside achievement, this approach fosters a positive cycle of motivation and engagement. Ultimately, it emphasizes the possible use of such a modality as an inclusive, student-centered framework to enhance both participation and performance in mathematics.

**Keywords:** gamified learning; open-ended mathematical tasks; self-directed learning; motivation; engagement

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## 1. Introduction

Mathematics plays an important role in developing critical thinking and problem-solving skills, yet it is often perceived as difficult and abstract, leading to low performance (Akpalu et al., 2025) and perceptions of mathematics as a challenging subject in which students struggle to develop competence (Jamaluddin et al., 2024). Traditional instructional methods in mathematics, predominantly characterized by teacher-centered lectures, whole-class board demonstrations, and fixed group seatwork, sometimes facilitate profound conceptual understanding. These methodologies frequently leave students as passive recipients of procedures, prioritizing rote memorization of algorithms rather than comprehension and providing limited opportunity for guided practice, prompt feedback, and differentiation (Khasawneh et al., 2023).

As a result, students may acquire procedural fluency without grasping conceptual comprehension, have challenges with applying knowledge to novel problems, and exhibit diminished engagement and motivation, leading to decreased performance. Fixed activities and uniform pacing limit chances for student autonomy, collaborative problem-solving, and the cultivation of higher order thinking essential in modern classrooms (Akpalu et al., 2025; Jamaluddin et al., 2024). Although certain traditional classrooms can and do evolve to become more learner-centered (Dietrich & Evans, 2022), the ongoing reliance on teacher-led types stresses the necessity for methods of instruction that actively foster thinking, diverse solution routes, and self-regulated learning. Such limitations have motivated the exploration of innovative, student-centered strategies in mathematics instruction.

In response to these limitations, teachers are now implementing innovative and student-centered strategies. Among these, gamified learning, which integrates game elements such as points, levels, and badges into instructional activities, has become a promising approach utilizing technology to promote student learning (Mandal & Morados, 2023) and experience (Karabıyık, 2024). By designing lessons as interactive experiences with progressive activities, gamified approaches create environments that are both stimulating and pedagogically effective. According to research, gamification can enhance learning personality, retention, cognitive and social skills, and math anxiety while also increasing student engagement (Jutin & Maat, 2024).

To effectively implement gamified learning, however, it should be designed based on the needs of the students (Yan, 2023). This belief is aligned with the competitive gamification model to ensure inclusivity and avoid negative outcomes such as exclusion or reduced motivation. In contrast, collaborative gamified learning emphasizes teamwork, shared achievements, and collective rewards, fostering communication, social skills, and learning from peers' strengths (Karabıyık, 2024). Literature also indicates that problem-based gamified activities are particularly effective in promoting students' motivation and gameful experiences (Alt, 2023), while digital game-based interventions in mathematics education have produced generally positive learning outcomes, particularly in secondary schools (Erşen & Ergül, 2022). Factors contributing to these positive outcomes include competitive and collaborative learning environments, the use of rewards, interactive features, technology integration, and feedback mechanisms, which collectively help address diverse student learning needs (Nob et al., 2024). However, Ratinho and Martins (2023) contended that both the novelty effect and prolonged exposure to gamification need to be further investigated.

Together with gamification, open-ended mathematical tasks encourage creativity, divergent thinking, and multiple solution strategies. These tasks, which allow students to have multiple solution paths and generate varied outcomes (Bingölbali & Bingölbali, 2021), often serve as a foundation for developing new questions, thereby promoting continuous inquiry and higher-order thinking (Aziza, 2021). Aside from higher-order thinking and mathematical creativity, open-ended tasks also promote autonomy (Berisha & Bytyqi, 2020) while offering equal opportunities for learners with diverse abilities, including those with learning disorders (Ron-Ezra & Levenson, 2025). Moreover, by promoting multiple solution pathways and collaborative reasoning, open-ended tasks encourage critical thinking and the problem-solving skills essential for practical applications (Lee et al., 2024).

Another innovative and student-centered strategy is the use of self-directed learning (SDL), one which has become critical, particularly in response to the shift toward modular, blended, and online learning environments. Cultivating SDL abilities at the classroom level is increasingly necessary, as students are expected to navigate diverse resources and take ownership of their educational trajectories (Sekano et al., 2025). This process facilitates deeper comprehension and long-term retention (Tang et al., 2025).

Video-based instruction has also emerged to provide learners with opportunities to develop self-directed and self-paced learning skills (Khodaei et al., 2022), allowing learners to enhance mathematics performance by reducing cognitive load and improving comprehension of complex concepts through visual and interactive elements (Ofril et al., 2024). In addition, it provides options for review and accessibility; thus, individual learning needs are better met (Sagge & Delos Reyes, 2024). Research has shown that flipped classroom models and video-based e-modules enhance engagement, understanding, and learning efficiency (Nabayra, 2020).

Researchers have examined open-ended tasks, video-based instruction, and gamified learning independently; therefore, this study fills an empirical gap because there has been little focus on integrating these three approaches into a coherent instructional framework. At the same time, this lack of integration also indicates a theoretical gap, since understanding how these strategies complement one another can inform the design of mathematics instruction that enhances engagement, motivation, self-directed learning, and achievement. Filling these gaps is significant because it provides math teachers a useful tool to help them support diverse students through an integrated approach. Additionally, it advances theoretical knowledge by suggesting how these methods can work together to promote autonomy, engagement, and problem-solving. Furthermore, the results have educational implications for professional development and curriculum design, assisting in the creation of more student-centered mathematical learning environments.

The present study addresses these gaps by investigating how the integration of gamified elements, open-ended tasks, and video-based resources works collectively. Specifically, this research examines the following objectives: (1) to determine students' perceptions and (2) to explore students' experiences in incorporating gamified learning, open-ended tasks, and self-directed learning through video lessons in mathematics, and (3) to propose pathways to motivation and engagement in mathematics.

## 2. Literature Review

### 2.1 Gamified Learning

Game-based learning (GBL) is one of the research trends in the 21st century (Hui et al., 2023) and several studies have conducted meta-analyses and systematic reviews to examine the effects of gamification on students. Li et al.'s (2023) study synthesized the empirical data currently available regarding the efficacy of gamification as a teaching and learning tool in educational settings and found positive effects.

Zeng et al. (2024) also conducted meta-analyses about gamification, investigating its influence on students' academic performance from gamified and non-gamified classes. In similar manner, Ortiz-Rojas et al. (2025) observed a moderately positive effect of gamification on student academic performance while Hui et al. (2023) found that GBL positively impacted students' mathematics learning. A review of literature supports these outcomes: 68% of studies confirm that gamification improves students' academic performance in mathematics (Nob et al., 2024).

The implications of GBL were found to be associated with two types of cognitive domains (knowledge and mathematical skills) and five types of affective domains (achievement, attitude, motivation, interest, and engagement). In a meta-analysis study to investigate the effectiveness of GBL on students' mathematics higher-order thinking skills (HOTS), Anggoro et al. (2025) found a positive effect. Furthermore, the improvement of HOTS using GBL was significantly influenced by moderator variables such as continent, control treatment, measured thinking skills, educational level, and intervention duration.

Studies investigating the effect of gamified lessons on early childhood education were examined by Alotaibi et al. (2024), who found they have moderate to large effects on cognitive, social, emotional, motivational, and engagement outcomes. Additionally, students' perceptions of autonomy and relatedness were positively and significantly impacted by gamification but had a slight impact on competence (Li et al., 2024). The combined results show that gamified learning consistently fosters students' motivation, engagement, and higher-order thinking, making it a potent and pertinent strategy for teaching mathematics in the 21$^{st}$ century, even though its effects differ depending on the context and design.

### 2.2 Open-ended Tasks in Mathematics

As a result of worldwide educational reform in the 21st century, teachers have developed and extensively utilized open-ended tasks in mathematics classes, these believed to be more appropriate for group problem-solving (Liu et al., 2025). Furthermore, in various grade-level contexts, it has been suggested to design tasks that allow for multiple approaches (Canogullari & Akcay, 2025). Teachers should therefore assign assignments with multiple possible answers and use logical rubrics. In the study by Levinson and Ron-Ezra (2024), groups were given two open-ended geometry tasks, and the fluency and flexibility of their responses were examined. The findings demonstrated that, while working simultaneously online will increase fluency, using gestures in in-person classes will increase flexibility.

Furthermore, open-ended problem-solving was found to be effective in grabbing participants' attention and encouraging them to try out and develop various problem-solving techniques (Rizos et al., 2023); the students acquired a positive attitude about the entire process. However, educators should establish roles and discuss strategies to guarantee fair participation and highlight various approaches. Despite the utilization of open-ended tasks in mathematics, longitudinal studies that connect participation in open-ended tasks to standardized performance and mathematics identity are needed, particularly in secondary settings.

### 2.3 Self-directed Learning using Video Lessons

According to Lin et al. (2023), curriculum reforms in many nations concentrate on fostering the self-directed learning (SDL) skills of the next generation to handle the rapid changes in society and the sustainable development of the environment. A mathematics SDL scale (MSDLS) was created for the study, and it found that students' SDLs do not rise with grade. This finding reminds us that nurturing self-directed learning in mathematics is not automatic with age or grade level but requires intentional support and guidance from teachers and curriculum.

Noetel et al. (2021) found that substituting video for current teaching methods resulted in small improvements in student learning, while adding video to existing teaching produced strong learning benefits. Conversely, a study by Morgado et al. (2024) demonstrated that video-based learning (VBL) has a moderate impact on attitude and an effect on knowledge acquisition. Taken together, these studies suggest that video lessons are most powerful when used to complement rather than replace traditional teaching, as they can boost both learning outcomes and students' attitudes toward mathematics. Self-paced, replay, and just-in-time review are just some features that video lessons offer, which can ease perceived pressure and encourage perseverance.

## 3. Methodology

### 3.1 Research Design

This research employs a descriptive explanatory mixed method that gathers both quantitative and qualitative data to find out more about students' perceptions and experiences regarding mathematics lessons incorporating gamified activities, open-ended problem-solving, and video-based self-directed learning. The study first used a structured perception questionnaire with Likert-scale items to collect quantitative data. Second, thematic analysis was used to examine qualitative data from open-ended questions collected through Google Forms to gain a deeper understanding of students' experiences.

### 3.2 Research Participants and Setting

The sample enlisted 128 Grade 10 students from a laboratory high school affiliated with a state university in Northern Mindanao, Philippines, enrolled for SY 2024-2025. These students, distributed across four sections, learned the fourth-quarter mathematics topics through teacher-made lessons incorporating gamified elements, open-ended tasks, and video lessons. Only the 120 Grade 10 students who were able to fully participate in the study were included as participants. Two primary factors led to the decision to include every participant, even though purposive sampling or smaller subsets are usually used in qualitative research to achieve data saturation. First, short written reflections that could be collected quickly were used in this light and non-intrusive data collection method. Second, this method of conducting the census guaranteed inclusivity, recorded a range of viewpoints, and improved the reliability and thoroughness of the results.

### 3.3 Instruments

The primary instructional tool used in the study was the teacher-made lessons incorporating gamified elements, open-ended tasks, and self-directed learning via video lessons, which covered all the required topics for the fourth quarter of AY 2024-2025, such as lines and circles. To gain insight into students' perception of gamified learning integrating open tasks and video lessons in mathematics, a 5-point Likert scale was drafted with the assistance of ChatGPT; however, following Ampo (2025), its outputs were carefully reviewed and verified against reliable sources.

The Likert scale has been adapted from a parallel paper by the author, underwent face validation by experts, and had additional terms modified to better align with the study's objectives. The instrument, however, was not the subject of a pilot study. During the actual data collection process, internal consistency was assessed and verified using Cronbach's alpha, which produced a value of 0.93978. This shows that the instrument consistently measures the intended construct and indicates excellent reliability.

The survey had open-ended questions administered to participants via Google Forms. The questionnaire was developed based on established research and evaluated by experts to ensure clarity and relevance in the content. The incorporation of Likert-scale items alongside open-ended questions enhanced methodological triangulation within the instrument, allowing for both detailed and nuanced participant responses. This study employed methodological triangulation by integrating Likert-scale items with open-ended questions in the survey instrument. This strategy enabled the collection of both quantitative and qualitative data, thereby improving the validity and applicability of the instrument within the study's scope. However, the study suggests that including interviews and classroom observations might have further enhanced triangulation.

**3.4 Data Collection and Analysis**

The lessons were designed to incorporate various activities aimed at motivating students and keeping them engaged. Students started with foundational concepts such as writing linear equations and understanding parallel and perpendicular lines, then proceeded with increasingly complex tasks accompanied by video lessons, collaborative problem-solving, and interactive graphing activities using Desmos. This sequence provided a natural structure for data collection, as each stage revealed how students' perceptions, experiences, and strategies evolved.

Each level of the sequence included main challenges, side quests (quizzes), and checkpoints to assess understanding before progressing. This structure encourages teamwork, accountability, and continuous feedback, while making learning meaningful and enjoyable. As S47 described:

> *"We explored topics like writing line equations, graphing circles, and using the distance formula by combining gamified learning, video lessons, and open-ended tasks."*

Students worked in groups to watch instructional videos, apply formulas, solve problems, and submit outputs for teacher validation. For instance:

> S10 reflected: *"We leveled up together—my groupmates and I helped each other progress through the activities."*
>
> S14 emphasized efficiency: *"We discussed what to do in each level to complete them and gave each member a task so that pas-pas ang progress [the progress is fast]."*
>
> S57 explained: *"During the levels, our mentor would give us a handout or a printed guideline... After watching the video, each member should provide an example."*

In this study, as students progressed, they encountered more complex tasks such as circle equations and geometric design applications. The culminating task required students to design an artistic composition using at least 10 unique circles, each labeled with its equation and symmetrical properties. Along the way, they documented their strategies, justified mathematical decisions, and refined outputs through mentor feedback.

During data collection for analysis, the students completed a perception questionnaire to assess their perception and answered open-ended questions regarding their experiences after implementing lessons in the fourth quarter, which incorporated gamified elements, open-ended tasks, and video lessons. The link to the form was shared with the students by their mathematics teacher during class time, and they submitted responses individually using their institutional email accounts to ensure authenticity. The researcher collected all data directly from the students using Google Forms, automatically recording it in the database for analysis.

For data analysis of the quantitative data, descriptive statistics, such as the mean and standard deviation, were used to interpret students' perceptions of the learning modality. Table 1 shows the interpretation of the mean range for the 5-point Likert scale perception questionnaire. In addition, content and thematic analysis were employed to identify and compare emerging themes in the reflections and insights of students regarding their experiences with the integration of gamified elements, open-ended tasks, and video lessons in mathematics.

**Table 1: Likert Scale Interpretation**

| Mean Range | Interpretation |
|---|---|
| 4.21 - 5.00 | Strongly Agree |
| 3.41 - 4.20 | Agree |
| 2.61 - 3.40 | Neutral |
| 1.81 - 2.60 | Disagree |
| 1.00 - 1.80 | Strongly Disagree |

## 4. Results and Findings

### 4.1 Students' Perceptions of Learning Mathematics Through Gamified Learning, Open-Ended Tasks, and Self-Directed Learning

Students' perceptions, as shown in Table 2, provided valuable information about how innovative strategies shape their learning experiences.

**Table 2: Students' Perceptions of the Implemented Learning Modality**

| Indicators | Mean | SD | Interpretation |
|---|---|---|---|
| The implemented modality of learning in class is effective in enhancing my learning. | 4.24 | 0.77 | Strongly Agree |
| The implemented modality of learning is well-suited to the course content. | 4.35 | 0.76 | Strongly Agree |
| The implemented modality of learning is innovative and engaging. | 4.58 | 0.64 | Strongly Agree |
| I feel comfortable participating in class activities under the implemented modality of learning. | 4.38 | 0.73 | Strongly Agree |
| The implemented modality of learning aligns with my preferred learning style. | 4.18 | 0.92 | Agree |
| This implemented modality of learning helps me understand complex topics more effectively. | 4.03 | 0.82 | Agree |
| I feel more motivated to complete assignments and tasks because of the implemented modality of learning. | 4.24 | 0.89 | Strongly Agree |

| | | | |
|---|---|---|---|
| The implemented modality of learning encourages me to think critically about the subject. | 4.24 | 0.75 | Strongly Agree |
| This implemented modality of learning has positively influenced my academic performance. | 4.18 | 0.78 | Agree |
| I feel more confident in applying what I have learned in real-world scenarios. | 3.98 | 0.86 | Agree |
| Overall, I am satisfied with the implemented modality of learning used in this class. | 4.35 | 0.78 | Strongly Agree |
| This implemented modality of learning has enhanced my overall learning experience compared to other methods. | 4.16 | 0.85 | Agree |
| I would recommend the implemented modality of learning approach for other subjects. | 4.19 | 0.96 | Agree |
| Overall | 4.24 | 0.81 | Strongly Agree |

In this study, gamified learning, open-ended tasks, and self-directed video lessons were integrated to make mathematics more engaging, flexible, and exploratory. Understanding students' perception of these approaches highlights their impact on motivation, engagement, and achievement.

The implemented modality of learning in class has proven to be highly effective and well-received by students, as reflected in the consistently high ratings across various aspects of their learning experience. Students strongly agreed that the approach enhanced their learning (4.24), was well suited to the course content (4.35), and was both innovative and engaging (4.58). This indicates that the modality successfully captured students' interest and made complex mathematical concepts more accessible. Moreover, a high level of comfort in participating in activities (4.38) and alignment with students' preferred learning styles (4.18) further suggest that the modality was inclusive and adaptable to diverse learner needs.

In addition to fostering engagement, the modality encouraged deeper cognitive involvement, with strong agreement that it enhanced motivation (4.24) and critical thinking (4.24). Students also reported increased understanding of complex topics (4.03), improved academic performance (4.18), and greater confidence in applying what they learned to real-world contexts (3.98). The overall satisfaction rating (4.35) reinforces the success of this approach in comparison to traditional methods, and students expressed willingness to recommend its application to other subjects (4.19). These responses collectively demonstrate that the gamified and interactive learning structure positively influenced student outcomes and provided a meaningful, student-centered learning experience. Yan (2023) argued that, whether in arithmetic or geometry, gamification may ignite students' interest, increase participation, and effectively improve their academic achievement.

### 4.2 Students' Experiences of Learning Mathematics Through Gamified Learning, Open-Ended Tasks and Self-Directed Learning

*4.2.1 Students' Motivation and Engagement Through Gamified Learning*

a) Increased Motivation Through Game Mechanics

For the majority of the students, around 98 responses, they frequently mentioned how game features like points, levels, and rewards encouraged them to finish assignments and participate more fully.

> *"It motivated me to try and complete every level to collect all the stickers." (S15)*
>
> *"Knowing that we are given points or bonuses, we are extra motivated..." (S87)*
>
> *"I got very motivated because I wanted to finish all the levels." (S9)*
>
> *"It made learning math more exciting... it made me want to keep learning and improving." (S110)*

Findings suggest that gamified learning is a promising tool for enhancing short-term motivation and achievement (Karabıyık, 2024). These reward-based features primarily stimulate extrinsic motivation, as noted by Karabıyık (2024).

b) Positive Engagement and Enjoyment

The gamified structure, according to 86 responses, helped transform mathematics into a fun and engaging experience, making lessons feel less tedious.

> *"Honestly, this type of learning made me love mathematics." (S8)*
>
> *"It made the learning experience engaging... encouraged us to continue learning." (S6)*
>
> *"It made learning very engaging and fun." (S95)*
>
> *"This modality made me enjoy learning the topics in algebra." (S119)*

Studies on gamified learning in mathematics suggest that it has significant potential to improve student achievement (Karabıyık, 2024). More than half of the reviewed studies reported that gamification fostered greater engagement and motivation among students who experienced the intervention (Nob et al., 2024). Similarly, Haase and Hanel (2022) noted that games tend to be more engaging, encouraging learners to adopt a more open and creative mindset.

c) Completion and Collaboration

Based on the analysis, 64 students were encouraged to be more dedicated and cooperative through friendly competition and shared objectives.

> *"It gave a sense of urgency to learn everything... so we can say that we had finished 11 out of 11 levels." (S1)*
> *"It motivated me/us to level up and fasten our pace too... leveling up faster than other groups felt like an accomplishment." (S76)*
>
> *"It motivated me because I don't want to be left out by my group." (S71)*

> *"It ignited my competitiveness, which is why I persevered to finish all the tasks." (S22)*

Research has shown that implementing gamification through digital game-based learning enhances students' interaction, communication, and collaboration (Jutin & Maat, 2024). Similarly, Große (2022) suggested that while having comparable prior knowledge can support collaborative work, the unique qualities of each partner's prior knowledge may also create a strong foundation for active and committed collaboration.

d) Pressure and Time Constraints

While 29 students found the pressure motivating, others felt stressed or overwhelmed by time limitations and group dependencies.

> *"It pressured us to finish the levels and understand the videos faster." (S118)*
>
> *"After going through the levels, it suddenly became stale... it was a race against time." (S5)*
>
> *"Some tasks were time consuming and hard, so it made me feel unmotivated." (S79)*
>
> *"The excitement faded a bit due to the tight schedule." (S111)*

Almeida et al. (2023) cited a study showing that competition diminished the overall quality of the environment and led to increased stress. Additionally, Ratinho and Martins (2023) discovered that gamification techniques had a positive impact on students' motivation, albeit one that tended to decrease with time.

e) Goal-Setting and Self-Regulation

Forty-one students shared that the gamified structure supported their learning by dividing tasks into levels, allowing them to track progress, and encouraging them to set individual or group goals. Similarly, Ali et al. (2021) reported that using an open-ended approach in mathematics enhances students' creative thinking and strengthens their self-regulated learning.

> *"The structured challenges help break down the material, making it feel less overwhelming." (S29)*
>
> *"It made me more responsible." (S93)*
>
> *"It made me determined to cooperate and contribute more since it is group work." (S30)*
>
> *"The game-like approach made this subject more exciting and something to look forward to." (S104)*

The student reflections show that gamified learning had a positive impact on motivation and engagement, with many citing the interactive format as the reason for their perseverance and enhanced mathematical comprehension. While most students responded positively, a subset reported feeling pressured or overwhelmed, particularly when time was short or team dynamics faltered. Moreover, the clear structure and feedback system provided by game elements allowed students to self-regulate their learning and monitor their performance through progression, badges, and feedback loops.

*4.2.2 Students' Learning Through Open-Ended Mathematical Tasks*

a) Deeper Understanding of Mathematical Concepts

According to 68 students' responses, open-ended tasks helped them grasp the concept more clearly and thoroughly.

> *"It made my understanding of the concept very clear. So I have become very confident about solving math problems related to the topic." (S9)*
>
> *"Doing math tasks with multiple solutions helped me understand concepts more deeply. It showed me that there isn't always just one correct way to solve a problem and improved my critical thinking and problem-solving skills." (S63)*

Nob et al. (2024) found that while non-routine problems promoted critical and creative thinking, their high difficulty and the lack of a control group limited student performance and the study's generalizability.

b) Flexible and Strategic Thinking

By encouraging students to select or contrast various approaches to solving problems, the tasks fostered flexible thinking, according to 51 responses.

> *"It made me identify which one is the easiest path to take, or what path is suitable for a certain problem." (S46)*
>
> *"I went to find the most efficient and straightforward route in doing math tasks that had multiple solutions. Because of that, I got to learn the concepts more quickly and apply those to other concepts as well." (S67)*

Nieminen et al. (2022) found that when students were given open-ended, real-life problems connected to everyday situations without a single correct answer, they were able to share agency. This meant they could make their own decisions, take initiative, and influence the way the task was carried out.

c) Awareness of Multiple Pathways in Math

Forty students appreciated that math can be solved through various valid approaches.

> *"It helped me realize that equations could be solved with more than one solution." (S79)*
>
> *"It showed me that math isn't just about one right way, but about understanding and problem-solving." (S33)*

According to Osakwe et al. (2023), it is essential to adopt suitable teaching methods that improve students' performance and foster creativity in mathematics. One such approach is the use of "Multiple Solution Tasks," where learners are presented with rich mathematical problems and guided to explore different solutions or proofs.

d) Improved Confidence and Independence
Of the students, thirty-nine reported increased self-trust and comfort in solving math problems on their own.

> *"Trying different methods helped me understand the concept better because I could see how and why each strategy worked. It also made me more confident in solving problems." (S57)*
>
> *"It made me kind of trust my answers a bit more. Before, I always had doubt with my answers… Having to solve open-ended math tasks allowed me to let the concept 'marinate' into my mind." (S85)*

Engaging with open-ended tasks not only deepened students' conceptual understanding but also fostered greater confidence and independence in their mathematical thinking.

e) Enjoyment, Engagement, and Creativity
According to 47 students, tasks sparked creativity and made math feel more fun, interesting, and motivating.

> *"It was fun learning about different kinds of solutions. It fueled me to learn the different aspects/parts on how to make circles from equations." (S5)*
>
> *"It was fun and much more engaging… it made me learn how to 'panginabuhi'* [persevere] *when finding how to answer it and to find the correct solution and answer." (S91)*

Berisha and Bytyqi (2020) noted that mathematics instruction often follows a strictly closed approach, leaving little space for developing broader skills such as creativity, problem-solving autonomy, and productive thinking. In contrast, Haase and Hanel (2022) examined a game-based approach in which one of the games encouraged divergent thinking by allowing for multiple possible solutions.

*4.2.3 Self-Directed Learning of Students Through Video Lessons*
a) Convenience and Flexible Pacing in Learning
Seventy-eight students shared how video lessons provided both convenience and flexibility, allowing them to decide when, where, and how they studied.

> *"The use of video lessons helped me… by allowing me to study at my own pace and in a comfortable setting. I could watch the lessons whenever it was convenient for me." (S11)*
>
> *"It made learning flexible because you can watch anytime and anywhere." (S95)*
> *"Using video lessons helped me take control of my own learning by letting me go at my own pace. I could pause or rewatch parts I didn't understand and focus on the areas I needed more practice with." (S2)*

*"Throughout watching video lessons, I can learn in my own pace. I can rewatch the videos all over again if I'm still lost without getting shy for not understanding the topic/process." (S30)*

The accessibility of video lessons made learning more manageable and reduced stress. At the same time, the ability to pause, rewind, rewatch, or adjust the speed of lessons empowered them to learn at their pace. These features gave students autonomy over their understanding, boosted confidence, and eliminated the fear of falling behind in class.

b) Increased Independence and Responsibility
According to 36 responses, video lessons nurtured students' sense of self-discipline, ownership, and initiative in learning mathematics on their own.

*"The video lessons made me more independent and helped me take responsibility for my own learning in math." (S57)*

*"It made me feel quite independent in learning math. I also had the option to search for more examples on YouTube to reinforce what I learned." (S2)*

In this way, video lessons empowered students to take charge of their learning, reinforcing independence while cultivating responsibility and initiative in studying mathematics. This finding differs from Ampo et al. (2025), who found that students experienced stress during independent learning in a blended learning environment, suggesting that the design and support of the learning modality can influence students' experiences of autonomy.

c) Reduced Pressure and Anxiety
Eighteen (students felt less pressured compared to live classes and were more comfortable revisiting unclear parts without embarrassment.

*"It lessened the pressure that I had been feeling recently since I am really behind in class… I didn't have to worry much." (S85)*

*"I could go back to portions of the video/topic that I'm confused about… I don't feel pressure to catch up." (S70)*

The flexibility of video lessons provided a supportive space where students could learn at their pace, reducing anxiety and allowing them to review concepts without fear of judgment.

d) Improved Conceptual Understanding Through Repetition
For 42 students, the ability to review examples and steps multiple times helped them internalize mathematical concepts better.

*"Rewatching the videos again and again made me understand and remember how to solve problems in math." (S26)*
*"Watching video lessons help me understand complex concepts in a way that I can rewind, pause, and play again the video until I get it." (S105)*

The result aligns with the findings of Insorio and Macandog (2022), which indicated that video lessons support students' understanding of mathematical concepts.

### 4.2 Pathways to Motivation and Engagement in Mathematics: Gamified Learning, Open-Ended Tasks, and Self-Directed Learning

The framework demonstrates how various teaching philosophies come together to improve motivation, engagement, and mathematical achievement by drawing on both student reflections and the body of existing literature. With points, prizes, and friendly competition, gamified learning encouraged enjoyment and perseverance. However, some students also expressed stress due to time constraints, which is in line with Almeida et al.'s (2023) findings about the negative effects of excessive competition.

In addition to encouraging creativity, confidence, and persistence in problem-solving, open-ended tasks promoted flexible thinking and deeper conceptual understanding. Self-directed video courses, on the other hand, provided independence and control over the pace, which lessened anxiety and promoted accountability. Tang et al. (2025) stress that self-directed learning combined with game-based strategies can be especially successful in promoting mastery of difficult concepts.

These pathways all work together to support the main idea of student motivation and engagement, as seen in Figure 1. The findings point to interpretive loops: a positive cycle in which motivation propels perseverance and success, a negative cycle in which pressure compromises engagement, and balancing strategies that maintain fruitful learning experiences, like goal setting, self-control, and teamwork.

Responses from students support this dynamic. While open-ended tasks promoted perseverance by allowing them to try out different solutions, game mechanics encouraged them to finish levels and receive recognition. Simultaneously, tools like group collaboration and video replay served as stress relievers, guaranteeing that students stayed interested even in the face of difficulties.

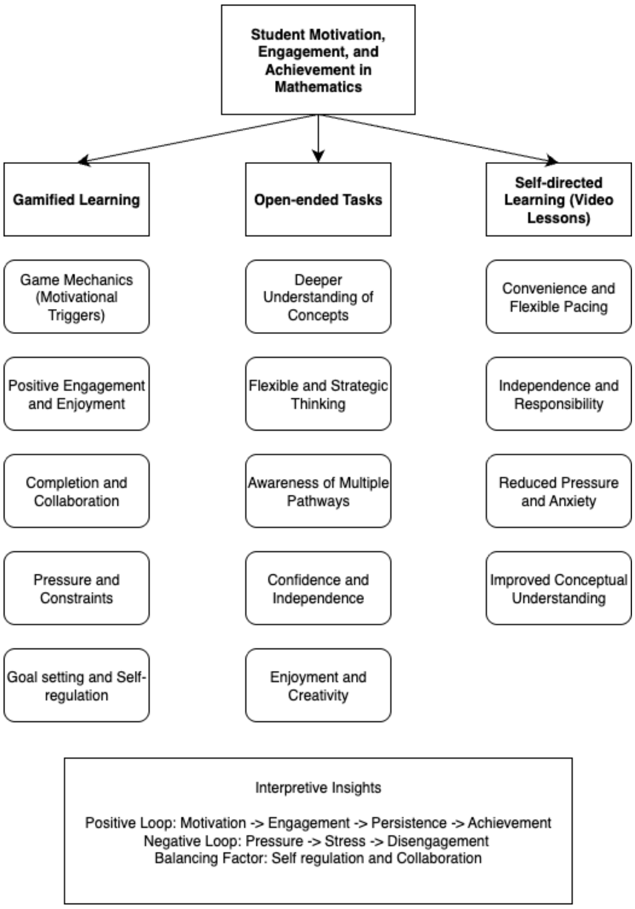


**Figure 1: Pathways to Motivation and Engagement in Mathematics**

Overall, the integration of these strategies encouraged high levels of motivation (4.24), engagement (4.58), conceptual understanding (4.03), and academic performance (4.18). The interpretive loops demonstrate the value of independence, flexibility, and peer support in sustaining a positive cycle, even in the face of potential disengagement. This result shows that mathematics education can be significantly improved by a blended, student-centered approach based on gamification, open-ended inquiry, and self-directed learning.

## 5. Discussion

Utilizing gamified learning in the classroom was found to greatly boost students' motivation (Alsadoon et al., 2022), engagement, and sense of progress in mathematics. Many students shared that elements like points, levels, badges, and side quests made learning more exciting and encouraged them to push through challenges, consistent with the findings of Ratinho and Martins' (2023) study on the motivational impact of game elements. These features not only made math feel more enjoyable but also fostered healthy competition and teamwork, as classmates worked together to move up levels and achieve group milestones.

However, a few students admitted that they felt pressured to participate in gamified learning (e.g., Malahito & Quimbo,2020), either by the limited time or due to uneven group participation. Despite these challenges, the game's structure, clear goals, visible progress, and timely feedback helped students take charge of their learning, set personal targets, and stay focused. This finding diverges from Ortiz-Rojas et al. (2025), who found no evidence of gamification's impact on individual motivation and self-efficacy. While gamification enhanced motivation and engagement, students also shared that open-ended mathematical tasks allowed them to explore different strategies and solution paths, which is in line with Bobis et al.'s (2021) definition.

This approach strengthened their conceptual understanding while building critical thinking and problem-solving flexibility. Within the game, teachers guided this process by asking open-ended and progressively challenging questions, thus prompting students to reflect on their mathematical thinking (Yan, 2023). Learners appreciated seeing that math problems do not always have a single solution, which led to increased confidence and independence in their reasoning. Moreover, students found open-ended tasks more enjoyable and intellectually stimulating, as they encouraged creativity (e.g., Schoevers et al., 2022) and exploration beyond rote procedures.

Supporting this flexible learning environment was the use of video lessons, which empowered students to learn at their pace, revisit difficult concepts, and manage their study time based on personal needs, consistent with Sagge and Delos Reyes (2024), who highlight video media as a novel and accessible mode of learning. The videos also reduced classroom anxiety and fostered independent learning habits, with many students taking the initiative to study ahead or supplement their understanding using additional resources.

This practice is consistent with the findings of Insorio and Macandog (2022), which show that students benefit from video lessons that supplement module lessons in understanding mathematical concepts. These approaches combined with creating a student-centered learning experience, one that promoted autonomy, engagement, collaboration, and deeper mathematical thinking.

## 6. Conclusion

The findings show that integrating gamification, open-ended tasks, and video-based lessons created a dynamic and meaningful learning experience for students. The consistently high student ratings across engagement, motivation, understanding, and confidence indicate that the implemented gamified and interactive learning modality was highly effective, well-received, and successful in making complex mathematical concepts more accessible and meaningful. The approach not only captured their interest and made mathematics more engaging but also helped them think critically, work collaboratively, and build confidence in applying concepts to real-world situations.

While some students acknowledged challenges such as time pressure or uneven group participation, the overall structure, with clear goals, feedback, and flexible pacing, supported self-regulation and persistence. Beyond these outcomes, the study offers practical insights for educators by providing a flexible model of instruction that balances enjoyment, creativity, and independence with academic achievement. Theoretically, it contributes to the literature on student-centered learning by demonstrating how gamification, open-ended problem-solving, and video-based resources can work in synergy to sustain motivation and engagement, offering new perspectives on pathways to self-directed learning and collaborative problem-solving in mathematics.

## 7. Limitations and Recommendations

Despite the significant contributions of this study, we should interpret the conclusions with caution, considering its main findings and limitations. The study focused on Grade 10 students in Northern Mindanao, Philippines, which limits the results' generalizability to other contexts.

Moreover, it relies on perception surveys and open-ended questions as the only data sources and descriptive statistics (mean and standard deviation) for quantitative analysis in addition to content and thematic analysis for qualitative data. To build on these findings, future researchers are encouraged to refine the methodology by addressing the lowest-rated perception, particularly students' confidence in applying what they have learned to real-world scenarios and in solving complex mathematical problems.

It is also recommended to further investigate the pathways to motivation and engagement in mathematics, particularly focusing on how the "negative loop," such as pressure leading to stress and disengagement, affects learning. These directions are relevant not only to researchers but also to educators and students, as they can inform classroom practices that foster confidence, reduce stress, and promote sustained engagement in mathematics.

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**Appendix 1**

Sample Learning Materials and Activities

*Sample badges for Gamified Learning*



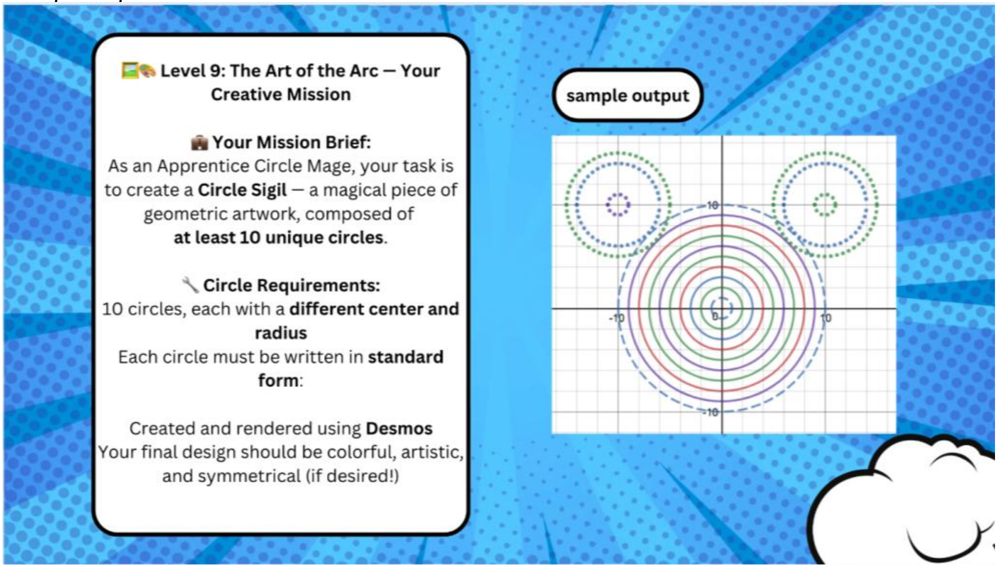


*Sample group names*

Group Names for Section Tau

1. TauTalizers
   *Energizing every challenge with Tau-power!*
2. Trailblazers of Tau
   *Pioneers of math, masters of the unknown!*
3. The Tau-Rminators
   *Crushing every challenge with precision!*
4. Team Infinite Tau
   *Boundless thinkers, limitless possibilities!*
5. Guardians of Tau
   *Protecting logic, strategy, and fun!*
6. TauTroopers
   *Ready for action, equipped with knowledge!*
7. Taugetics
   *Precision thinkers with unstoppable focus!*
8. The Tauthentic Eight
   *Authentic minds, authentic math!*

*Sample Open-ended tasks*




*Sample use of video lessons to promote self-directed learning*