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Unlocking Math Potential: Investigating the Influence of Gamification on Grade 10 Students' Math Skills and Confidence

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ABSTRACT

In this quasi-experimental research, gamification referred to as an innovative pedagogical intervention that used game elements to improve learners' understanding of concepts and principles, problem-solving ability, and logical reasoning and confidence levels in math tasks involving permutation and combination. Guided by Self-Determination Theory (SDT), Constructivist Learning Theory, and Cognitive Load Theory, the study employed experimental design to achieve its objective. Using stratified random sampling, participants were selected and divided into two groups, where one group received instruction via gamified methods and the other via traditional teaching. Gamified instruction involved well-blended game mechanisms, such as point systems, badges, and achievements, collectively referred to as Reward Dynamics, which were designed to satisfy students' psychological needs for competence, autonomy, and relatedness. Pretests, post-tests, and 5-point Likert-scale questionnaires were used to gather both qualitative and quantitative data. The study employed mean, standard deviation, and paired sample t-tests to describe and determine significant differences between the pre-test and post-test scores, as well as the confidence levels before and after the implementation of gamification. The study found a significant improvement in both the mathematical skills and confidence of the learners after the implementation of gamification.

Keywords: *Gamification, Mathematics skills, Confidence levels, Rewards Dynamics*

1. Introduction

Mathematics is often perceived as a challenging subject, eliciting anxiety and frustration among the students (Dowker, Sarkar, & Looi, 2016). This difficulty intensifies as learners advance to higher grade levels where more abstract and complex concepts are introduced, resulting in a decline in mathematical performance, coupled with reduced confidence in their ability to succeed.

In the Philippines, the Department of Education reported that only 31% of Grade 10 students achieved the proficiency level in mathematics in the 2018 National Achievement Test, reflecting a significant gap in foundational skills critical for academic and professional advancement (DepEd, 2018). Studies in the Philippines also indicate that approximately 70% of secondary students experience moderate to elevated levels of math anxiety, with fear of failure and negative past experiences cited as primary contributors (Tan, 2019). Similar studies also reported that about 65 percent of high school students have moderate to higher levels of anxiety when solving mathematical problems (Relunia et al., 2017; Trinidad, 2020). This common problem highlights the need to address not only skills but also emotional and psychological barriers that prevent effective mathematics performance. When skills deficits and lack of confidence are combined, it can form a cycle of disengagement whereby students do not complete math tasks, which in turn worsens their skills deficits. Mathematics is a subject vital to academic and professional achievements and discovering new methods that increase student participation and competence in mathematics is crucial.

The use of gamified instruction represents a promising solution to address these educational challenges. Gamification incorporates game design elements, such as point scoring, leaderboards, rewards, and competitive dynamics, which are utilized in non-game settings to enhance learner engagement, motivation, and participation (Sailer & Homner, 2020).

After the widespread adoption of gamification in business marketing and fitness fields, studies on the educational application of gamification in mathematics classrooms followed, mostly adopting it as a tool to enhance student involvement and engagement, and others aimed at improving academic achievements. These studies demonstrate that educational systems incorporating reward systems, progress tracking, and competitive elements have led to students becoming more motivated and actively participating in class. One example is the research conducted by Anderson and Dill (2018) and Gee (2017) that demonstrated how gamification enhances understanding and critical thinking, particularly in complex mathematical subjects.

According to Surendeleg et al. (2021) and Hamari et al. (2018), gamification enhances student participation and improves their knowledge retention and performance. This is supported by research studies thatthat provide empirical evidence that gamification can be applied in education byto enhance student motivation and participation. For instance, a meta-analysis conducted by Subhash and Cudney (2018) reported that the application of gamification in education significantly influenced learning results, especially in STEM courses, as it allowed students to sustain their interest for a longer period and improved their conceptualization. By focusing on what makes games enjoyable and intrinsically motivating, the teachers create learning experiences that are not only fun but also successful in developing greater understanding among students.

In mathematics, there have been encouraging benefits, including improved learning outcomes and enhanced performance. A study conducted by Domínguez et al. (2013) and Su and Cheng (2015) found that students in a gamified classroom setting exhibited higher levels of engagement, better retention of mathematics concepts, and greater motivation compared to those in traditional instructional settings. Furthermore, gamified systems can provide immediate feedback, correct errors, and reinforce a growth mindset in learners, helping them develop the right mindset.

Some schools in the Philippines have also found them successful in an attempt to gamify math instruction. As an example of such projects, Dela Cruz and Santos (2021) tested the use of a gamified learning interface with Grade 10 students in Metro Manila and found that it increased problem-solving outcomes by 25%. According to this study, the use of competition and rewards has increased student involvement and decreased math anxiety, thereby enhancing the learning environment.

The educational value of gamification has been reinforced by subsequent research studies conducted after 2015. To illustrate, Su and Cheng (2019) found that students exposed to gamified learning settings improved their arithmetic scores by 12%. Similarly, Kim et al. (2020) mentioned the way in which adaptive game-based systems can be trained to recognize students' strengths and weaknesses, allowing them to tailor their lessons accordingly, particularly in challenging subject areas such as algebra and geometry.

Although gamification is a promising method, it is essential to note that effective gamification must be highly integrated with learning goals and executed with utmost attention. As suggested by several studies, including the work of Huang et al. (2020), poorly designed gamification components can lead to shallow participation at the expense of limited learning achievement. Gamified activities must, therefore, be carefully designed if educators want both engaging and pedagogically effective outcomes.

Gamification in education is supported by motivational theories such as self-determination theory, which suggests that students are more likely to be motivated and engaged when their psychological needs for competence, autonomy, and relatedness are met (Deci & Ryan, 2015). Gamified learning environments offer students opportunities to experience incremental successes, make choices, and collaborate with peers, which enhances their motivation and engagement. Furthermore, the immediate feedback and rewards provided by gamified activities can help students build a sense of accomplishment and develop a growth mindset, perceiving challenges as opportunities to gain experience rather than obstacles to avoid (Kim et al., 2018).

Despite the growing interest in gamification, a systematic review identifies gaps in the application of gamification to traditional and hybrid learning settings, calling for more studies to understand its effectiveness across diverse learning modes (Educational Technology Journal, 2022). While gamification has shown the potential to enhance student engagement and motivation, most existing studies have focused on general education or non-mathematics subjects (Hamari et al., 2016).

Literature on the gamification of learning math has been widely concerned with gamification among learners at either the primary or university level, leaving the scope of its influence to be explored in secondary schooling studies, more specifically, among Grade 10 students with challenging subjects like algebra and geometry (Kapp, 2012). Furthermore, Lampropoulos and Sidiropoulos (2024) find that although gamification is seen to affect motivation and retention, more studies are required to determine its precise effect on critical thinking and problem-solving capacity. Baah et al. (2024) examined the effect of gamification on engagement, cognitive load, and motivation, highlighting the need for further research on its actual impact on cognitive skills and learning outcomes. This study aims to fill the gap by investigating how gamification affects the cognitive and affective dimensions of learning mathematics among secondary-level learners. The cognitive aspect embraces development skills such as problem-solving, critical thinking, and mathematical reasoning, whilst the aspect of effect focuses on the students' self-confidence, attitude, and self-efficacy toward Mathematics (Looyestyn et al., 2017). Both of these aspects are important because the students' confidence in themselves is a strong predictor of academic resilience and performance.

Evidence of the direct effect on math learning among high school students in the Philippine setting is still limited (Borja, 2021). The use of gamification approaches, such as point systems, leaderboards, and reward-based games, in previous studies has proven to potentially improve math attainment and interest. For example, the study of Zainuddin et al. (2020) demonstrated that gamified lessons substantially improved students' problem-solving abilities and their engagement in collaborative learning. Similarly, Hung (2017) highlighted in his study how gamification is used to reduce the fear of failure among students and develop their growth mindset in mathematics. Most of these works were conducted in a Western or other Asian setting, with hardly any studies considering the special sociocultural and pedagogical concerns of Filipino students.

Focusing on a Grade 10 cohort, this study seeksaims to assess the impact of gamified learning on their mathematics abilities, including conceptual knowledge, problem-solving skills, and critical thinking (Looyestyn et al., 2017). The study also examines the effect of gamification on students' confidence in performing mathematics exercises, reducing math performance anxiety and promoting a positive outlook towards the subject. Self-confidence is important in mathematics because confident individuals are more likely to persist in solving difficult problems and become resilient in dealing with failure (Usher et al., 2019).

Teachers and instructional content developers can benefit from the findings of this research to plan and implement gamified learning effectively. Gamification can serve as a template forfor improving students' performance and engagement in mathematics classes, not just in the Philippines but in other nations where mathematics is a top concern. By establishing a more challenging, dynamic, and nurturing learning environment, the aim is to enable students to achieve their full potential in mathematics and enhance their academic and self-esteem performance.

Background of the Study

Mathematics classes form the foundation for the development of students' analytical and problem-solving skills, which are essential in both school and daily life. Mathematical competence is globally a significant indicator of occupational opportunities in life, particularly in science, technology, and engineering professions. Most students, however, view mathematics as challenging, especially abstract courses like permutations and combinations that involve reasoning and problem-solving skills.

Global tests, such as the Programme for International Student Assessment (PISA), have consistently shown that Filipino students lag behind their peers worldwide in mathematics. In 2018, the Philippines was among low-performing nations where only 19.7% of students had achieved minimum proficiency, compared to 76% in the rest of the world. Filipino learners had a mean of 353 in mathematics, which is significantly lower than the OECD average of 489. The 2022 PISA performance did not fare any better, with a mean of 355, still far from the OECD mean of 472. Likewise, National Achievement Test (NAT) scores have consistently identified math as a challenging subject among Filipino learners, with no more than 37.44% of Grade 10 students attaining proficiency in 2019. These trends are a testament to deeply ingrained areas of weaknesses in higher-order mathematical skills, particularly in complex problem-solving and abstract reasoning, underscoring the urgent need for effective interventions to enhance mathematical skills and confidence among students in the Philippines.

Across the country, mathematics remains a difficult subject for most students. The National Achievement Test (NAT) consistently showed math to be one of the lowest performers, with only 37.44% of Grade 10 students proficient in 2019. Both Magno and Miranda (2020) and Trinidad & Ramos (2019) studies have shown that students struggle with permutations and combinations due to misconceptions about factorials, confusion in distinguishing between problem types, and an over-reliance on memorization rather than understanding. The conventional way of delivering mathematics via lectures often turns off students, instead confirming low levels of self-confidence and poor attitudes toward math.

At the school level, Lumbang Integrated National High School (Lumbang INHS) mirrors these national trends. The MPS in mathematics of the school has historically trailed behind the Department of Education (DepEd) target of 75%. In S.Y. 2022-2023, the worst MPS achieved was 59.96% during Quarter 2 and only 73.16% in Quarter 4. The MPS dropped again the following year to 53.28% in Quarter 3, indicating that students of mathematics were still not performing well. Large test score standard deviations indicate significant ranges of student performance, likely due to variations in pre-learning, instructional quality, and resources.

To address the above problems, there is a need for an innovative learning structure that extends beyond the classroom. It has been proven that gamification of game elements into learning—improves learners' motivation and comprehension. Gamified learning modules have been shown to improve learners' mathematical problem-solving ability and self-efficacy (Alabbasi, 2018; Tang & Chaw, 2021). Gamification is an inexpensive and environmentally friendly solution for addressing limited resources and demotivating conventional pedagogy in the Philippines.

This study intended to investigate the gamification potential for studying permutations and combinations in Lumbang INHS. With more engaging and interesting learning experiences, it is possible to develop the mathematical abilities and confidence of learners, in line with DepEd's vision of enhancing 21st-century competencies in learning.

Theoretical Framework

One of the theory models utilized and applied this research is Self-Determination Theory (SDT) conceptualized by Edward Deci and Richard Ryan in the early 1980s. SDT is a psychological intrinsic motivation theory based on the postulation that human behavior and overall motivation, and most specifically learning, are intrinsically based on intrinsic motivation. SDT contends that human beings possess three innate psychological needs: autonomy, competence, and relatedness. Autonomy is to want the ability to exert control over decision and action, competence is to feel the skills and ability to perform the job, and relatedness is to feel supported by and connected to group members. In schools, provided the needs are met, students are likely to be engaged, motivated, and achievement motivated. This theory emphasizes the importance of instructional strategies that instill intrinsic motivation in a bid to build deeper and quality problem-solving fundamental goals of this research, especially in teaching difficult mathematics concepts such as permutations and combinations. While SDT is useful in providing information regarding motivation, it is not without weakness. One of the weaknesses of SDT is that it cannot fully account for the cross-cultural differences in the way students are perceiving autonomy, competence, and relatedness. For example, in collectivist cultures such as the Philippines, students would desire more relational needs and group cohesion than individual autonomy, which could influence their response to gamified learning environments (Chirkov et al., 2003). Also, according to Deci, Vallerand, Pelletier, & Ryan (1991) SDT's overlook the influence of extrinsic factors like social recognition or rewards which are influential in certain educational contexts because of its focus on the intrinsic motivations.

Second, SDT's emphasis on intrinsic motivation overlooks the influence of extrinsic causes, i.e., rewards or social reward, which can be extremely influential in certain classrooms (Deci, Vallerand, Pelletier, & Ryan, 1991). Hence, this study will explore how the interaction between intrinsic and extrinsic motivators lead to the formation of student mathematics engagement. The application of SDT in the current study occurred within the cultural backdrop of Filipino culture, where belonging, social harmony, and interdependence are valued. These values could potentially affect how students respond to gamification pedagogies, which are achievement- and competition-based through the individual. While autonomy may be motivating for students from individualist cultures, for example, Filipino students might be more inspired by group work that elicits relatedness and collective triumph.

Therefore, the present study would examine how focus on bayanihan (solidarity) as a cultural strength can supplement SDT's theory, particularly through teamwork and peer support exercises (Chua, 2001).

In this regard, SDT is a conceptual scheme to explain how gamified learning is likely to influence students' motivation and learning achievement. Through the integration of game-like features in math teaching, the research seeks to satisfy the intrinsic needs of students. For instance, gamified pedagogies can grant autonomy in the form of providing choices in the learning process, i.e., the selection of problem type to solve or selection of their own lines of progression. This ownership enhances students' motivation and empowerment. In math education, Problem-Based Learning (PBL) and Inquiry-Based Learning (IBL) provide valuable comments on the application of game-like aspects towards facilitating deep learning. PBL involves solving real-life problems that demand critical thinking and collaboration, which aligns well with gamified activities where students encounter increasingly complex tasks (Hmelo-Silver, 2004). Parallel to this, IBL is also meant to lead students to develop questions, form hypotheses, and test solutions through inquiry, precisely in tune with the autonomy aspect of gamification (Barrows, 2000). Such learning theories will be considered to develop further gamified learning activities that enhance higher-order mathematical thinking. In addition, gamified pedagogy involves increasingly difficult tasks that augment students' proficiency, as they gain mastery of increasingly sophisticated concepts. Finally, aspects such as group problem-solving and peer competition can possibly establish relatedness by providing avenues for collaboration and peer assistance, inducing a sense of belongingness and exchanging learning experiences.

In this experiment research, SDT guided the development of two learning methods to the instruction of permutations and combinations. Gamified instruction with features like rewards, challenge, and leaderboard will be used for one group, while traditional instruction without gamification will be used for the control group. The gamified learning method will be guided in a way addressing the psychological needs as outlined in SDT. For instance, autonomy was supported by student choice in activity selection and collaborative learning participation. The classes included a series of tasks aimed at increasing the proficiency of the students as they reach milestones and get instant feedback on their performance. Peer interaction time and collaboration established relatedness through collaborative interaction time, which provided a secure arena where students are motivated to interact and collaborate.

These are supplementary to other supplementary theories required to critically analyze the motivation and engagement of learners in mathematics education.The theory of Constructivist Learning (Piaget, 1973; Vygotsky, 1978), on the other hand, is interested in the conviction that learning is active, experiential, and socially interactive to construct knowledge. The constructivist principles are utilized through gamification by creating assignments with students adding on from what they have already learned and conducting group projects, thereby increasing the cognitive as well as social development (Brusilovsky & Millán, 2007). Additionally, Cognitive Load Theory (Sweller, 2011) can be applied to make the gamified process challenging but not too demanding in order not to overwhelm learners, thereby providing the optimal learning.

To assess the effect of gamified learning, quantitative and qualitative data were gathered for students' mathematics skills and confidence in dealing with mathematical tasks. Pre- and post-tests were used to assess knowledge in permutations and combinations, and questionnaires to assess motivation and attitude towards mathematics. The hypothesis is that students who are taught using gamified instruction have higher improvement in their math skills and self-confidence to be accounted for by satisfying their psychological needs as proposed by SDT.

Conceptual Framework

Independent variables in this research include major components of gamification that enhance student engagement and learning performance, particularly through Reward Dynamics in Educational Gamification. Gamification in the education system involves applying game design features, such as leaderboards, achievements, points, badges, and levels, to encourage learners to participate in their learning (Meccaway et al., 2023). The points system is an incentive device that awards students points as they complete an assignment, answer a question, or perform an activity, thereby motivating frequent effort and attendance. Badges and achievements, in contrast, are awards for surpassing certain benchmarks, such as understanding difficult mathematical concepts or performing well in problem-solving exercises, providing a sense of accomplishment. Leaderboards bring competition to the exhibition of students' rankings based on total points, motivating students to perform better while instilling healthy competition. Challenges and quests introduce a structured, game-like activity with different difficulty levels and intensities, where students can try lessons that enhance learning and math concept application through fun and entertainment. Both leaderboards and challenges and quests were intentionally excluded from the study due to practical reasons, including preparation and timeframe, to focus on intrinsic motivation that promotes a growth mindset.

The dependent variable in this study focuses on the mathematical skills and the confidence levels of the students. From a mathematically empowered perspective, the study will first consider how students' comprehension of mathematical ideas and formulas relates to their ability to manage elementary topics, such as permutations and combinations (Sung & Hwang, 2013). Mastery of such topics forms the foundation for advanced mathematical learning, as students need to identify patterns and connections to link topics (Kilpatrick et al., 2014). Almond (2022) also suggests that the acquisition of mathematical competence has a close relationship with learning and teaching mathematical concepts. In contrast, the acquisition of these concepts is crucial for enhancing students' achievement and performance.

Mathematical skills encompass the ability to generate, apply, and comprehend mathematical concepts in order to solve problems in various real-world situations (Sabasaje & Oco, 2023). Mathematical skills encompass reasoning, communication, and the application of problem-solving strategies to solve mathematical problems. While investigating Grade 7 students, Sabasaje and Oco (2023) noted that reasoning abilities were largely high, while problem-solving abilities and mathematical abilities were moderate. Their research highlights a significant correlation between students' mathematical ability and theirtheir overall performance in the subject, emphasizing the need for targeted strategies towardto enhance reasoning and problem-solving skills.

Problem-solving is a vital measure of mathematical competence, where the principles learned are applied to solve real-world issues effectively. It is reasoning-oriented rather than memorization-based, where students can justify their knowledge and construct balanced solutions (Almond, 2022; Sabasaje & Oco, 2023). Logical reasoning complements the process of enabling pupils to reason logically and systematically, as evident in the work of Heuvel-Panhuizen and Drijvers (2014). These examples illustrate the need to develop problem-solving skills alongside rational skills to enhance overall mathematical performance.

These aspects—understanding of mathematical concepts, ability to solve problems, and logical reasoning—included completing the picture in the mathematical skills assessment, offering a sound and extensive approach to students' evaluation and teaching.

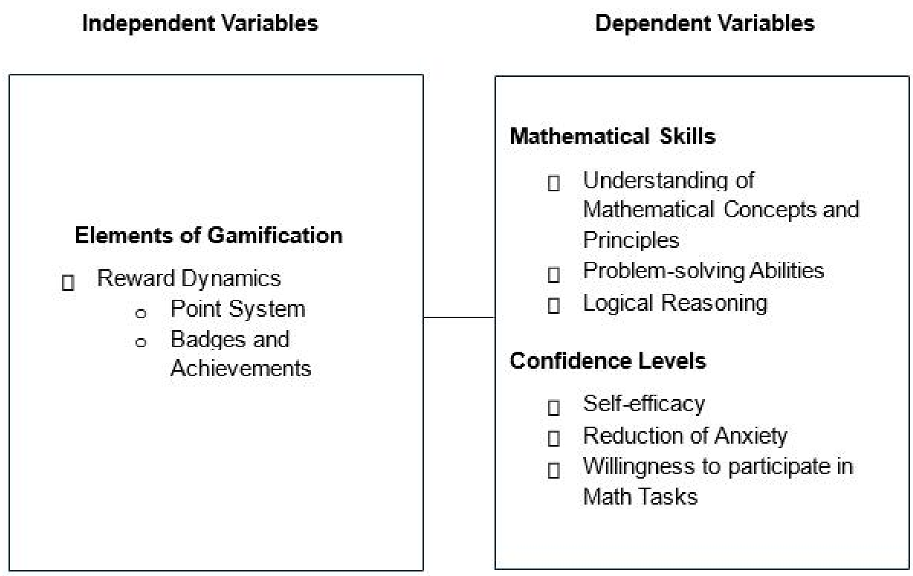
Concerning confidence, the research examined the self-efficacy of the students, specifically their belief in their ability to accomplish mathematics-related tasks (Meccaway et al., 2023). Anxiety reduction was investigated with a special emphasis on the degree to which gamification decreases stress associated with math, a common performance hindrance (Vasalou et al., 2014). Lastly, students' willingness to participate in math tasks was measured, observing the increases in motivation and engagement provided through gamified learning contexts. These dependent measures are essential in examining how gamification influences not only academic performance but also psychological well-being.

Confidence levels are crucial to the success of students, particularly in mathematics, where self-efficacy and the willingness to apply it play a significant role in establishing a high level of confidence. Self-efficacy determines the way students learn, establish goals, and persist through challenges. According to Meccaway et al. (2023), game-based learning has also been shown to positively impact the self-efficacy of learners, thereby increasing their confidence and enhancing their learning. This confidence not only improves learning but also fosters a high sense of competence, which is essential for developing math confidence. When students believe that they can do it, they will be able to tackle difficult problems in advance, thereby building their confidence with every success.

Moreover, students' leaning towards mathematics activities plays a significant role in confidence building. Constructive participation in learning fosters the ability to learn and excel in mathematical topics. Research indicates that self-assured learners are better equipped to experiment and participate in classroom discussions, group discussions, and problem-solving exercises, which provide them with multiple successful experiences and increase their confidence (Meyer & Turner, 2019). This interaction forms a virtuous cycle, as growing confidence feeds higher participation and ensuing success at school. Less confident students, however, tend to avoid participation, thereby missing out on rich learning opportunities. Hence, developing self-efficacy and promoting active participation are complementary approaches that can make an enormous difference in students' confidence and performance in mathematics.

Figure 1

1 *Research Paradigm*



Statement of the Problem

The research investigated the effect of gamification on Grade 10 students' mathematics skills and levels of confidence. It tried to assess whether the inclusion of game-like components in math learning influences the learning achievements of mathematics among students as well as their confidence in responding to mathematics problems.

Below are the specific questions that the study sought to answer:

1. What is the level of math skills of Grade 10 students before and after the implementation of gamification in math instruction in terms of:

1.1 understanding of mathematical concepts and principles;

1.2 problem-solving abilities and application; and

1.3 logical reasoning?

2. How do students' confidence levels in solving math problems change before and after the use of gamification in terms of:

2.1 self-efficacy;

2.2 reduction of anxiety; and

2.3 willingness to participate in math tasks?

3. Is there a significant difference in the mathematical skills and confidence levels of Grade 10 students before and after the implementation of gamification in mathematics instruction, specifically in solving problems involving permutations and combinations?

Hypothesis

There is no significant difference in the mathematical skills and confidence levels of Grade 10 students before and after the implementation of gamification in mathematics instruction, specifically in solving problems involving permutations and combinations.

Significance of Study

The result of the study could be significant to the following groups or individuals:

Division. The study could be significant to the Division as it provides valuable insights into innovative teaching methods, such as gamification, which could improve student outcomes in mathematics. By exploring how gamification influences both mathematical skills and confidence levels, the division could identify the best practices that can be implemented across schools to enhance overall student performance. The findings could help in making informed decisions when designing teaching methods, professional development programs, and policies that support effective teaching strategies in mathematics and other subjects.

District. For the District, the study could provide a benchmark for the degree to which game-style learning approaches can address traditional math learning issues. District-wide plans envisioned through the findings could yield greater student engagement and comprehension of advanced mathematical functions like permutations and combinations. The research also assessed student-led, innovation-centered strategies, which could give policymakers in districts evidence-based avenues through which they can channel support to curriculum development and school initiative.

Learning Area Supervisor. The study is significant to Learning Area Supervisors because it empirically justifies gamification to enhance children's mathematics achievement and confidence. With this evidence, supervisors could effectively counsel teachers on how to apply innovative teaching strategies aligned with curriculum standards. The results of the study could also assist the supervisors in assessing the teaching practices and providing customized guidance and training to instructors so that mathematical education in their area of management continues to improve.

School Head. The research is highly relevant to the School Head as it provides real-life evidence of how different pedagogies such as gamification could enhance students' math competence and confidence. Based on statistics from the research, the school head could advocate programs that integrate game-based learning as well as encourage educators to do the same. It could also serve as a foundation for requesting further resources or training to expand instruction methods and student performance, thus raising the level of overall academic performance within the school.

School. This study is crucial to school because it promotes a culture of innovation in education and teaching. By using gamification methods, the school could enhance student performance and participation in mathematics, a subject that is difficult to master. The outcomes of the study could help enhance the academic performance of the school and also promote the overall development of students, rendering the school a better and livelier learning environment. It could also render the school a leader in using modern pedagogical techniques in learning.

Teachers. To the educators, this research could provide new insights into the way complex mathematics can be displayed in an interesting and understandable fashion for students. In illustrating the effect of gamification, it could provide educators with tangible ways in which learner knowledge and interest may be improved. The research could also make teachers capable of trying new things in teaching and modifying their teaching practice to cope with the changing needs of the students in the 21st century, making them efficient professionals and productive instructors in the classroom.

Learners. This research is relevant to students in real-time since it aims to provide a more interactive and immersive method of learning mathematics, a field that intimidates most students. Gamification could enable students to grasp mathematical concepts better, improve problem-solving skills, and gain confidence in solving math problems. By making class interesting, this research could reduce anxiety toward math and engage the students to work actively during lessons, leading to better class performance and disposition toward the topic.

Future Researchers. Future scholars could be interested in this study as it makes contribution to expanding studies on gamification and its education impacts specifically in math subject. It could provide scope for future research in the application of game-based learning to other subjects or levels of study. The study also has a measurement model of gamification effect, which could be utilized by future researchers as a point of reference in exploring new and other aspects of gamified learning and its impact on students.

Scope and Limitations of the Study

The study measured the influence of gamification on the math skills and self-confidence levels of Grade 10 students at Lumbang Integrated National High School. The school had a diverse population of Grade 10 students with varying levels of mathematical skills and confidence in handling mathematics, making it an ideal setting for exploring the impact of gamification. The choice of Lumbang Integrated National High School is also situated within a region with specific educational challenges and opportunities; hence, the study adds value to its context. The school's readiness to participate and cooperate with the researchers ensured the successful conduct of the study. Its focus is to explore more deeply how gamification strategies can be applied in ways to suit the needs of students in such school settings and add to the literature that reports the use of innovative teaching methodologies in mathematics education.

Grade 10 students were chosen as respondents because they are at a critical developmental stage, transitioning from foundational learning to more advanced academic challenges. Taking this into consideration, this research highlighted that this period is crucial for enhancing students' self-confidence and academic skills, particularly in subjects like mathematics, which are fundamental for future academic success (Martin et al., 2020). By using Grade 10 students as respondents, the researcher aimed to address their needs to prepare them for future academic demands and to help them build the necessary skills and confidence for success in higher education.

The study specifically investigated how the integration of game-like elements, such as points and badges, influences students' understanding of mathematical concepts, problem-solving abilities, and logical reasoning. The study also examined changes in students' self-efficacy, anxiety levels, and willingness to engage in math tasks. Additionally, it sought to identify whether gamification leads to significant improvements in solving complex problems, particularly those involving permutations and combinations.

The study's limitations included its focus on a specific group of Grade 10 students within a single school or district, which may affect the generalizability of the results to other populations or grade levels. A notable limitation was the decision to utilize only two elements of gamification—Points System and Badges and Achievements—combined into a single category termed Reward Dynamics due to the study's limited six-week timeframe and the need to manage classroom dynamics as well as the promotion of intrinsic motivation, focusing on self-improvement, progress tracking, and a growth mindset. Such selectivity could limit the study's ability to fully evaluate the overall effect of gamification on learning outcomes, as the exclusion of other components, such as leaderboards and Challenges, could eliminate their possible role in improving student motivation and engagement. Therefore, the results would not accurately report the extent of gamified education that utilizes more game mechanisms, thereby limiting the extent of recommendations that can be provided for teachers who want to introduce more diversified gamification regimes in instruction. Lastly, the research was based on quantitative scales and self-reports by the students, which could be confounded by external factors like student motivation and honesty in reporting confidence levels.

Definition of Terms

Operational and conceptual definitions of the following terms were employed for the understanding of the study as follows:

Badges and Achievements. It refers to physical badges with symbols and text detailing the criteria met and awarded to learners to represent their accomplishment when they achieve specific milestones, demonstrated or gained a skill, or successfully completed a task during the gamified math instruction (Gibson et al., 2016). As the research established, the badges serve as signals of accomplishment causing their achievement to become perceptible and necessitating them to seek further achievements, thereby strengthening intrinsic motivation. Operationally, the number of badges participants earned are the quantitative measure for students' activity engagement and achievement in the gamified math instruction (Deterding et al., 2011).

Combinations. In this study, it refers to the selection of items where the order does not matter, a mathematical concept taught to the students in a gamified manner, with mathematical tasks that require students to determine the number of ways to select items from a group using the combination formula. Gamified activities involving combination problems are used to assess students' understanding of the concept and ability to apply the formula to solve real-life problems. Learning combinations is essential for students as it lays the groundwork for more complex mathematical concepts, including probability and statistical analysis, thereby enhancing their overall mathematical literacy (Blitzer, 2017).

Confidence Levels. It refers to a student's belief in their ability to succeed in various mathematical tasks. This concept indicates the degree of certainty students feel when solving math problems and is influenced by multiple factors such as self-efficacy, anxiety reduction, and their willingness to engage in math activities. A high level of confidence often correlates with better performance, as students who believe in their abilities are more likely to tackle challenging problems and persist through difficulties. Confidence will be measured using a validated questionnaire that evaluates students' self-perception of their abilities, readiness to attempt challenging problems, and their comfort level in math tasks before and after the intervention (Bandura, 1997).

Gamification. It is the process of applying the principles of game design in the non-game environment with the hope of engaging and encouraging learners. Gamification practice entails applying features such as points, badges and achievements, leaderboards, and challenges to the teaching of mathematics, which has proved to boost the level of participation and performance of learners to a great extent. In this study, gamification is integrated to mathematical instruction using elements such as point system and badges and achievements to convert passive learning environments into active ones that are supportive of exploration and discovery (Kapp, 2012).

Influence. It is defined as the ability to shape behaviors, results, or attitudes. In mathematics education, it pertains to how determinants like gamification instruction impact students' confidence, performance, and motivation in math learning. An understanding of such influences is worthwhile in designing effective instructional practices with diverse learners and accomplishing learning gains (Vygotsky, 1978).

Logical Reasoning. It refers to the ability to think systematically, step-by-step, and infer from information provided. In this study, students apply logical patterns of thinking and systematic thinking in solving mathematical problems involving topics such as permutation and combination. Logical reasoning is a skill that involves being able to provide complete, concise, and detailed logical explanation or answer in a certain problem, an essential skill that the students are expected to enhance with the application of gamification. Logical reasoning will be enhanced though gamified tasks and evaluated by pre-test and post-test to quantify improvement in solving various mathematical problems (Mason et al., 1982).

Mathematical Skills. It refers to the knowledge and abilities that enable students to comprehend, apply math concepts, and reason out. These are the skills of doing calculations, comprehending mathematical information, and solving different problems logically. This research assesses these skills through curriculum-based and validated teacher-made tests. Competence in mathematical skills is not only required for academic achievement but also in practice. (NCTM, 2000).

Permutation. It refers to the arrangements of objects in a specific order. In this concept, the order matters. Gamified activities about permutation involve mathematical problems that prompt students to find the number of ways to arrange a set of items, emphasizing the importance of order in outcomes. Student learning of permutations is assessed and measured through the gamified task problems and quantified by giving points or badges in successfully doing the task. Comprehension of permutations enables students to understand the basic principles of combinations, a skill required in advance mathematical thinking (Harris, 2008).

Point System. It is a gamification element that quantifies the students' actions and accomplishments in a gamified learning environment. Points are concurrently awarded for the successful completion of tasks class participation, and skill demonstration in the math sessions. The total of points achieved by the student achieved quantifies the level of a student's engagement and performance in class, offering instant reinforcement while acting as feedback enabling students to persevere in real time. In this study, students are encouraged to shift toward more optimal performance. In this study, this element enhances intrinsic motivation by making students' progress visible to them and rewarding their consistent effort to foster a sense of accomplishment and encourage continued and increased participation in the learning process. (Deterding et al., 2011).

Problem-Solving Abilities and Application. It is a mathematical skill that this study aims to enhance among the students. It involves the student's ability to successfully identify, analyze, and solve math problems involving combination and permutation. It entails the skill to apply methods, use appropriate formulas, and apply mathematical principles in solving word problems. Problem-solving is very applicable in broadening good performance by students in mathematics and other disciplines because it enhances critical thinking as well as analytical abilities. These skills will be assessed by doing gamified exercises that necessitate strategic reasoning and the application of mathematical principles (Polya, 1973).

Reduction of Anxiety. It refers to the elimination of nervousness or fear of doing mathematical work. In this study, it is one of the aspects that determines one's confidence. In the math sessions, gamified instruction is employed to provide a supportive learning environment enabling students to become more confident and at ease in their mathematical skills. An encouraging learning environment can greatly enhance students' disposition toward an intimidating subject like mathematics. This will be measured quantitatively through a Likert scale questionnaire that identifies students' comfort and anxiety level while solving mathematics problems after gamified interventions (Pajares, 1996).

Rewards Dynamics. It is a term used to refer to both game elements such as point system and badges and achievements that are used to recognize accomplishments and encourage students' performance and achievements in a gamified learning framework. These are awarded concurrently in all gamified sessions. Rewards dynamics play a crucial role in enhancing student engagement and motivation by providing measurable, tangible, and instant acknowledgments of their accomplishments. By integrating rewards dynamics into the learning process, educators can create a positive feedback loop that encourages students to set and pursue personal goals, ultimately leading to improved performance and a greater sense of ownership over their learning experience (Deci & Ryan, 2000).

Self-efficacy. It refers to the belief in one's ability to accomplish tasks and achieve goals with practice. Within the gamified math instruction, it pertains to students' confidence in their capacity to engage successfully with mathematical tasks, participate in class discussions, and complete assignments. High self-efficacy is associated with improved academic performance, as students who believe in their abilities are more likely to tackle difficult tasks and persist in the face of challenges. It is measured using self-report surveys that assess students' confidence in completing and tackling challenging math tasks. (Bandura, 1997).

Understanding Mathematical Concepts and Principles. It is one of the mathematical skills that refers to the students' ability to identify, classify, comprehend fundamental ideas, theories, and methods in mathematics, even in real-life situations, specifically, in this study, topics like combination and permutation. This encompasses an appreciation of numbers, operations, relationships, and structures upon which mathematics is founded. Students' realization of these is essential since they can use mathematical thinking effectively in a variety of contexts. Pre- and post-tests will be used to measure improvements in this skill. (NCTM, 2000).

Willingness to Participate in Math Tasks. It is one of the indicators of confidence of the students that refers to the willingness of students to solve mathematical problems and engage with different math activities during the implementation of gamification. Participating in doing math tasks and active involvement indicates their motivation and desire towards mathematics studies, which may be phenomenally influenced by their confidence levels and the overall learning environment. In this study, this is measured using self-report confidence survey about completing and tackling challenging math tasks or problems which is given before and after the experimentation (Ryan and Deci, 2000).

2. LITERATURE REVIEW

This chapter should offer a general overview of academic literature and available research related to the current study. This section critically evaluates the most influential theories, models, and empirical research underpinning the study and provides background and academic context. The review not only indicates useful contributions of literature but also pinpoints gaps, inconsistencies, or areas requiring more research, and this study has attempted to fill the gaps. Placing the research in the broader scholarship discourse, the chapter positions the worth and contribution of the research in the field via relevance.

Rewards Dynamics (Points System and Badges and Achievements)

Gamification, or the application of game design into a non-game scenario, has gained much popularity over recent years, particularly in the educational sector. One of the most important gamification attributes is the points system, which offers instant feedback and a reward for performing tasks, thus making the students become more actively involved in learning activities. In learning mathematics, particularly in learning complicated subjects like permutations and combinations, the points system has been a crucial component in encouraging students' engagement and performance. Local research shows growing interest in gamification's use in Filipino classrooms. Baysa (2018) used gamified technology adopting point systems in Philippine classrooms and brought increased levels of participation from students, especially in mathematics subjects where participation is normally low. The study was based on the fact that gamification, if well designed, can change math from the traditionally dreaded subject into one that gives rise to a sense achievement and progress. Students could be more inclined towards following difficult topics like permutations and combinations if they are rewarded for the right response or work performed, hence encouraging positive learning and behavior.

The Department of Education (DepEd) in the Philippines also saw the potential of using gamification in teaching. According to an article by The Philippine Star (2019), various local schools have started to adopt the gamified teaching strategies, such as a points system, to make mathematics subjects more approachable. Educators indicate that students are well-received to such strategies, especially when tied to concrete rewards, such as additional credit or badges. For permutations and combinations, which are complicated logical operations, this points system allows students to learn each step by step and build confidence as they solve more complicated exercises.

Foreign literature provides elaborate discussions on the success of the points system as a learning gamification tool. Deterding (2015) is observed to comment that the points system is an essential tool for instant feedback to students, an important element in reinforcing learning behaviors. His gamification study on virtual learning environments contends that points foster feelings of achievement and encourage further learning. Deterding's study concurs with the constructivist principles of learning where students construct knowledge through interactive action, especially for courses involving problem-solving skills like permutations and combinations.

Additionally, Werbach and Hunter (2016) detail how gamification, and more particularly points system, creates extrinsic and intrinsic motivation among students. For the authors, while extrinsic reward in the form of points draws students initially, gamification eventually fosters intrinsic motivation. This is more particularly applicable in areas such as mathematics, where students will tend to do poorly with abstract concepts such as permutations and combinations. By regularly accumulating points, students receive not only external, extrinsic motivation but also internal, intrinsic motivation to learn the subject matter. This intrinsic motivation is required in learning complicated math procedures with logical progression and analytical thinking.

Gamification has recently been incorporated into online learning portals to make learning more effective among students, particularly mathematics. An EdTech Magazine (2021) article reports how Prodigy and Khan Academy implement point systems to monitor progress and have students react to mathematics problems. Both websites, which are used by the world's top schools, employed gamification in educating hard concepts like permutations and combinations. The possibility of getting points, badges, and getting to a more advanced level motivates students to eagerly work on math activities that they find intimidating. It is also reported that gamification can bridge the theory and practice gap by reducing the abstraction of the concepts in mathematics, also making it learnable through repeated practice while validated by awarding points.

As noted by Hamari et al. (2020), the points system in gamified learning serves to enhance motivation, while at the same time, establishing a competitive environment that can surpass the targets of learning. The authors understood that in some gamified learning environments, users' ability to see their points and achievements in comparison to others fueled competition to its peak. Many students were willing to invest extra time and energy into learning difficult mathematical problems, particularly those concerning combinations and permutations. In this case, points also act as social capital, in so doing, actively encouraging and even deeper engagement and commitment to learning of complex problems.

In spite of the benefits associated with points systems gamification, concerns are also starting to emerge regarding concerns the use of points systems gamification is excessive in education. According to Gee (2017), one drawback is that students may become more interested in accumulating points than engaging and understanding the material. It is true that the "points chase" could be used as an initial incentive for students; however, they have become too engaged in immediate rewards instead of their lengthy learning. When it comes to the application of permutations and combinations in teaching, this implies that students will be able to perform activities to achieve points but cannot apply the theories in real circumstances. According to Gee (2017), for the points system to be used effectively, it should be supported by some activities that allow students to reflect and apply the mathematics concepts they learn in rea life.

Gamification of learning using the points system has gained popularity in recent years as a way to stimulate the interests of the learners, their motivation, as well as their performance. Its efficacy has been evaluated in different subjects, including the subject, mathematics, where topics such as permutations and combinations are known to be challenging to learn. This research has attempted to determine how gamification, particularly the implementation of a point system, can affect students' math competence, skills, and confidence.

The research conducted by Landicho (2019) in the Philippines investigated the use of gamification in learning mathematics for Grade 10 students by employing gamified learning. The influence of points on students' motivation and their persistence in learning secondary school mathematics concepts such as permutations and combinations was assessed. Based on the results of the research, students who had undergone a point system incentive were more motivated and willing to deal with mathematical tasks even if it is challenging for them. This points system proved to raise self-worth and create a positive attitude of students towards challenging tasks. Additionally, it gave way for the students to become more confident about themselves with each point they get, hence resulting in a performance improvement on the evaluation of mathematical abilities.

In a different study, Cuaresma (2020) investigated whether using gamification was effective in enhancing capabilities of high school students in mathematics and reducing their mathematics anxiety. Gamification using the points system methodology was used and targeted the students' proficiency in working with topics like permutations and combinations. The findings showed that the use of points was deemed to have the most importance as a factor to induce high school students to contribute and participate more to the lesson. Most importantly, the students exhibited great improvement in solving challenging word problems once gamification was used. Additionally, a decrease in math anxiety in students was identified in the study as shown by the confidence they portrayed, sustained by practice and points earning, fostering positive learning patterns.

Internationally, the effect of using points systems in gamified learning was also explored. For example, Attali and Arieli-Attali (2015) studied the application of gamification to improve mathematics skills among the high school students. Their study also utilized a points system, reward dynamics scheme for solving mathematical problems and activities. The findings showed that the students who were involved in these gamified math activities displayed higher levels of engagement and participation and demonstrated a significant positive change in their ability to solve problems. The authors explained that this is due to the points system's capability to offer immediate feedback and provide cumulative rewards, which maintained the student's engagement in continuing to solve more complex problems. Interestingly, the research discovered that the points system assisted in closing the gap between the students of different levels of proficiency since the lower-performing students were encouraged to catch up with other students or their counterparts.

Likewise, the dissertation study conducted by Li (2017) also investigated the effect of game-based learning that utilizes the application of a points system in the instruction among high school students. The study was based on self-determination theory, whose premise is that students will be motivated when they feel competent and autonomous. The dissertation was able to prove that the points system created a feeling of achievement among students, something which enabled them to develop confidence in their math abilities. The students who had received points for solving math problems were going to embrace greater levels of difficulty and endure more challenging content. The dissertation also urged the balancing act between extrinsic reward, through points, and intrinsic motivation so students won't be derailed by mastering math concepts but maintain a win-win attitude instead.

Another recent study by Chen et al. (2021) examined gamification, e.g., the long-term effect of points systems on mathematics ability and self-efficacy. The intervention was an experiment for a year with high school students being part of a math program with gamification emphasizing permutations, combinations, and higher mathematics. Chen and co-authors established that using a points system exponentially improved students' mathematics ability and overall confidence in what they can accomplish. It was observed that the students who were consistently earning more points for their efforts displayed greater perseverance and resilience when they are faced with difficult math problems. The points system also created a competitive but co-operative learning environment, in which the students were encouraged by both their own performance and that of others.

In the Philippines, Yuson (2022) conducted a gamification using point systems in senior high school mathematics. The research emphasized how the use of gamified approaches can help the students enhance higher-order thinking skills, particularly in topics involving word problems. It was identified that the points system played a significant role in the student's motivation and willingness to work through different challenging problem-solving activities which considerably enhanced their mathematical thinking in the end. The study also indicated that the points system gave a definite model of development, where the students were able to easily picture their learning path and monitor their progress in mathematics. This visual feedback was highly effective in promoting the self-confidence of the senior high school students and it consequently affected their performance positively as shown in their formative as well as summative tests.

Research findings collectively show that point systems represent effective main gamification instruments for teaching mathematics. Research confirms that points deployed within the local or global settings produce enhanced confidence levels and mathematical abilities of learners who seek to learn mathematics. For immediate reward and feeling of achievement, the points system addresses common challenges towards learning mathematics, such as de-motivation and fearfulness, and promotes persistence and resilience. But such studies also bring to the forefront the need for making sure gamification is used with restraint, weighing extrinsic rewards of points against more profound, intrinsic motivation to learn mathematics. If used correctly the points system creates total mathematical potential in the students and makes subjects that were harrowing like permutations and combinations simple and interesting.

Gamification has been more and more of a vital component in learning settings, with elements such as badges and achievements at the forefront in motivating motivation, participation, and learning outcomes. Such gamified features have found applications in mathematics learning, where abstract and complex subjects such as permutations and combinations are likely to present significant challenges to learners. Through the awarding of the student's achievement and badges, they are encouraged to conquer challenges, develop confidence, and master difficult mathematics concepts.

Applications of badges in school are based on nonformal learning settings, i.e., computer games and scouting, in which badges are markers of accomplishment and progress. They have settled firmly, nonetheless, in formal school settings of late. Anderson speculates on the role of badges as public markers of accomplishment and progress offering students instant feedback about their success in Motivating Students with Gamification (2020). She explains that badges create a sense of achievement that creates intrinsic motivation that is well worth leveraging in maintaining students' interest in topics that they are having difficulties with, such as math. Anderson also argues that badges, when combined with sound instructional design, offer students short- and long-term advantages, encouraging them to construct small wins to ultimate success. Small increment learning is critical to understand in lessons like permutations and combinations and that's particularly important.

In recent years across the globe, gamification for education has been proven to be a one solution to ignite students' passion, in particular in the cultivation of such subjects as mathematics, with more than half of the students being unable to comprehend. All of the cases observed that explore gamification has been successful in improving motivation and academic achievement in math for USA, Finland and South Korea based on Deterding et al. (2011), Hamari et al. (2016). Evidence suggests that gamified learning spaces can encourage students to become more willing to tackle challenging assignments and form a stronger sense of abstractions like permutations and combinations (Moreno & Mayer, 2021; Yang, 2019). Gamification is an enhancement into experiential and interactive math problems, which challenges the idea of merely receiving the answers, and prompts the students to be part of the learning process in a much more enjoyable way (O'Reilly, 2020). For instance, virtual worlds let students observe mathematical steps and use problem solving in the simulation of the real world (Nguyen, 2020). Students who receive gamification instruction not only increase their problem-solving skill, but also increase their confidence level in math skill (Sung et al., 2016; Zhao & Li, 2019). Additionally, this is one to which this research study's objective of studying whether gamification could potentially promote the Grade 10 students' skills and confidence in the context of math lessons, with a special focus on mastering challenging concepts such as permutations and combinations, fits.

These findings are also praised by local studies. As part of encouraging students especially in the STEM courses, this write up by Philippine Daily Inquirer (2019) stated that Philippine schools are already including badges and accomplishments into their Educational platforms online. The write up had said that besides being useful in terms of monitoring advancement, badges are important in fostering a feeling of ownness among the students. The solution of mathematical problems or obtaining of specific skills, of course, makes the students part of an achievement community because they are receiving badges upon completion of tasks. Advancement such as this can inspire as it is a common feeling, and especially for learning systems similar to permutations and combinations that often trip students up. The article also highlighted the use of culturally relevant badges, with local icons and themes, that have effectively connected well with Filipino students, which aid in increasing engagement and relevance in their learning.

Badges and achievements have been of great potential in helping build confidence in the domain of mathematics education. In her Mathematics Teaching Today (2018) journal article, Lewis examined the impact of digital badges implementation in high school math classes on students' attitudes towards math. It is found that the students' self-efficacy had skyrocketed when the math problems that they solve to earn badges are complicated ones. As students obtained badges that not only applauded their accomplishments but also reflected their mastery and incremental progress students felt more confident in their abilities. Also, students may have been aware that a badge signified external validation of their competence, the usage of badges also acted as external reinforcement of a growth mindset that students could improve their skills through sustained effort. Additionally, the article touched on how badges played a part in decreasing math anxiety as students felt in control of their learning and there was proof that their abilities.

That same benefit is proved by global gamification research. In the study, The Gamification of Learning and Instruction (2015), Kapp explains the psychological basis on which the use of achievements and badges in learning environments is on the right track. According to Kapp (2015), badges are both intrinsic and extrinsic motivators that also relate proximal and distant goals. Badges are great for something like math education where we are trying to eliminate the barriers, and something like permutations and combinations is very difficult and tedious, and badges give instant reward for effort, which is very helpful long term. Kapp reiterates that not only do badges encourage learners towards short-term success but also instill a feeling of accomplishment that will create further interest in the topic. Kapp says that badges make intangible concepts more concrete by making them instantly, visual representation of progress, which can be especially beneficial for subjects that require sequential understanding, such as mathematics.

Online teaching journals also contain articles that explain the work of achievements in shaping a mastery-learning culture. In an Edutopia article (2021), Johnson explains how online achievements, including badges, generate a culture where learners are mastery-oriented, not performance-oriented. Johnson says that for normal classroom learning, students are coerced into acquiring high grades as opposed to comprehending the content. But in a gamified setting where badges and achievements are used, students are motivated to learn content at their own pace. In subjects such as permutations and combinations, where students become stuck on early concepts, badges can be used as a reward mechanism that motivates students even when the content becomes challenging. The article also adds that badges have been most effective with students who are not necessarily star performers in a traditional school environment and offer them more mechanisms to show accomplishment and gain confidence.

Also, education books and publications have promoted the use of badges as an incentive mechanism for students. Hernandez's Learning by Playing (2022) explains how badges introduce a sense of competition and reward that not all formal learning experiences possess. According to Hernandez, badges have a social validation component in which the effort is apparent and has admiration from peers of the students. While learning mathematics, this can be beneficial as it transforms the learning process into a social process instead of individual learning in which students motivate one another in the process through earning badges. Socialness in badges makes the learning process a fun learning environment where students belong and there is collective achievement, which can be particularly helpful in dealing with complex mathematical problems like permutations and combinations.

In Philippine online literature, an article by Rappler (2023) described how Philippine schools used badges and achievements in mathematics curriculums to reverse the trend of decreasing math scores. The article gave the example of using the internet site where students earned badges as incentives for finishing mathematics modules on permutations and combinations. Teachers in the article confirmed that math was made more engaging and interactive for students because of badges. The instant and visual feedback offered by badges was thought to be at the center of keeping students engaged in what would otherwise prove to be a dull topic. Moreover, the article stated that students would be more willing to seek assistance and work together to earn badges, thereby creating a more cooperative learning environment that would suit students of varying skill levels.

In conclusion, it can be said that the application of badges and achievements in gamified learning instructions or contexts is an effective way of improving student motivation, self-esteem, and competence in mathematics education.

Local and foreign literature both proved that the use of badges are not only encouraging but also helpful in building the classroom environment where achievement and advancement are concrete, tangible, and always valued. Providing a social feedback, immediate feedback, or building the growth mindset with the use of badges are important in helping learners fill the gaps of abstract mathematics such as permutations and combinations. As gamification is adopted by different schools and teachers, a broader scope of achievements and badges can expand which will empower students with more innovative means to engage with increasingly demanding studies.

In the context of mathematics education, where students often face challenges with abstract concepts like permutations and combinations, badges and achievements offer a novel method to stimulate perseverance and build confidence.

Suh et al. (2017) examined the effect of gamified badges on students' performance in a mathematics and discovered that the students who received badges after being able to accomplish certain activities involving math problem-solving tasks has reported higher levels of engagement and intrinsic motivation among students compared to students who were not given or rewarded badges. The badges had served as extrinsic rewards and intrinsic motivators for the students, and it resulted in the students spending more time on problem-solving exercises like the permutations and combinations. The badges were used as rewards for the students as it motivated them to keep on solving more challenging problems, which in the end enhanced their general math performance.

In the Philippine context, Reyes (2019) experimented by conducting action research to test the use of badges in a high school mathematics class. The subjects were the Grade 10 students, and they were provided with digital badges when they had mastered some concepts or concepts in mathematics such as permutations and combinations. It is discovered that students accepted the badge system, and although it aided them to feel successful and confirming in the fact that they are acknowledged for what they do. Furthermore, the study indicated that there was significant progress in student confidence because the students were increasingly encouraged to take on more challenging math problems. The badges primarily helped to alleviate fear of math anxiety by breaking big tasks into very small tasks that someone could achieve without getting anxiety, allowing advancement at the student’s pace.

The success of badges in the learning environment has also been extrapolated to non-local studies. In his dissertation, Landers (2015) investigated the effect of gamification, or badges and achievements, on the outcome of learning in a mathematics undergraduate course. A control group and an experimental group were also used — the experimental group was given badges on completion of mathematical exercises, such as problems about combinations. Nevertheless, results found that the experimental group also did better on exams and approached more difficult problems more persistently. The badges served as outside endorsement of their abilities which as a result generated a growth mindset among the students.

Another recent publication by Dichev and Dicheva (2020) continued to examine the effect of badges on students' motivation and engagement. In the study, the high school students illustrated how badges assist in creating a mastery culture by being motivated to always enhance and perfect their skills. This is important in mathematics because students might need to make multiple attempts before they understand complicated lessons permutations and combinations. The research ended up establishing that the employment of badges enhanced the performance of the students and their learning attitude because instead of seeing the mathematical challenges as hindrances, the students started viewing these challenges as their opportunities to attain more achievements.

In the study conducted by Cruz (2020) badges and achievements were used on one Grade 10 math class in Metro Manila. The focus was on how these elements of gamification affected the understanding of concepts like permutations and combinations. Cruz's observations revealed that the students who were rewarded with badges for their progress displayed a greater sense of responsibility for their learning. Students became more interested in asking, seeking clarification, and collaborating with their peers and classmates to solve different challenging math problems. The badges did not only display their improvement but also serve as peer recognition, since students was able to look at each other's achievement, fostering a co-learning environment.

At a massive scale, Hamari (2017) conducted a study wherein online learning mechanisms and badges, and achievement were studied, and the effect on students' level of engagement in math class was afforded special consideration. It is reported that the greater levels of retention and engagement among students are seen in students who were offered badges for the solving of challenging mathematical problems. The study also unfolded that the utilization of interactive and visual badges was motivating to learners, particularly those who were poor learners in terms of conventional teaching. By giving instant feedback and visuality of accomplishment through badges, it eased the cognitive burden of struggling with challenging math problems, and learning became more effortless and enjoyable for students.

In a dissertation by Ramos (2021), how a gamified mathematics curriculum can be integrated within a Quezon City public secondary school was investigated. Its purpose was to determine whether badges implementation was having an effect to improve students' performance in the topics concerning permutations and combination. According to the study, the gamified group of students performed better than the peers on formative and summative assessments. Offering badges for completing increasingly challenging math questions and providing a sense of accomplishment to students helped them persevere through learning the conceptual parts of the curriculum. The dissertation also claimed that through badges students gained a greater sense of equality in the classroom, as students achieved small victories in the classroom and built up their self-confidence over time.

Another study of Lee and Hammer (2015) wondered how badges could serve as a scaffold during learning of difficult subjects such as Mathematics. Their research was with badges in a middle school setting and found badges could help students break down grand, scary tasks into relatively smaller, more manageable ones. Badges were given for completing certain problem-solving stages to keep students going despite difficulties. The study found out that badges not only help students with problem solving but it also improved the student's math related anxiety and made them feel more in control of their learning journey.

In summary, the application of badges and achievements as a gamification element has been shown to have a significant contribution towards encouraging, engaging, and influencing the performance of students in mathematics. Both domestic and international research identify the capacity of badges in boosting student confidence and perseverance, particularly in tough topics such as permutations and combinations.

Understanding Mathematical Concepts and Principles

The student should thoroughly study permutations and combinations so that he or she could specialize and proceed towards advanced topics on combinations and probability. Permutations and combinations are integral concepts of combinations as a mathematical discipline that deals with counting, arrangements, and selection of objects. Not only do these concepts become a component in solving issues regarding probability, but they become important when applied to issues in so many real-life situations, such as computer science, cryptography, and even game theory. This review refers to domestic and foreign literature that offers the perception of these mathematics principles, and here, conceptual understanding as well as understanding is highlighted towards students, but particularly towards Grade 10 learners. Reviews will cross literature offered by books, newspapers, journals, and articles offering insights into teaching and learning the principles with particular focus laid on the role of understanding towards strengthening the ability of learners and mathematics confidence.

In studying mathematics, knowing permutations and combinations concepts hinges on the grasp of the difference between the choice of objects and the structure, which is the essence of the two concepts. Permutations denote the structure of objects where the structure is essential, while combinations denote the choice of objects where structure is irrelevant. It is not unusual in Burton's (2017) opinion that students fail to distinguish between the two, hence commit usual mistakes when solving problems. Burton's contention is that teaching techniques focusing on conceptual awareness, and not just memorizing formulas, are better in enabling the learner to understand the concepts underlying. Writers such as Stewart (2019) attest to this by how much visual support and tangible examples go to serve the otherwise abstract concept to the learner.

The fact that permutations and combinations calculations are factorial based makes them intricate. The concept of factorials on which permutations and combinations are found can be hard for students to understand initially. Factorials are used in the counting of possible arrangements of a collection of objects, and the arithmetic operation of factorials plays a central role in solving permutation and combination-based problems. Math education journal articles, including those of Gillis (2018), demonstrate that students are helped by the decomposition of difficult problems into simpler, more manageable steps when learning these concepts. Gillis suggests a problem-based learning strategy, where students are invited to try out small groups of objects and learn to calculate how various arrangements and selections are calculated step by step.

Local Philippine writings also discuss the issue of instructing permutations and combinations. Reyes (2021), for example, observes that Filipino learners find it difficult to apply permutations and combinations in problems on probability, particularly when given criterion-referenced tests. Reyes observes that such problems are rooted in ancient procedural knowledge emphasis, where learners are taught formulas without fully understanding their derivation and application. Reyes responds by promoting a more inquiry-based strategy for learning, where students are led to discover various problem-solving methods, hence enhancing their understanding of mathematical principles.

There has been some research in foreign literature, especially from North America and Europe, on the application of technology and computer software in teaching permutations and combinations. Computer software through which students are able to experience learning in an interactive way, as per Johnson (2020), has performed effectively in enabling students to see permutations and combinations. Johnson talks about how computer software that imitates real-world situations, including games or making decisions, has been used in enabling students to implement combinatorial concepts. The interactive form of learning enables students to grasp how permutations and combinations are utilized in the real world, therefore becoming more fascinated and motivated in learning these concepts. In addition, Johnson offers that gamification, or applying game elements to learning, can be an effective reinforcement of mathematical knowledge, another purpose of the study, "Unlocking Math Potential."

Additionally, cognitive process of learning texts, e.g., that by Anderson (2016), state that learning permutations and combinations entails more than memorization of formulas. Anderson reminds us of how cognitive load theory is relevant in mathematics education in that students are easily swamped when attempting to use multiple formulas and rules concurrently. Anderson suggests scaffolding methods that place lower cognitive load, for example, providing worked examples and increasing the level of difficulty in problems. Such a method allows students to accumulate problem-solving capability step by step, especially for ideas with multi-stage calculation like permutations and combinations.

In practical real-life problem-solving use, news articles and stories, including one by Davis (2019), have explained how permutations and combinations are applied in data protection aspects, organizing games, and even deciding on what to wear daily. Davis discusses how consciousness of these principles has the potential to enable students to see the relevance of mathematics to their own lives. An example is calculating the number of combinations of computer passwords or deciding on a good sports team strategy for line-up as applications of combinatorial methods. Connecting what is taught in class to actual examples is what enables instructors to make the study of combinations and permutations relevant and interesting to learners.

In general, books have always quoted extensive knowledge of permutations and combinations as the key to success in math teaching. However, the vehicle may be through visual aid, interactive software, or utilization of everyday experience. The goal is to be able to guide students beyond rote recitation to increase their understanding of how the theories apply. Under a gamified learning setting, as the study "Unlocking Math Potential: Investigating the Influence of Gamification on Grade 10 Students' Math Skills and Confidence with Permutations and Combinations" suggested, students are supposed to gain from challenges and interactive tasks that promote active learning. By including some aspects of gamification, teachers can facilitate a clearer insight into mathematical concepts and at the same time instill confidence in students to solve problems.

Permutations and combinations, which are fundamental to combinations, are also central to comprehension of how diverse mathematical concepts interrelate with each other, especially in the case of problems of selection or arrangement. Research in empirical tradition has accentuated the prominence of conceptual knowing in the didactics of the two concepts. Singh and Mahajan (2018) conducted research in India on the challenge faced by secondary school students with the difference between permutations (where the order matters) and combinations (where the order does not matter). They concluded that most of the students confused these, and this resulted in systematic errors in their solutions. The researchers supported the use of visual and interactive learning materials to enable the students to differentiate more effectively between the two concepts. In the Philippines, Del Rosario (2019) conducted a study on the effectiveness of different approaches to teaching permutations and combinations in enhancing Grade 10 students' understanding.

This study targeted the fact that Filipino students are traditionally introduced to these subjects in high school, and how they are abstract and less able to be brought out to real-life scenarios. Del Rosario discovered that exposure to context-based examples, like real-life decision-making situations, improved the interest and understanding of the students immensely. The research also highlighted the role of cooperative learning exercises in making the students familiar with the distinction between permutations and combinations, easily confused as they have so much in common.

The other key aspect of learning permutations and combinations is factorials. Calculations involving factorials form the core of these topics, and students must have a firm grasp of this concept to solve problems correctly. Wang (2020) conducted a study in China on the cognitive difficulty faced by students when working with factorials of large numbers. The study found that students are unable to comprehend the exponential increase in numbers in factorials, and this puzzles them while generalizing similar knowledge to permutations and combinations. Wang believed that sequential pedagogical practices, which segment factorials into manageable small portions, would encourage students to gain confidence to work on more complex problems.

In America, Roberts (2020) conducted a dissertation examining whether online combinations software was an effective way of improving learning. The experiment included the use of experimentation with using online materials that offered opportunities for attempting various sets of tasks and observing what changes have occurred. Roberts discovered that students working on these interactive websites learned more about combinations and permutations than students who were instructed in them without using any interactive materials. The experiment indicated that the use of digital tools could be especially be useful in understanding mathematics that is abstract, enabling better understanding of what they were studying.

Other local research in the Philippines also provides an idea on what cultural and pedagogical environments that Mathematics concepts are being taught and understood in. The thesis of Santos (2021) explored how inquiry-based learning affected Filipino high school students' thinking about the meanings of permutations and combinations. One of the things that the research found was that the students were much more likely to acquire an understanding of these ideas, if they were motivated to look at how the ideas could be applied in real life, like in sporting events or gambling in lotteries. Santos also noted that students were more likely to learn when the topic related to them personally. This is in line with the international literatures, which shows that learning through application of complex mathematics makes it approachable for learners.

An important aspect that is in addition to learning mathematics that allows the understanding of permutations and combinations is previous mathematics learning. Hernández and López (2017) conducted a study, where the researchers found that students who had excellent prior knowledge in number theory and algebra understood better combinatorial concepts – permutations and combinations. The research emphasized how one needs a sound foundation in mathematics prior to learning these more advanced subjects. It also noted that struggling students of algebra would memorize the formulas mechanically without maybe fully understanding their derivation and usage, hence restricting them to never being able to correctly solve problems.

Miller (2018) had carried out a study in Australia to find out the impact of teaching style on teachers on students' understanding of permutations and combinations. The research revealed that teachers who used a step-by-step, inquiry-based approach to teaching, examining with students’ alternative ways of solving problems and encouraging them to ask and explore these approaches—performed better than teachers focused on memorizing formulas. Miller emphasized scaffolding the learning activity, particularly with material as complex as permutations and combinations, in a way that permits students to construct their learning step by step and not become overwhelmed by the subject.

Finally, it has been made evident through an extensive literature review that students' math confidence correlates with their familiarity with some of the mathematical ideas, i.e., permutations and combinations. One South Korean Ph.D. dissertation titled "The relationships between students' confidence of mathematics and performance in combinatorics" by Kim (2019) studied the relationship between students' math confidence and combinations performance. As a result, Kim was able to improve student understanding on the topic of permutations and combinations, and consequently, students' confidence in dealing with similar problems led to a positive impact on their final mathematics performance. The study demonstrated that the construction of a deep appreciation of mathematical ideas not only enhances problem-solving ability but also raises students' self-efficacy, and this is one of the main aims of the current study.

In summary, this review of relevant literature reveals that the lessons in mathematics like permutations and combinations is a rich challenge among students demanding conceptual maturity and use of a good pedagogy. Results from varied contexts underline the strength of inquiry learning, computer laboratory settings, graphic media, and use-based deployment to render such intangible concepts engaging to students. Foreign as well as domestic studies provide findings that determine teaching approaches favorable to intensive serious study instead of memorization of formulas by rote. Findings will be of significant application to the current study for it aims to enhance mathematical skills and self-esteem among students through innovative schooling techniques.

Problem-solving Abilities and Application

Though mathematical concepts are being researched and applied—here, permutations and combinations—problem-solving ability is also very important. Almost all the school subjects, such as probability, statistics, computer science, and operations research, are founded on such principles, and their understanding contributes a great deal to refining students' analytical and critical minds. The problem-solving mathematics and mathematics applications literature has expanded over the years to cover problem-solving strategies and pedagogical strategies through which teachers are able to disseminate information. Books, papers, journal articles, and web resources are among the numerous resources tapped in this review in a bid to determine the complexity of problem-solving in the context of permutations and combinations, emphasizing the cognitive processes involved, the pedagogical approaches to teaching these concepts, and the relevance of these skills in real-world applications.

One of the biggest challenges for students with permutations and combinations is grasping the intrinsic nature of these objects. As much as Mason (2016) would want, most students confuse the two because they do not understand when to apply each. Permutations involve the arrangement of objects based on where order is important, but combinations involve selection where order does not matter. Mason reiterates that students' lack of comprehension for these differences is usually brought about by excessive reliance on simple memorization of the formulas rather than conceptual understanding. The author informs us that educators must focus on developing intuitive feelings for when and why to use each approach because this enhances problem-solving ability and allows for efficient application of such mathematical tools. Most of the literature supports interactive learning approaches in order to create problem-solving skills in terms of permutations and combinations.

A paper by Schwartz (2018) emphasizes the way problem-solving exercises need to transcend conventional lecture-based learning. Schwartz promotes the use of real-world examples to make these abstract concepts more concrete for students. For example, using decision-making problems for day-to-day activities like event planning or sports tournament organization is an effective way of making students understand the application of permutations and combinations in everyday life. By presenting problems in real-life scenarios, students will be made to relate with the material and improve their problem-solving skills.

In journals, Lee (2019) reflects in a discussion explaining the mental process of solving combinations problems. Lee posits that problem solving in this area requires students to engage in higher-order thinking, which involves analyzing, synthesizing, and evaluating information. This is a cognitive issue that requires that students possess a solid background in logical reasoning and pattern recognition. As Lee's study identifies, poor students in permutations and combinations tend to be lacking in these rudimentary skills required to approach more complex math problems. The author advocates a more organized method of problem-solving instruction, with the students led step by step through the thought process so that they gain confidence and competence in small increments.

Along with studying permutations and combinations, the ability to apply such knowledge to different situations is also an integral component of mathematical problem-solving. As Bryant put it in a 2020 article, students need to understand when specific mathematical principles can be applied to new situations. That kind of flexibility is essential for problem-solving in the "real world," where things will not always fit with textbook scenarios. Bryant recommends that the teacher present a range of different kinds of problem—low-level, structured problems, through to higher-level, open-ended ones—to enable the pupils to use their knowledge in a flexible and creative way.

Another of the most common themes throughout texts is how to promote a growth mindset in pupils when solving problems. Dweck (2017), in her extremely highly rated book Mindset: The New Psychology of Success, writes about how students' perceptions of their abilities can powerfully influence how well they will do at solving math problems. Dweck is emphasizing that students with a mindset that intelligence and skills can be altered—rather than being fixed—are more likely to persist when they encounter problem sets that are challenging, such as permutations and combinations. This capacity to rebound is required to construct problem-solving abilities, as students are more likely to explore different strategies, learn from their mistakes, and ultimately achieve a deeper understanding of the concepts.

Technologically, internet resources have been increasingly helpful as teaching and learning materials for permutations and combinations. In a comprehensive overview by Johnson (2021), it is known how combinatorial ideas can stimulate students' interest through problem-solving packages and interactive websites. Web and mobile web pages that allow students to experiment with different combinations of objects, track their performance, and receive instant feedback solidify their grasp on the ideas. Johnson posits that such tools are particularly useful for visual learners, who may find it difficult to understand abstract mathematical concepts if they are not given in a purely theoretical context. Literature briefly mentions the real-life uses of problem-solving techniques through permutations and combinations.

A Scientific American (2022) article, for example, discusses how all these mathematical methods form the core of data analysis, cyber security, and cryptography. Permutation and combination are used here to manage massive amounts of data, create secure codes, and enhance algorithms. The essay reminds us of that STEM professional careers suit students who understand efficient problem-solving methods in the respective disciplines. Since the application of permutations and combinations by students to solve problems has long-term implications on their professional and academic success, it is thus even more important that they learn the general skill of high school success.

Finally, citing some reviewed literature, here are some of the primary findings on problem-solving capability and how permutations and combinations can be used.

First, the students will most probably find it difficult to distinguish between these two mathematical concepts, which underscores the need for pedagogical strategies that emphasize conceptual understanding rather than rote memorization. Second, problem-solving experience through contact and everyday circumstances has been demonstrated to improve the students' participation and comprehension of such topics. Third, development of the growth mindset and developing persistence when confronting difficult problems is of basic importance in building exemplary problem-solving capabilities. Lastly, the skill of applying permutations and combinations in real-life contexts is a skill that one has to learn but is useful with broad application in many STEM subjects. What can be concluded from this literature shall guide the current study, whose purpose is to explore how gamification can maximize Grade 10 students' math ability and degree of confidence in solving permutation and combination problems.

Problem-solving skills, grounded in permutations and combinations, are an important contributor to students performing well in mathematics and to their capability of handling complex real-world situations. Problem-solving has been shown by studies to be a key math skill, particularly when it comes to handling combinatorial subjects like permutations and combinations. This article presents some local and foreign research studies, theses, and dissertations that tested problem-solving ability and how they can be used to apply to such mathematics concepts and how the skills affect students' learning achievement and math confidence.

The issue that confronts Filipino high school students in trying to solve permutation and combination issues was investigated by Bautista (2016). In this study, the research concludes that most of the students lack basic counting principles needed to resolve the issues. This theoretical foundation has a tendency of leading to overuse of formulas and failing to differentiate between combinations, in which order does not matter, and permutations, in which it does. The study distinctly ascertained the need for teaching approaches that scaffold students' understanding of these concepts, providing them with strategies to approach problem-solving more systematically.

Consistent with this, studies have been carried out globally on metacognitive processes of problem-solving in combinations. Kim (2017) carried out a study in South Korea where she investigated the role of metacognitive strategies in solving problems involving permutations and combinations. Kim's study found that students who were made to analyze their own thinking and chart their problem-solving stages scored better in combinatorial problems. The research found that metacognitive instruction, where students were made to analyze the thinking and decision-making process, greatly improved their ability to solve multistep complex problems such as in permutations and combinations.

In a comprehensive US-based study by Lopez (2019), the dissertation analyzed the students' use of different visual representations—like tree diagrams, formula, and graphic organizer—to solve word problems. Based on the study, students taught using multiple solution strategies proved to be better able to switch between different representations and use the right solution strategies in solving problems. This alternation among different strategies was accompanied by a greater insight and improved problem-solving abilities, particularly in difficult combinatorial problems.

A study conducted by Velasco (2020) was conducted in a Philippine university with undergraduate students as participants who were required to solve real life problems that involved permutations and combinations. Specifically, Velasco researched contextualized problem solving, the process of relating mathematical ideas to real life situations. This study also found that the students' ability to solve problems or to apply mathematical concepts to all the problems they had to face in their daily life, be it organization or the keeping of data, improved more than the ability to solve problems via permutations and combinations.

Singh (2021) research in India substantiated the reality that students who were exposed to problem-based learning (PBL), wherein they were required to solve problems collaboratively and come to a solution of intricate, open-ended problems, resulted to an improvement in their understanding as well as application of combinatorial concepts. It was found that the PBL not only enhanced the problem-solving capacity in the students but also generated a positive attitude towards mathematics which would lead to building confidence to solve complex problems.

Williams (2018) conducted a study in Australia based on the assumption of educational interventions using digital tools and gamified learning environments for enhancement of problem-solving skills in mathematics, with focus on permutations and combinations. To motivate the students and to give them a timely feedback for their attempts in solving problems, the study employed gamification elements like challenges and rewards. Williams' research found that students who were exposed to a gamified learning environment were more likely to continue trying to find a solution to a problem and experimenting with various methods to solve the problem to increase their problem-solving ability.

Finally, a Hong Kong dissertation by Cheng (2022) offered the correlation between anxiety among students and problem-solving ability for combinatorial mathematics. Cheng's study found that students are more anxious when they encounter permutation and combination problems because the subject matter was deemed abstract. But the study found that providing students with formal problem-solving structures, in which they were able to break down tough problems into bite-sized pieces, had a wonderful anxiety-reducing effect and improved their problem-solving skill. Cheng recommended that teaching anxiety-reducing strategies such as guided practice and positive feedback be used to allow students to become comfortable using their problem-solving abilities.

In general, existing research on problem-solving skills and usage of permutations and combinations supports some notable points for this research. Firstly, the students tend to face problems with these in terms of insufficient basic knowledge and mental load in order to solve higher-level problems. With the application of metacognitive approaches, multiple representations, and realistic contexts, problem-solving capacity has been proven to be significantly enhanced among students. Problem-based learning and game environments are also highly suggested as potent instruments to inspire students to survive and resolve combinatorial problems. Lastly, minimizing student fear and presenting problem-solving plans in a straightforward way is crucial to ensure confidence and enhance mathematical performance. These findings will inform the present research, seeking to explore how gamification might promote Grade 10 students' mathematical proficiency and confidence in solving permutations and combinations problems.

Logical Reasoning

Logical reasoning is not only an asset when handling mathematical ideas, especially in the area of permutations and combinations. This aspect of combinations not only calls for one to be familiar with the makeup of mathematical concepts but also with the capability to implement logical thinking to systematically solve problems. Literature in books, journals, and articles in various sources has placed heavy emphasis on logical thinking for scholarly as well as practical purposes. For Grade 10 students, the acquisition of understanding logical reasoning is crucial for being able to efficiently work out permutations and combinations, since they are founded on straightforward step-by-step thought in order to come up with a correct solution. The review expounds the application of logical reasoning towards study of permutations and combinations using diversified local and overseas literature to provide an overall portrait of how the skill intersects mathematics problem-solving.

One of the better explanations of mathematical logic thinking is that of Devlin (2016), whose book Mathematical Thinking has an Introduction to Logic and addresses how students can be instructed in reasoning by systematic problem-solving. Devlin's view is that logical thinking is at the heart of any mathematical problem, particularly combinations, where problems become increasingly complicated and counterintuitive. He emphasizes the need for students to be able to break down large, daunting problems into manageable bits—a skill that is particularly necessary when dealing with permutations and combinations. Devlin indicates that formulas are important, but the logical progression of steps and understanding of why a specific operation is performed that confers mastery over these topics.

In a journal article by Siegel and Rachlin (2019), rational reasoning is defined as a skill that not only increases problem-solving capacity but also enhances mathematical proficiency in general. Authors describe the process by which students acquire reasoning ability through solving challenging combinatorial problems, for example, finding the number of possible combinations of a collection of objects or choosing subsets from a set. Siegel and Rachlin discovered that those students who did logical deduction regularly were more successful in identifying patterns and solving permutation and combination problems. They claim that this is because of combinations, which tend to involve learning to solve problems from a great variety of perspectives before arriving at a solution that is effective. Such flexible thinking is essential to the success of a mathematician and is developed through emphasis on the use of reason.

Another important source, a journal article entitled "Student Difficulty in Combinatorics: A Review of the Literature" by Garcia (2020), emphasizes the use of thinking by logic in solving the mental difficulties of students when studying permutations and combinations. Garcia notes that students have problems differentiating among the several types of problems in combinations, where the order is involved in permutations but not in combinations. Logical thinking, as he explains, enables students to have a means of expressing the correct questions: "What are we actually putting in order? How does the placement of objects affect the number of possible arrangements?" By having teachers instruct students to first solve the problem logically and then try to use formulas, teachers can ensure that they do not fall into mistakes and learn the subject more effectively.

In more recent work, Clark (2021) writes on logical reasoning in gamified and virtual classrooms. His Educational Technology paper summarizes how learning online games and studying apps for permutations and combinations can be used to support logical reasoning. Clark argues that most educational technologies these days involve scaffolding techniques that guide students through the process of logical reasoning to arrive at combinatorial solutions. These kinds of websites normally prompt students to elaborate on their answers, thereby compelling them to engage reflectively with their reasoning process. Clark's research demonstrates that when students can visualize and manipulate mathematical problems in an orderly, logical sequence, their overall ability at coping with permutations and combinations is significantly improved.

Best-seller titles like Bellos's Alex's Adventures in Numberland (2015) and others also discuss how reasoning is used in real life, and particularly when it comes to probability and combination problems. Bellos illustrates the applications of combinatorial mathematics using examples from everyday life, including team make-up during sporting events and seating arrangements at social events. He illustrates that employing the use of logical reasoning is similar to mathematical abstract problems and everyday making decisions when there are several things to take into consideration. Students ought to listen carefully to this because it illustrates how class happens in mathematics, which translates to everyday life outside of the classroom.

In addition, Fisher and Stern in the Psychological Science journal (2018) explain that critical thinking and decision-making are facilitated by logical reasoning in several fields, including mathematics. They propose that logical reasoning is accompanied by the higher-order thinking skills to manage multi-step problems such as permutations and combinations. The article highlights the fact that high-achieving students in logical reasoning approach problems in a methodical manner, shunning trial-and-error techniques and instead handling the logical framework of the problem. This is consistent with the objectives in learning permutations and combinations, which are to learn more about the underlying concepts and not memorize formulas.

In Mathematics Teaching, Nelson (2019) in a discussion of the application of logical reasoning in problem solving of mathematics, describes a classroom approach that enables realizing the potential of the students to reason. Nelson (2019) argued that exercise involved in problem-solving tasks can be an effective way of instructing students in logical reasoning because it engages the students in analyzing the logical relationship between the various members of a set. Teachers can encourage students to develop a logical approach towards solving problems by highlighting the importance of justification and proof in these activities and this will facilitate understanding of permutations and combinations.

Ranging from formal problem-solving methods to computer software that guides logical thinking, logical reasoning to tackle intricate problems is vital to the success of students in mathematics. This article has explained how logical reasoning not only helps students understand the complexities of combinations but also helps them apply these in real-life, practical situations. As literary and academic texts have elaborated, skill acquisition in logical reasoning can result in increased problem-solving ability, increased confidence in mathematical procedures, and overall performance improvement in combinatorial mathematics.

Logical reasoning is important in the learning of mathematical concepts, especially in combinations like permutations and combinations. Mathematical learning about logical reasoning concentrates on how people use systematic reasoning in making conclusions, especially in resolving sophisticated problems that need systematic methods. This article will present different research, studies, theses, and dissertations which have studied the effect of logical reasoning towards the comprehension of permutations and combinations, specifically on Grade 10 students and the effect of gamification towards their math skill and confidence level.

Among the major areas of research in mathematical thinking and its application to combinations and permutations is the achievement of higher-order thinking. Deductive reasoning has been cited by a dissertation by Cruz (2018) as a key predictor of achievement in combinations with the ability to utilize it to reach mathematical conclusions. Cruz researched how students applied deductive reasoning and identified significant improvements in students' ability to solve problems after they had been taught how to systematically approach these problems. The study had shown that if the students were guided through reasoning steps, they would better be able to recognize patterns and apply the proper methods to compute permutations and combinations and thereby get improved grades.

In a study conducted by Lee (2020), the author explained the need for logical thinking among students in comprehending mathematical ideas such as permutations and combinations. Students lose their way with the abstractness of combinations because the subject needs to be deeply understood not only by mathematical processes but also by the underlying logical systems of such processes. With pedagogies in experiments stressing logical reasoning, students were more confident and able to solve combinatorial problems. The research indicated that the inclusion of logic-based problem-solving strategies in the mathematics curriculum had the potential to improve students' knowledge of permutations and combinations dramatically.

A thesis conducted by Gutierrez (2019) investigated the relationship between logical reasoning and problem-solving skill in combinations, particularly permutations and combinations. Gutierrez's research compared the problem-solving strategies of high school students and revealed that students with better logical reasoning skill performed better in comprehending the interrelationship among various elements in a set as well as in solving problems where the order of the elements mattered. Through the use of applying logical deduction in ascertaining whether a problem used permutations or combinations or not the students learned the methodical method of solving combinatorial problems.

Another study by Hoffman (2017) investigated the impact of logical reasoning on students' performance in solving real life problems like in permutations and combinations lessons. Hoffman's work showed that students who were instructed with focus on developing logical reasoning were more competent to tackle permutation and combination problems in fields like probability, event planning, and decision-making. The research confirmed that both the performance of calculations and having the capability to comprehend the reason why a particular approach would be suited for a particular type of problem of the students has improved. This method enabled students to use what they already know about the topic in different contexts, thus improving their problem-solving abilities.

Additionally, a dissertation by Alcaraz (2021) addressed the connection between logical reasoning and students' performance in mathematics on Grade 10 students. Alcaraz's study investigated the impact of training a single mental ability of logical thinking and it found that it was a significant contributor to the overall throughput on the combinatorial mathematics problems. The research showed that through a culture of students being asked to think logically of problems, students ended up with greater conceptual understanding as to the differences between permutations (order matters) and combinations (order doesn't matter) and therefore ended up producing more accurate answers to the same problem type.

According to Singh (2022), one of the approaches used in his study focused on an application of logical reasoning in combination with gamification with a view of facilitating students' interest and understanding of permutations and combinations. According to Singh, the research showed that students can more effectively solve problems by using gamified learning puzzles to solve logical reasoning. The gamification framework allowed students to solve complex combinatorial problems as they could solve with logical thinking. The result was that, combined with logical reasoning, gamification also strengthened students' math skills and increased their belief of being capable of solving complicated problems.

Diaz (2016) emphasized the potential that rational thinking is the middle ground between mathematical theory and practical application. Diaz studied how students applied deductive logic to solve problems like combination and permutation related in day-to-day life. The study confirmed that when the students were instructed to tackle problems of this kind using an interactive process, they were able to present better the problem structure and apply the corresponding mathematical tools to arrive at correct solutions.

All these studies have been repeatedly emphasizing the role of logical reasoning in studies of permutations and combinations. So, logical reasoning gives students the ability to understand the theory behind combinations and therefore to be able to apply formulas and ways. It also develops critical thinking skills, which students would need to be able to use efficiently to unravel complex problems of mathematics. Also, the use of logical reasoning in practicing math, both with and without gamification methods, has also been shown to raise students’ mathematical capacities and confidence to give answers to complicated problems.

The fact that logically reasoning and its application to combinatorics should be taught in a more structured way is driven by literature on the logical reasoning and its use in gamification. Teachers can encourage students to focus on logical thinking and problem-solving approaches to permutations and combinations so that they achieve a better grasping of permutations and combinations through increased overall academic performance and increased mathematical self-confidence. Finally, these studies offer very useful insights into how logical reasoning should be used on untap students' potential in mathematics (e.g., in the case of permutations and combinations), but similarly in other areas that require a high level of cognitive engagement, such as set theory, graph theory or mathematical logic.

Confidence Levels

Confidence levels are an important factor in the shaping of students' mathematical competence, especially when handling tough subjects such as permutations and combinations. Self-efficacy, reducing anxiety, and students' willingness to participate in math activity are some of the factors that significantly contribute towards understanding how something such as gamification can improve performance and attitude towards mathematics. This research explores relevant local and international literature, including research articles, theses, and studies, which present such variables and how they are connected to the study of mathematics, in this case, permutations and combinations. Self-efficacy, which describes the capacity of a student to believe in his/her own ability to execute certain tasks, has been largely established as an important determinant of success in mathematics.

Bandura's self-efficacy theory assumes that students who believe in themselves work best and are likely to confront challenges and persevere under adversity (Bandura, 1997). Schunk (2016) highlights that students with greater mathematical self-efficacy are more inclined to engage challenging tasks, including permutations and combinations, persistently and courageously. This perspective accentuates the significantly important role that self-efficacy plays in students' proficiency and confidence in problem-solving. Confidence, necessitated in mathematics problems with reasonableness, a sequence of steps, and abstractness, such as permutations and combinations, is a quite important concern.

At the local level, Fernandez (2018) investigated Filipino high school students with results that support these findings. Students who are higher in math self-efficacy were more willing to engage in challenging topics, including probability and combinations. Fernandez's work also demonstrated how gamified learning spaces are capable of building self-confidence by demonstrating that exposure to increasingly harder problems and ongoing feedback in a game significantly enhanced students' mathematical self-efficacy. Implications of such a finding are that self-efficacy can be developed through adaptive pedagogic approaches that elicit persistence and confidence.

Math anxiety, a prevalent issue among students, tends to decrease students' confidence in solving challenging math problems such as permutations and combinations. In a meta-analysis conducted by Dowker, Sarkar, and Looi (2016), math anxiety was discovered to play a significant role in undermining the performance and willingness of students in solving math problems. Math-anxious students will avoid grappling with difficult problems, reinforcing their lack of confidence and creating a cycle of avoidance and low performance. But the researchers also found that teaching strategies designed to minimize anxiety, such as gamified instruction, can make students more actively engaged and less anxious. It is through this that anxiety reduction follows more involvement and accomplishment in mathematical procedures, specifically higher-order thinking and problem-solving mathematical procedures like permutations and combinations.

In the same vein, Ramirez, Chang, Maloney, Levine, and Beilock (2018) examined the reduction of classroom anxiety practices and concluded that the practices resulted in better performance by students on permutation and combination problems. The practices were most effective for logical reasoning and systematic problem-solving strategy problems, which are high in cognitive load. Teachers may be persuaded to encourage children to tackle challenging math problems with more confidence if math anxiety is reduced.

Many studies in education have also looked at the willingness to complete math assignments, which is also linked to anxiety levels and self-efficacy. Velasco (2020) had a thesis regarding the influence of student participation in math activities on students' problem-solving skills, specifically on high school students. The research stressed that students who are likely to engage in mathematics activities either as a result of higher self-efficacy or lower anxiety will be more likely to perform better in subjects such as combinations. The research by Velasco illustrated the way gamified learning spaces, where challenges involving permutations and combinations are utilized, really boost the level of participation among students since it makes the activities less daunting and more thrilling.

Anderson (2019) in a cross-cultural context investigated the use of gamification to enhance math engagement and student participation. The dissertation established that gamification reduced the anxiety of the students and enhanced more engagement in problem-solving exercises, particularly in traditionally abstract and difficult subjects like permutations and combinations. Through creating learning spaces with incremental difficulties and real-time feedback, gamified activities foster a growth mindset, which encourages the students to work on challenging mathematics problems with confidence.

In addition, a study conducted by Zientek, Yetkiner, and Thompson (2016) examined how math skill confidence affects student performance in advanced mathematical ideas such as permutations and combinations. The results found that students given continuous assurance and collaborative work in gamified learning contexts have enhanced self-confidence as well as enhanced problem-solving accomplishment. Results of the research provided evidence of harnessing the establishment of confidence through favorable learning settings that let students acquire perseverance for solving hard math problems.

Deterding et al. (2014) in his article about the ability of gamification to serve as a powerful tool to build confidence, particularly among students who would feel disconnected from doing mathematics exercises. Through the use of rewards, challenges, and leaderboards it reduced anxiety and raised levels of motivation of students. The article stated that learners can perform better in solving math problems, like solving permutations and combinations, if the stakes are low and the learning is fun. Thus, gamification is an essential addition to a classroom culture where students can feel comfortable enough to solve challenging math problems.

Finally, both domestic and international literature agree that self-efficacy, reduction of anxiety, and motivation are all central constructs in developing the confidence levels of the students in mathematics, especially when it comes to topics such as permutations and combinations. Gamified learning environments were found to significantly reduce anxiety, improve motivation, and develop the confidence of the students, leading to improved mathematical problem-solving performance. By emphasizing these essential dimensions of confidence, educators can facilitate successful learning situations in which math students can achieve their greatest math potential.

Role of Confidence in Academic Performance

Research has long confirmed the central role of confidence among students' accomplishments, with a focus on mathematics. Hattie's (2015) meta-analysis reveals that self-efficacy or believing one can do—contributes significantly to pupil motivation and mathematical achievement. Consistent with the findings in such a study, it was determined that interventions on pupils by pupil confidence-building hold promise for impact on astounding levels of performance gain. Consistent with such rationale, Zimmerman and Schunk (2014) elaborate the impact played by belief of students upon themselves with regards to ability for learning success. It is consistent with Bandura's self-efficacy theory, confidence can be enhanced through positive reinforcement and opportunities for skill mastery, leading to improved academic performance (Bandura, 2018). Furthermore, Klassen and Tze's (2014) studies demonstrate that the more self-efficacious students are also more likely to engage in demanding activities and persevere through adversity.

Impact of Gamification on Student Confidence

Substantiating such findings, in a longitudinal examination, Wylie and Mesner (2021) probed the effects of varying approaches of teaching on confidence levels, whereby increased confidence for students studying within gamified spaces over a span of time. This signifies not only an augmented engagement level but also being instrumental in self-efficacy generation among mathematics learners. In educational gamification, Hamari, Koivisto, and Sarsa (2014) analyzed the effect of a six-week gamification treatment on the classroom environment. The outcomes indicated that there were marked improvements in the level of engagement and self-efficacy by students from the gamification interventions that were used across this duration period. The research highlighted that repeated exposure to gamified components over several weeks is significant in the development of a support culture for learning, facilitating risk-taking and student confidence building.

Duration of Interventions

Understanding that confidence is not static, particularly in the case of focused learning activity, having gamification measures in place across a scheduled six- to eight-week timeframe allows for several points of observation where students' confidence and supportive changes to their mathematical competency may be drastically noted. The argument that this particular duration is reasonable enough to produce observable results in students' confidence and academic performance is also backed by research. For example, Hagger et al. (2015) investigated the effect of an eight weeks structured physical education program in which the finding showed that frequent exposure to the program leads to higher self-efficacy and motivation followed by performance gains. The researchers concluded that repetitive practice enhanced abilities and confidence levels within the participants.

Similarly, the Durlak et al., (2015) social and emotional learning (SEL) program review concluded that six-to eight-week interventions could produce significant positive student engagement and academic outcomes. It is determined that this duration was found effective as it was long enough to allow the students to learn and practice new skills and look back at their achievements, strengthening the feelings of competence, and fostering engagement in the long term.

Finally, these studies conclude that a six-to-eight-week period is indeed promising for short instructional treatments to promote students' self-efficacy as well as their math proficiency. Through this structured period this allows for continuous skill development, use of good feedback, and the creation of an environment that strongly supports self-efficacy.

Synthesis

The literature review of Study, Unlocking Math Potential: Exploring the Role of Gamification in Developing Math Skills and Math Confidence Among Grade 10 Students, has guiding principles that direct its strategy fully. Gamification has been cited as a high-powered learning mechanism, with badges, achievements, and structured rewards elements as proven to enhance intrinsic motivation as well as enthusiasm (Deterding et al., 2011; Deci & Ryan, 2000). These features make traditional learning a fun experience, encouraging frequent interaction and the development of goal-directed behaviors. In addition, logical thinking and problem-solving skills are underscored as critical competencies for students, aligning with the study's focus on using gamified tasks to enhance these abilities. Strategies grounded in Polya's problem-solving process, and the use of formal mathematical thinking (Mason et al., 1982) offer an extremely effective means for the encouragement of more solid conceptual understanding.

Aside from the cognitive process, literature also focuses on emotional and motivational processes in learning mathematics. Bandura's (1997) self-efficacy theory highlights levels of confidence and academic achievement, with students having confidence in themselves performing better in difficult tasks. The criticism also describes the damaging effect of math anxiety and proposes that game-based learning can overcome the negative effects by providing a supportive, immersive environment (Pajares, 1996). Also, by combining missions and challenges, educators can offer students positive action which promotes balance between learning ability and entertainment based on current pedagogical belief. To bring about a shift from entertaining capability to affective coping, they provide ample room for study on gamification impact on enhancing Grade 10 math students' capability and math confidence at once.

3. RESEARCH METHODOLOGY

This chapter outlines the research design utilized by the researcher in this study. It includes the survey respondents, sampling technique, research instrument, validation, data gathering procedure, and statistical treatment of the study.

Research Design

This study employed an experimental research design with pre-tests and post-tests to determine the impact of gamification on the mathematics capabilities and confidence levels of Grade 10 students. Two groups of students were involved in this design: an experimental group that received gamified instruction featuring aspects such as point systems, badges, and achievements, and control group that received traditional math instruction without game-like features. The students in the experimental and control groups were matched based on their prior mathematics ability, as indicated by their recent grades, to minimize any bias. Achieving this approach made it easier to determine whether the mathematical capacity or self-confidence is influenced by gamification, as any observed difference would more accurately be a result of the instructional style than due to inherent group variation.

Both groups took a pre-test to assess their baseline knowledge of mathematical concepts, problem-solving abilities, logical thinking processes, and levels of self-confidence when performing mathematics-based activities. The experimental group received instruction with gamification, while the control group received traditional modes of instruction. The post-test was administered to both groups after the experiment period to monitor if there was an improvement in their mathematical skills and confidence. The post-test and pre-test results were compared to determine the efficiency of gamification in boosting math ability and confidence level.

Respondents of the Study

The research involved seventy (70) Lumbang Integrated National High School Grade 10 students enrolled during the S.Y. 2024-2025. Grade 10 students were chosen as respondents because they are moving towards a higher level with more complex math topics, a reason for addressing an enhancement of their math skills and confidence. Research shows that such children are more responsive to interventions designed to enhance their self-efficacy, a factor that is extremely critical in guaranteeing improved academic performance (Zimmerman, 2015). Research also showed that confidence development among students at this time can have long-term implications for their academic life, especially as they enroll in more advanced courses in the following years (Schunk & Dibenedetto, 2017).

In particular, the sample target population involved 30% of the total Grade 10 population consisting of diverse learners based on varying mathematical performance. Having ability-diverse students enabled closer examination of the extent to which gamification could be tuned to respond to an array of diverse learning requirements. This inclusive framework yields to more valuable research findings and forms a base for innovations in mathematical teaching.

Population and Sampling Technique

To ensure a representative sample of Lumbang Integrated National High School Grade 10 students for the study, the researcher selected a sample of 30% (70 students) and employed a stratified random sampling technique. The respondents were divided into two groups for this study. Thirty-five (35) students for each group (experimental and controlled) were assigned.

The selection of a sample of 30% from the population of Grade 10 students allowed the researcher to have sufficient respondents to perform the appropriate analysis of the impact of gamification on mathematical abilities and confidence levels. It is a practical decision and a statistical practice employed in educational research. This ratio consequently balances obtaining an adequate sample size that corresponds with addressing certain logistical limitations, like time and finances. It also suggests that the sample size is large enough to correspond with medium or large effect sizes with good accuracy, in comparison to a 95% level of confidence with a population standard deviation, which is a concern for researchers in the domain of mathematics education (Cohen, 1988). This research aimed to balance the sample size, ensuring it was neither unnecessarily small to provide meaningful insights nor so large as to become impractical, thereby maintaining optimal reliability and generalizability while ensuring operational effectiveness.

Stratified sampling enabled the researcher to divide the population into various subgroups, or strata, based on specific attributes such as previous achievement and exposure to gamification learning techniques. The sampling was carried out in a manner that all sections of grade 10 are included, and students are categorized into subgroups based on their previous grades: Beginning (74% and below); Developing (75-79%); Approaching Proficiency (80-84%); Proficient (85-89%); and Advanced (90% and above), thus making the data more generalizable and credible. The participants from each stratum were selected randomly and assigned to either the experimental group (instruction with gamification) or the control group (instruction without gamification), taking into consideration the section they belonged to, to avoid conflicts in class scheduling. This procedure enabled the researcher to minimize bias and maximize the comparability between the groups. It contributed to enhancing both the validity and the reliability of the findings by ensuring that the observed differences between the groups could be attributed to the application of gamification instruction.

Table 1 shows the distribution of the respondents to the study.

Table 1.

1 *Stratified Random Sampling Distribution Grade 10 Students by Grade Category and Group Assignment*

Grade Category	**Population (N)**	**Proportion**	**Sample Size (30%)**	**Experimental Group (n)**	**Control Group (n)**
Beginning (74% and below)	33	14.2%	10	5	5
Developing (75-79%)	55	23.6%	17	9	8
Approaching Proficiency (80-84%)	57	24.5%	17	8	9
Proficient (85-89%)	50	21.5%	15	8	7
Advanced (90% and above)	38	16.3%	11	5	6
Total	233	100%	70	**35**	**35**

Data Gathering Procedures

Data collection in the study was conducted in a manner that ensured the collection of valid and descriptive data from the respondents. The data collection process involved pretests and post-tests to determine the mathematical competence of the students, as well as a questionnaire assessing confidence levels before and after the application of gamification interventions in the class.

The researcher designed survey questionnaires and pre- and post-test questionnaires, and then sought expert validation from experienced educators and researchers from the Schools Division of Lipa City to evaluate their content and structure. To ensure reliability, the validated research instruments were also pilot-tested on 20 students with characteristics similar to those of the actual respondents before the actual data collection. For ethical measures, the researcher obtained permission from the school administration and teachers to conduct the research at Lumbang Integrated National High School. The researcher prepared a formal request letter to conduct the study, addressed to the superintendent of Lipa City's division and endorsed by the school principal of Lumbang National High School and the researcher's adviser.

After receiving the required approvals, the researcher conducted an information session with the respondents. At this session, the students received a concise presentation on the aim and relevance of the study, the research activities, the duration, and the tasks they would be required to complete. Students were also guaranteed confidentiality in their answers, and the data collected from the study and their participation during the experimentation would be used solely for the study and would not be used for grading.

Before administering the pretest, the researcher conducted a review session with the students, covering the mathematical concepts to be assessed in the pretest pre-test through discussion and practicing exercises. Then, the pretest was administered in a quiet classroom environment under a 45-minute fixed time limit. The pretest consisted of 20 multiple-choice questions and a written practical scenario test to measure the student's comprehension of mathematical concepts and principles, problem-solving ability and application, and logical reasoning skills. The survey questionnaire on confidence was also provided, and students were given ample time to complete it. The researcher supervised the testing room, ensuring that all students took the test without interruption.

After the pretest, the researcher applied the gamified instruction consistently to the experimental group, following a structured lesson plan, and provided instruction without gamified features to the control group for six weeks. For some instances where class interruption cannot be avoided, the researcher ensured that compromised sessions were compensated by using some of the Numeracy Mathematics Program (NMP) period for math instruction.

Six weeks were selected for the implementation period, as they represented a fair balance between practical limitations, such as the academic calendar and teacher availability. They provided enough time to notice significant improvements in both mathematical ability and confidence levels. This duration aligns with current gamification research on learning, which has shown improvements within similar time frames (Deterding et al., 2011). This duration also provides adequate exposure to gamification methods, including repeated reinforcement of concepts, ongoing reinforcement of learning, and continuous feedback. Although long-term changes may take longer to implement, the selected period must be able to capture the initial improvements and provide a strong foundation for further research into the effects of gamification. To ensure consistency of implementation across different classes, the researcher developed lesson plans, tests, and instructional materials to maintain uniformity. Check-ins and monitoring were done to ensure adherence to the implementation.

The gamification strategies included the following activities:

1. Points System: Students were rewarded for completing tasks, participating in class, and providing correct solutions to math problems. The number of points given depended on the difficulty of the activity or question, which the teacher determined. For some timed activities, students were given varying points depending on how fast they correctly answered it. The maximum point value is ten (10) points, and the minimum is one point. Points were given concurrently in all sessions.

2. Badges and Achievements: When goals are reached, for example, when a particular math ability is mastered or a challenging task is done, a physical badge prepared by the teacher is handed out. Badges are given concurrently in all sessions. The following are the badges given:

a. Knowledge Refresher. It is earned when the student successfully recalls math facts, formulas, processes, or vocabulary during the review session.

b. Concept Clarifier. It is earned when the student provides insights and explains a math concept clearly to a peer or the class.

c. Math Visionary. It is earned when students answer questions about the importance of the lesson and connect it to real-world situations

d. Problem Solver. It is earned when students correctly solve a given problem using the correct steps in assessments or exercises or when students volunteer to solve it on the board and explain their solution.

e. Logical Thinker. It is earned when students are given a logical question and provide a complete and correct justification for their answers in a logical manner.

f. Math Whiz. It is earned when the student scores perfect in the evaluation part of the lesson.

g. Math Explorer. It is earned when students attempt to solve problems using different methods or win in group activities conducted outside the classroom.

h. Teamwork Titan. It is earned when the group is observed working effectively and supportively in group math activities by collaborating and helping teammates complete tasks successfully, as observed by the teacher.

i. Class Contributor. It is given to the top five (5) students who earned high points for the week.

j. Champion Badge. It is given to the group that ranked first for the week based on the total points earned.

3. Hands-on activities using non-technological tools, such as task cards, competitive group and individual challenges, and technological platforms like Quizziz, were employed along with a points and badge system, taking advantage of digital platforms for formative assessment.

The teacher posted a copy of the score and badges earned in one corner of the classroom, allowing students to monitor their points and fostering peer competition and motivation. These points and badges were tallied and tracked weekly so that students' achievements could be recognized and celebrated.

All thirty (30) sessions in six weeks were conducted face-to-face. During this period, the teacher took notes of any shift in behavior, motivation, and cooperation when gamification activities were used.

After implementing gamification, the researcher conducted a review session, followed by the administration of a post-test and survey to assess whether there were differences in students' math skills and confidence levels. The post-test had the same format as the pre-test and was administered in the same quiet classroom environment and time limit, ensuring consistent testing conditions. After the students finished the post-test, the researcher convened them for a debriefing session to discuss their experience with the gamified learning activities. This session provided students with an opportunity to share their thoughts on the role that gamification played in their learning process, as well as their feelings regarding their mathematical confidence and overall experience. To augment data collection, surveys, and questionnaires were administered to students.

Finally, the data collected was securely stored and organized. These data were submitted for statistical analysis by an experienced statistician and analyzed using descriptive and inferential methods. This analysis provided a thorough understanding of the findings, enabling the researcher to make meaningful inferences about the impact of gamification on students' mathematical skills and confidence levels. This structured approach aimed to ensure that the findings are actionable and relevant, informing future educational practices and enhancing instructional strategies in mathematics.

Research Instrument

The research instrument for this study employed both qualitative and quantitative tools that effectively gather the influence of gamification on math skills and confidence of Grade 10 student respondents. The most dominant tools used were pre-test, post-test and survey questionnaires about confidence. Students shared their experience using semi-structured interview questionnaires.

Pre-test and Post-test: The purpose of the pre-test and post-test is to evaluate the students' understanding of mathematical concepts, their capacity for problem-solving, and their ability to reason. Both tests were developed by the researcher and have undergone validation from the experts. As indicated by the research focus, each assessment consisted of twenty-five (25) items. The first ten (10) multiple choice questions measure the skill in understanding mathematical concepts and principles while the next ten (10) multiple choice questions assess the skill, problem solving ability and application. The tests also consisted of one situational open-ended question equivalent to five (5) points that assess the logical reasoning skill. A 5-point scale rubric is included to quantify the response of the student for this item. The topics covered for the pre-test are fundamental counting principles and sample space while the post-test covered the permutation and combination lessons. The pre-test was used to record the skill level of the students prior to the introduction of the gamification strategies, and the post-test validated the differences after applying the gamification strategies. The tests were pilot tested in relevance and reliability.

Surveys and Questionnaires: To obtain additional information regarding the confidence level of students towards mathematics, a systematic survey questionnaire was formulated by the researcher and validated by the expert educators and researchers. The survey comprised 5-point Likert-scale statements covering self-efficacy, reduction of anxiety, and willingness to participate in math-related tasks. Each aspect of confidence consisted of 8 indicator statements.

All of the instruments were validated by experienced educators and researchers from Schools Division of Lipa City to ensure that its contents and structure are appropriate and correct. The instruments were also pre-tested with a small group of students before final application to ensure clarity, relevance, and appropriateness of the items. The integration of these research instruments allowed for scrutiny of the influence of gamification on mathematical skill and confidence levels of Grade 10 students.

For ethical considerations, all the data gathered in the implementation of gamification and the use of these instruments were not utilized in any way as basis for grading the student respondents in the quarter when the experimentation took place.

Statistical Treatment of Data

To quantify the data obtained from pre-test as well as post-test scores, and responses via surveys of the Grade 10 respondents, different statistical methods were utilized. Guided by the research queries and data obtained the math skills and confidence levels of the respondents were analyzed.

Descriptive statistics were employed to tabulate pretest and post-test scores. Factors like mean, standard deviation, and frequency distribution effectively illustrate students' mathematical abilities and confidence levels prior to and after using gamification. This enabled to comprehend the general trends of performance among the sample population.

On the other hand, inferential statistics were used to contrast students' levels of confidence in mathematics and math skills before and after the implementation of gamification. Paired t-tests were conducted to compare the pre-test and post-test scores of both controlled and experimental groups, determining if there are statistically significant changes in their mathematical skills and confidence levels.

4. PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter presents the statistical analysis of data, along with its interpretation and discussion. The presentation of the data is outlined based on the primary topic established in the statement of the problem.

Level of Math Skills of Grade 10 Students Before and After the Implementation of Gamification in Math Instruction

Table 2.

2 *Pre- and Post-Intervention Mean Scores, Standard Deviations, and Verbal Interpretations of Mathematical Skills for the Controlled Group*

Skills		Before			After		
		Mean	**SD**	**VI**	**Mean**	**SD**	**VI**
1.	Understanding Mathematical Concepts and Principles (UMCP)	2.77	1.114	Basic	3.74	1.442	Basic
2.	Problem-solving Abilities and Application (PAA)	3.20	1.511	Basic	3.89	1.711	Basic
3.	Logical Reasoning (LA)	2.09	0.981	Basic	2.63	1.060	Adequate
	Overall	**2.69**	**1.202**	**Basic**	**3.42**	**1.404**	**Basic**

Legend: ***10-Items*** *(UMCP & PAA): 1-2 (Needs Improvement); 3-4 (Basic); 5-6 (Adequate); 7-8 (Proficient); 9-10 (Exemplary).* ***5-Items*** *(LR): 1 (Needs Improvement); 2 (Basic); 3 (Adequate); 4 (Proficient); 5 (Exemplary).* ***Overall:*** *1-5 (Needs Improvement); 6-10 (Basic); 11-15 (Adequate); 16-20 (Proficient); 21-25 (Exemplary)*

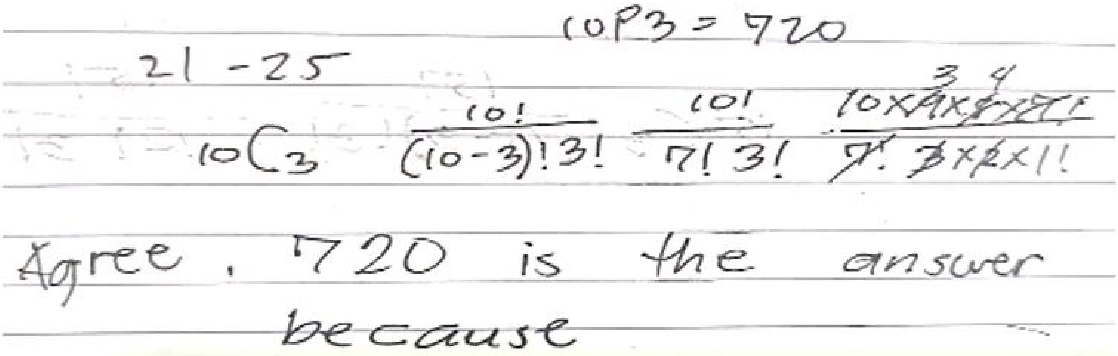
Table 2 presents the pre- and post-intervention performance of the control group with regular instruction alone. Although there was an increase in each domain of mathematics skills, overall performance remained at the Basic level. This indicates a noticeable yet limited increase in the mathematical skills of the students in the control group following the experiment. Specifically, a notable shift from the Basic to Adequate level of the students' logical reasoning ability indicates slight progress in their higher-order thinking. The results show that, regarding understanding concepts and principles, students in the controlled group demonstrated a partial understanding of the content, including experiment, outcome, sample space, event, and the Fundamental principle of counting, permutation, or combination, based on the results of their pretest and posttest. Specifically, students were only able to define a sample space, differentiate between outcome and event by definition, or identify the event in a given problem. Still, they had trouble applying these concepts to situation problems. For example, some students chose the correct answer for the question about which best defines a sample space. Still, most were unable to use a tree diagram to determine the total combinations of one drink and one dessert that can be made from two types of drinks (juice, soda) and three types of desserts (cake, pie, frosty).

Similarly, in terms of problem-solving ability and application, students' test results showed that they could only recognize key ideas, such as identifying the elements needed to solve the problem, but struggled to determine what to do next and continue the process of solving the problem correctly. For example, when asked about what is considered in the problem to find the number of ways the group can be arranged in the photo shoot, students chose the correct answer but were unable to choose the correct answer for the total number of ways.

Some students have shown slight improvement in their logical reasoning since they were able to provide a correct answer. Nonetheless, their explanations were mostly shallow, disorganized, indefinite, or incomplete, and showed a need for improvement in explaining mathematical thinking.

Figure 2

2 *Student's Sample Response on Question 21-25 in the Post Test*



These findings demonstrate that the students in the controlled group showed limited understanding of important concepts surrounding the experiment, outcome, sample space, event, and counting principles. The students were able to define terms and identify some elements and relations in a problem. Still, they appeared to have a limited understanding of how to apply concepts realistically, such as creating a tree diagram or completing arrangement problems. Their ability to solve problems was limited to identifying key ideas; it was difficult for students to bring this to a conclusion with solutions in hand. There was some improvement in logical reasoning compared to the previous result. However, they were often vague or incomplete in their explanations, further evidence of a significant lack of conceptual understanding and the ability to apply conceptual reasoning.

Table 3 shows that the mean scores in each category and the overall mean score of the students exposed to gamification have increased. This demonstrates the positive impact of gamification instruction on improving students' mathematical skills, from the basic to the proficient level.

Table 3

3 *Pre- and Post-Intervention Mean Scores, Standard Deviations, and Verbal Interpretations of Mathematical Skills for the Experimental Group*

Skills	Before			After		
	Mean	**SD**	**VI**	**Mean**	**SD**	**VI**
1. Understanding Mathematical Concepts and Principles (UMCP)	3.17	1.599	Basic	7.31	1.711	Proficient
2. Problem-solving Abilities and Application (PAA)	4.11	1.530	Basic	7.06	1.814	Proficient
3. Logical Reasoning (LA)	2.63	1.285	Basic	3.51	1.040	Proficient
Overall	**3.30**	**1.471**	**Basic**	**5.96**	**1.522**	**Proficient**

Legend: ***10-Items*** *(UMCP & PAA): 1-2 (Needs Improvement); 3-4 (Basic); 5-6 (Adequate); 7-8 (Proficient); 9-10 (Exemplary).* ***5-Items*** *(LR): 1 (Needs Improvement); 2 (Basic); 3 (Adequate); 4 (Proficient); 5 (Exemplary).* ***Overall:*** *1-5 (Needs Improvement); 6-10 (Basic); 11-15 (Adequate); 16-20 (Proficient); 21-25 (Exemplary)*

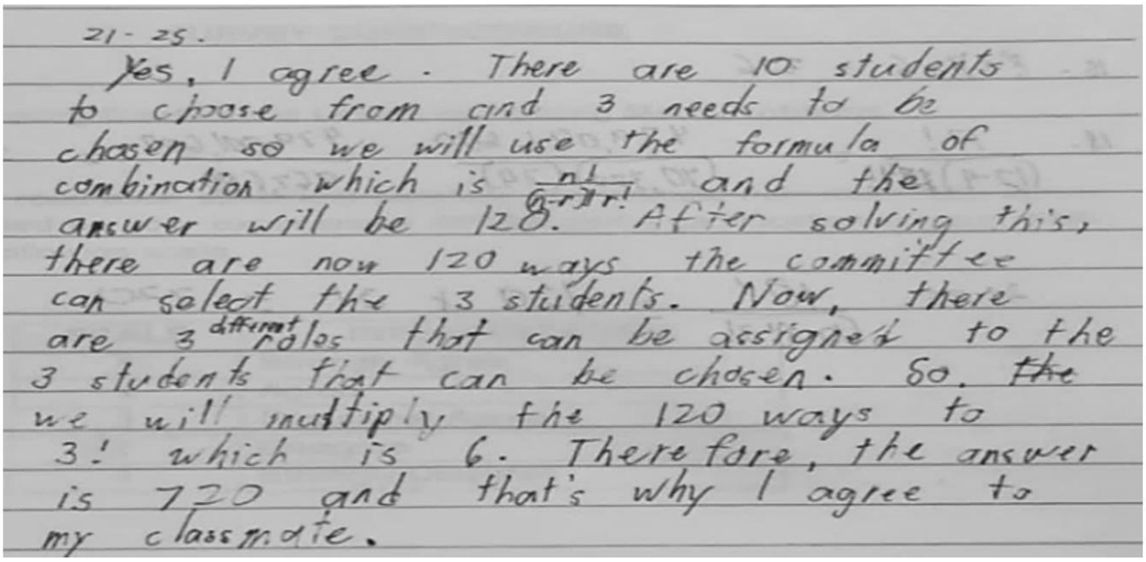
The students whose skill was previously at a basic level in understanding concepts and principles are now classified as proficient in topics such as permutations and combinations. They have finally demonstrated a solid understanding of these topics by being able to answer questions that require them to define and differentiate between combination and permutation, determine which situations involve combination or permutation, apply the formulas correctly, and represent them using their respective formulas in different contexts. For example, in a question that asked students to express the number of distinguishable permutations of the letters in the word CONCLUSIONS, most answered correctly, showing that they have a full understanding of this concept.

Similarly, in problem-solving, students showed proficiency in answering simple to complex problems that require determining what is needed to solve the problem, the steps to solve it, and which formula to use, and applying all of this to solve the problems successfully. For example, in the problem of selecting a team of 4 people for a school performance from a group of 12 people for a volunteer project, most students chose the correct answer to the related questions, leading to solving the problem and determining the number of ways to select a team.

Lastly, results showed that the students who were exposed to gamification are on a proficient level when it comes to logical reasoning because most of them were able to provide a correct answer and apply the reasoning method they have learned and provided an almost clear and complete detail in justification as shown in the example output below.

Figure 3

3 *Student's Sample Response on Question 21-25 in the Post Test*



21-25.
Yes, I agree. There are 10 students to choose from and 3 needs to be chosen so we will use the formula of combination which is $\frac{n!}{(n-r)!r!}$ and the answer will be 120. After solving this, there are now 120 ways the committee can select the 3 students. Now, there are 3 different roles that can be assigned to the 3 students that can be chosen. So, the we will multiply the 120 ways to 3! which is 6. Therefore, the answer is 720 and that's why I agree to my classmate.

These results show that incorporating game-like elements into math instruction can lead to an increase in the mean scores of the students in the post-assessment, reflecting improvements in their skills in understanding concepts and principles, problem-solving and application, and logical reasoning while having fun. The gamification's rewards dynamics increased students' motivation and engagement, encouraging consistent practice even on their own, and consequently strengthened their mathematical skills. This served as immediate feedback on their performance, provided a short-term goal of making dealing with math more manageable, and promoted a growth mindset, helping them build confidence and persist in challenging math tasks repeatedly, which are also essential for developing and reinforcing math skills.

2. Students' Level of Confidence Before and After the Use of Gamification

Table 4 presents the students' perceptions of their self-efficacy, which reflects their belief in their ability to successfully perform a task, mirroring the level of confidence they have in math. Before the intervention, the overall mean score indicated that students had a moderate level of confidence in their mathematical abilities. Following the intervention, the overall mean score increased, indicating that most students agreed with the statements about their self-efficacy. This result suggests that students developed high confidence in their ability to engage with and succeed in mathematical tasks after experiencing gamified instruction.

Furthermore, it was evident that during the implementation of gamification, students showed their belief in their abilities. For example, when there were board work activities involving problems that required solving permutations and combinations, students volunteered to compete and tried to solve the problems as fast as they could. The. The winner would explain their solution, and in return, they would receive points or badges. Motivated by the points and badges they would get, during discussions, students also actively shared their ideas in the class, for example, about how learning permutation and combination can be useful in real-life.

Table 4.

4 *Level of confidence as self-efficacy in mathematics*

Indicators	Before			After		
	Mean	**SD**	**VI**	**Mean**	**SD**	**VI**
1. I believe I can solve math problems such as equations or word problems successfully.	2.89	0.631	Somewhat Agree	3.86	0.733	Agree
2. I am confident in my ability to improve my math skills with practice.	3.26	1.067	Somewhat Agree	4.37	0.770	Agree
3. When faced with a difficult math problem, I feel capable of finding a solution.	2.77	0.843	Somewhat Agree	3.34	0.938	Somewhat Agree
4. I trust my ability to learn and apply new math concepts.	3.49	0.781	Somewhat Agree	3.97	0.785	Agree
5. I find it challenging to engage in math tasks outside of class.	3.29	0.789	Somewhat Agree	2.94	0.838	Somewhat Agree
6. I believe that my efforts in math will lead to positive outcomes.	3.86	0.648	Agree	4.31	0.932	Agree
7. I feel that I have the skills necessary to succeed in math class.	3.06	0.765	Somewhat Agree	3.83	0.785	Agree
8. I believe my participation in math tasks is often limited by my confidence levels.	3.40	1.035	Somewhat Agree	3.49	1.121	Somewhat Agree
Overall	**3.25**	**0.446**	**Moderate Confidence**	**3.76**	**0.506**	**High Confidence**

Legend: 4.50-5.0 (Strongly Agree = Extremely High Confidence); 3.50-4.49 (Agree = High Confidence); 2.50-3.49 (Somewhat Agree = Moderate Confidence); 1.50-2.49 (Disagree = Low Confidence); 1.0-1.49 (Strongly Disagree = Extremely Low Confidence).

In the speed math challenge activity, students eagerly solve the problem on their seats as fast as they can and run towards the teacher or line up for their computations to be checked. When they get the correct solutions, respective points are given based on their rank or how fast they finished the task. When their solutions are wrong, they try to solve them again and have them checked even when no more points would be acquired because the game round has already ended.

In connection with this, after the experiment, the students were also asked about their gamification experience and its effect on their confidence. The following are the students' responses:

Student 1: *"It is fun, I am happy when I get badges and points. I got used in solving math problems, sometimes I get it right, sometimes wrong, but it is okay because I can try again.".*

Student 2: *"With the math speed challenge and other exciting and fun games like math relay and games by station, I became more confident in my skills. I realized that all of us have the skills, it's just that we are scared showing it and try before. When I earn points or badges in the recitation and boardwork and it made me more confident. It made me study more and listen to ma'am".*

Student 3: *"I know that I can do better by practicing more that's why I also watch tutorial videos about our lesson in combination and permutation. Some lesson are hard, some are easy for me but I believe that I can do better if I study and try."*

These reflections of the students shone a light on the influence of gamification on their growth mindset. With the use of badges and points, it made earning not only fun but also encouraging for them leading them to stick wit it and bounce back again from the challenges that they face during math class. It reflects their readiness to embrace their mistakes and make it as just a part of their learning journey. This is an indication that the use of gamified instruction build confidence and nurtures their habits in learning that could be crucial for their long-term academic success.

These responses indicate that the integration of gamification had led the students to become more confident in their abilities. Through these responses, they expressed their belief in their own abilities. Their belief that they can improve with continued practice and exerting effort will lead to positive improvements was strengthened.

The data in Table 5 shows that before the intervention, students generally *agreed* that they experienced anxiety in math, specifically when doing math activities. These results suggest that prior to the implementation of gamification, students exhibited low confidence in math and their problem-solving abilities. After the use of gamification, students' anxiety levels decreased, indicating that the students developed moderate confidence on their abilities to engage with mathematical tasks. Furthermore, during the implementation of gamification, it was observed that students became comfortable and less anxious about committing mistakes in doing math tasks.

Table 5.

5 *Level of confidence as to reduction of anxiety in mathematics*

Indicators	Before			After		
	Mean	SD	VI	Mean	SD	VI
1. I often feel anxious when solving equations and word problems.	3.66	0.802	Agree	2.94	1.027	Somewhat Agree
2. I worry about making mistakes when solving math problems.	4.09	1.011	Agree	3.54	0.950	Agree
3. I feel nervous before math tests or quizzes.	4.09	0.818	Agree	3.26	1.268	Somewhat Agree
4. The thought of solving math problems makes me feels stressed.	3.57	1.008	Agree	2.66	1.162	Somewhat Agree
5. I find it hard to concentrate on math when I am feeling anxious.	3.86	0.912	Agree	3.46	0.980	Somewhat Agree
6. I often avoid math problems because I fear I won't be able to solve them.	3.03	1.098	Somewhat Agree	2.71	1.250	Somewhat Agree
7. I believe that my anxiety affects my performance in math.	3.54	1.120	Agree	3.26	1.245	Somewhat Agree
8. I feel more comfortable participating in other subjects than in math.	3.43	0.979	Somewhat Agree	2.60	1.117	Somewhat Agree
Overall	**3.66**	**0.555**	**Low Confidence**	**3.05**	**0.695**	**Moderate Confidence**

Legend: 4.50-5.0 (Strongly Agree = Extremely High Confidence); 3.50-4.49 (Agree = High Confidence); 2.50-3.49 (Somewhat Agree = Moderate Confidence); 1.50-2.49 (Disagree = Low Confidence); 1.0-1.49 (Strongly Disagree = Extremely Low Confidence)

In the speed math challenges, either on the board or at their seats, students tried to solve the problems and have themthem checked, even when they werewere not sure about the answers, because they also wanted to earn badges or points, just like their classmates. With excitement and smiles on their faces, they happily wait in line for their outputs to be checked and sometimes compare each other's solutions. They look forward to the Quizziz games, which feature strike and shield because, aside from practicing their skills and recalling what they have learned, students get to play as a group and compete with one another. They cheered whenever their ranks got higher because it meant they would receive more points. Instead of sulking with disappointment when they get answers wrong, they ask why the solution is wrong and try to make it right. Students also expressed their joy in playing math races and relays, involving problems that required identifying and solving strategies, as well as cheering their groupmates and asking if there would be another activity like that. Previously, whenever there was a quiz, students were afraid to have their papers checked first. However, when gamification is implemented, they become eager to know if they got the answers right in the quizzes, as they will receive another badge for it. Sometimes, even if it's almost time, students ask for more problems to solve because they want to earn more points. They even ask for overtime. These observations indicate that the student's anxiety levels in math have been reduced, suggesting they have gained confidence in their abilities after experiencing gamification.

In relation to this, after the experiment, the students were also asked about their gamification experience and its effect on their confidence. The following are the students' responses:

Student 1: *"I don't feel nervous anymore... the game is fun, I earn points and my mates cheered on me when it is my turn to answer. Before I am scared because I feel that my classmate will judge me but now I don't".*

Student 2: *"Because of the games that we do in class, I am not pressured to solve the problems, instead, I enjoy it. We are so happy when we win in the group activities."*

Student 3: *"I like math more now and not afraid because the activities are fun. I am more focused in the tasks to earn more points."*

These statements support the teacher's observation of the positive changes in the confidence level of the students who were exposed to gamification.

Table 6 shows the results of the willingness of students to participate in math tasks after the gamification which revealed that the students showed moderate confidence as reflected by the overall mean score. Even though their confidence level remained on the same level, the decrease in the overall mean score after the implementation of gamification still shows that their hesitation in participating in mathematical activities has been reduced and gamification has a positive effect on their confidence. The decrease in the mean of all indicators, especially indicators 1, 3, and 8, suggests that gamification created a more motivating and engaging learning environment, increasing the student's confidence and willingness in participating in different mathematical tasks.

Table 6.

6 *Level of confidence as to willingness to participate in math tasks*

Indicators		Before			After		
		Mean	SD	VI	Mean	SD	VI
1.	I often hesitate to participate in math class discussions or activities.	3.57	0.850	Agree	2.60	1.168	Somewhat Agree
2.	I feel reluctant to work on math problems in a group setting.	2.89	0.900	Somewhat Agree	2.74	1.094	Somewhat Agree
3.	I avoid volunteering to answer math questions during class.	3.97	0.891	Agree	2.26	1.197	Disagree
4.	I prefer to work alone rather than participate in math-related group work.	2.71	1.178	Somewhat Agree	2.54	1.120	Somewhat Agree
5.	I tend to avoid participating in math activities, when they seem difficult.	3.46	0.950	Somewhat Agree	2.54	0.852	Somewhat Agree
6.	I struggle to find motivation to work on math equations and problems.	3.34	1.027	Somewhat Agree	2.89	1.278	Somewhat Agree
7.	I am less enthusiastic about participating in tasks that involve solving word problems.	3.31	0.676	Somewhat Agree	2.69	0.993	Somewhat Agree
8.	I am willing to tackle challenging math problems without giving up.	3.46	0.950	Somewhat Agree	4.40	0.695	Agree
	Overall	**3.34**	**0.466**	**Moderate Confidence**	**2.83**	**0.624**	**Moderate Confidence**

Legend: 4.50-5.0 (Strongly Agree = Extremely High Confidence); 3.50-4.49 (Agree = High Confidence); 2.50-3.49 (Somewhat Agree = Moderate Confidence); 1.50-2.49 (Disagree = Low Confidence); 1.0-1.49 (Strongly Disagree = Extremely Low Confidence)

Furthermore, this change was observed during the implementation of gamification when the teacher was asking for volunteers to answer the questions or problems posted on the TV screen. Because many students want to answer to gain more points and badges, the teacher uses different ways to choose among them through name picker, wheel of fortune, or sometimes the students must do certain prompts testing their attentiveness as well. This way everybody gets a fair chance. Students who were observed to be hesitant to answer or solve problems on the board before now volunteer themselves or race with their classmates to show their solutions to the teacher in speed games to gain points or badges. In the group activities like math race, math relay, carousel, students happily participated with their groupmates doing their tasks as best as they can. In the math challenges, when students confirm that they answer is wrong, they try to solve it again, line up again, and wait for their turn to be checked. Even when the time is up and no more points will be gained, they still show their answer and volunteer to explain whenever they get the answer correct. These observations show that through the gamification, little by little students obtained more confidence and it was reflected by their willingness to participate in different math related activities.

In relation to this, after the experiment, the students were also asked to share their gamification experience and how it affected their confidence. The following are the students' responses:

Student 1: *"I like that we get to compete in group and individual games like, speed challenge, choose your battle, first to get the correct answer and more, and get points and badges from winning. At first, I'm shy because I am not sure but I want to try because to get the badges and points also like my classmates and I want also to contribute in our group score. That is why I try harder and participate more and practice more."*

Student 2: *"When it is almost time we don't notice it because we all listen to our teacher, we ask for one more problem to solve, we don't really notice the time because we are enjoying it. The way she teach us making math fun help improve my skill and confidence. Math was so light, fun and I love it."*

Student 3: *"Seeing my friends get more points and badges motivated me to do better and make myself proud. I study more. In our activity where the first 10 or first 5 to get the answers correct, I tried to solve the problem. I was not sure with it but I took the courage to show it to my teacher and surprisingly it is correct and I earned badge. Because of this I felt motivated to learn more and stay focused and be more confident in myself that I can do it."*

Some even said that they doubted and struggled at first but in this quarter, they started to see their mistakes to learn, and that Math taught them to keep trying and never give up, no matter how hard the problem is. The support they got from their classmates as they work together to succeed in their tasks also helped them push themselves to be better. These statements support the observations that the light atmosphere created by the gamification through the reward dynamics made it easier for students to contribute and participate in class, increasing their confidence. Gamification fostered not only competition but also collaboration among students making them willingly share their ideas, solve problems without hesitation, continuously strive to be better, and support one another.

The results showed the positive effect of gamification, specifically the incorporation of points, badges and achievements on the confidence levels of students in math and in solving math problems.

This study supports the findings of the other studies on gamification in schools with the premise that gamification can affect student confidence, motivation, and engagement. Gonzales et. al (2023) indicated that students with gamified learning experience have lower anxiety and higher motivation to resolve problems. As suggested by Hamari et al. (2020), the use of such gamification techniques as rewards, challenges, and interactive components enhanced student's engagement in learning activities by increasing feelings of accomplishment and cooperation. Wibowo and Haryanto (2021) indicate that the application of gamification in mathematics leads to learners getting confidence and a positive attitude towards the subject defeating the avoidance behavior and increasing the students' participation. Similarly, when Bai et al. (2021) studied students who were using gamified learning settings, they had a higher confidence and persistence on problem solving, especially in the difficult subject areas such as mathematics. These results support the idea that gamification plays an important role in the development of more interactive and engaging learning process, which in turn results in an increase in confidence among learners enabling them to engage themselves more actively in mathematical problem solving.

Table 7.

7 *Test of difference in the pretest and posttest mathematical skills of the two groups of respondents*

Mathematical skills	t	df	p
Controlled			
Understanding Mathematical Concepts and Principles	3.30	34.0	0.002
Problem Solving Ability and Application	1.67	34.0	0.105
Logical Reasoning	2.58	34.0	0.014
Experimental			
Understanding Mathematical Concepts and Principles	10.53	34.0	<.001
Problem Solving Ability and Application	7.22	34.0	<.001
Logical Reasoning	3.89	34.0	<.001

The result of the paired sample t-test analysis of the pretest and post-test indicates that using Gamification had a statistically significant influence on students' mathematical skills, specifically their understanding of mathematical concepts and principles, problem-solving ability, application, and logical reasoning. The positive mean difference in all domains in the experimental group indicates an increase in the post-test scores of the students. The recurring pattern of high t-statistics and very low p-values (all less than 0.001) indicate that the observed increase is highly unlikely to have occurred randomly or by chance. Moreover, the 95% confidence intervals for every domain of mathematical skills are entirely above zero, indicating that the average post-test scores were consistently higher than the pre-test scores of the students in the experimental group.

The most significant enhancement in performance was noted in students' understanding of mathematical concepts and principles, which had the largest mean difference, suggesting that Gamification had specific strengths in enhancing conceptual understanding. Students' problem-solving ability also demonstrated considerable improvement, as evidenced by the mean difference indicating students' improved ability to apply concepts in practical situations. Finally, although the change in logical reasoning was relatively small, it was still statistically significant, suggesting that even abstract cognitive skills benefited from Gamification.

In addition, a significant improvement in the students' skills, including understanding mathematical concepts and principles, problem-solving ability, and application, could stem from the observed change in behavior motivated by the possibility of earning points and badges during the implementation of Gamification. Students began to ask questions openly when they didn't understand the lesson, enabling them to keep up with their peers in earning points. Students even asked for more examples and took the initiative to study with their classmates in their free time or watch tutorial videos, as they suggested, to practice and improve their performance in games or activities assigned by the teacher. During math activities, students tend to recompute and check their solutions until they get it right, as they want to earn points or badges. Sometimes, even when there are no more points to be given, they still want to confirm and have their output checked by the teacher or compare their solutions to the answers of the students who got them correct first. Finally, regarding their skill in logical reasoning, being able to practice answering logical problems repeatedly, with the promise of earning a logical thinker badge during the evaluation or practical application part of the lesson, led to significant improvement in this area as well. Students show their answers to the teacher to check if they are correct before finally submitting them.

Recent studies have confirmed that Gamification in learning had a positive impact on the math performance of the students. For instance, González et al. (2021) demonstrated that incorporating game-based learning methods into math lessons resulted in increased student engagement and improved problem-solving abilities. Their work highlighted how traits such as point systems, rewards, and challenge interactions facilitated the development of a healthier attitude toward learning, resulting in an improvement in their math abilities. Likewise, Wouters and Van Oostendorp (2020) found that gamified educational platforms increase active engagement and solidify conceptual understanding, thereby making mathematical problems more enjoyable and less intimidating for students. These findings were indeed consistent with the results of the current study, which showed significant increases in students' inclination to engage in math activities, leading to improvements in their mathematical skills following the implementation of gamification.

The results of the paired sample t-test of the experimental group in Table 8 reveal the statistically significant and positive differences in the students' level of confidence across all domains: self-efficacy, reduction of anxiety, and willingness to participate in math tasks.

Table 8.

8 *Test of difference in the level of confidence before and after the gamification math instruction*

Level of Confidence	t	df	p
Self-efficacy	5.25	34.0	<.001
Reduction of anxiety	4.55	34.0	<.001
Willingness to participate in Math tasks	5.48	34.0	<.001

The consistent positive mean difference and t-statistics across all aspects indicates a holistic improvement in students' confidence in dealing with mathematical tasks. The big boost in participants' self-efficacy ratings, with the average gain being 0.514 points, suggests that after being exposed to gamified instruction, the students felt more capable and confident with their ability to perform math related tasks and to improve their own abilities. Additionally, the mean difference of 0.614 in the reduction anxiety implies that gamification also helped them lessen their fear and stress in dealing with mathematical tasks, making them comfortable and more open to learning math. The positive t-statistics clearly indicate that participants felt less anxious after experiencing gamification in math instruction. Following the intervention, the students also demonstrated their willingness to participate in math tasks, with a mean difference of 0.507, which implies that gamification in math instruction made it more engaging and enjoyable, encouraging students' involvement and participation.

The 95% confidence interval ranges from 0.315 to 0.713, indicating the positive effect is both statistically significant and meaningful. This suggests participants experienced a notable improvement in their belief in their own abilities after being exposed to gamification.

Collectively, these findings provide strong evidence that gamification used has a positive influence across all measured psychological dimensions. The consistency of significant results, with p-values below .001 for all measures and, the narrow confidence intervals that don't include zero, demonstrates the strong precision of the findings which means that the changes observed were unlikely to occur by chance. Gamification was found to have successfully traversed psychological obstacles to participation in mathematics through greater self-efficacy, reduced anxiety, and increased willingness to participate in math activities.

Additionally, this finding aligned with the teacher's observation during the implementation of gamification and the students' responses during the debriefing session. More and more students participate in the gamified activities and discussions from Week 1 to Week 6 of the implementation. Self-efficacy, willingness to participate, and reduction in anxiety were observed when more students started to volunteer in answering the questions, sharing their thoughts to the class, explaining the solution to the problem and doing board work. Students showed stronger confidence as they tried to solve the problems even if they were difficult because they wanted to earn badge and points too just like the others. One student shared that because of earning badges after successfully answering a problem gave her a sense of accomplishment and motivated her to keep trying, even when the task was difficult. Students felt that their efforts are recognized through the points and badge they earn and because of this they are encouraged to participate more.

Several repetition experiments have confirmed that interventions like incorporating games can be able to improve the self-efficacy of students, minimize anxiety, and optimize schoolwork engagement. Pajares and Graham (2021) used the term self-efficacy as one of the strongest predictors of math and other subjects' motivation and performance for students. Dowker et al. (2020) studied the effects of anxiety-reduction strategies on math performance and found that reducing anxiety is significantly associated with wanting to try math problem-solving. The findings showed that emotional and cognitive support interventions can effectively lower math anxiety and therefore encourage student engagement. Similarly, Jack et al. (2025) explored the impact of gamification on engagement in a statistics classroom and found that gamification strategies, when effectively implemented, can have a positive impact on student motivation and engagement. Further, Riconscente (2021) also stressed the need for developing growth mindset among students because if students think that they can grow, then they will be more likely to stick with challenging math problems. The studies are congruent with the current study, which identified that interventions to enhance self-efficacy, reduce anxiety, and promote motivation for involvement can lead to a significant shift in psychological preparedness among students leading to collaboration in mathematics and to develop confidence in themselves.

5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter contains the summary of findings, conclusions, and recommendations of the researcher about the result of this study. The findings are summarized based on the sequence of the statement of the problem of this study.

Summary of Findings

Based on the tabulated results, the following are therefore presented.

1. Level of math skills of Grade 10 students before and after the implementation of gamification in instruction

Controlled Group

Logical Reasoning in the controlled group shifted from Basic to Adequate, showing some progress in answering problems correctly, but overall, the group's proficiency remained at the Basic level, indicating that traditional teaching methods were not sufficient to significantly enhance mathematical skills.

Experimental Group

The mathematical skill of the students immensely enhanced from the Basic to Proficient level, attesting that gamification enormously improved their skill in understanding concepts and principles, problem-solving capacity, and logical reasoning.

2. Students' confidence levels in solving math problems before and after the use of gamification

Gamification enhanced the students' self-efficacy, decreased their anxiety, and enhanced their willingness to participate in math activities by increasing the enjoyment, interactivity, and interest in learning through features of gamification such as points and badges.

3. Significant difference in the mathematical skills and confidence levels of Grade 10 students before and after the implementation of gamification in mathematics instruction, specifically in solving problems involving permutations and combinations

3.1 Mathematical Skill

The significant improvement on the mathematical skills of the students who were exposed to gamification revealed by the positive statistical values, increased posttest scores on everything that was assessed, and higher proficiency level indicates the effectiveness of gamification to enhance conceptual understanding, logical reasoning, and problem-solving capacity through the reward dynamics and interactive learning experiences.

3.2 Confidence Levels

The results align with the noticeable increase in students' self-efficacy, reduced anxiety, and greater participation in math activities indicating that confidence level has increased after the gamification. Students felt less stress and more capable, showing that the use of gamification in math instruction helped lower psychological barriers to learning. creating an engaging and supportive learning environment

Conclusion

1. There is significant difference in the mathematical skills and confidence levels of Grade 10 students before and after the implementation of gamification in mathematics instruction, specifically in solving problems involving permutations and combinations. Hence, the hypothesis is rejected.

Recommendations

Based on the conclusions, the following recommendations are offered:

1. Based on the research results on how gamification can improve Grade 10 students' mathematical capabilities, it is highly recommended that teachers incorporate game-based teaching methods into their curriculum plans. Teachers can consider using interactive computer programs, leaderboards, and rewards to motivate and maintain students' interest. Curriculum developers should incorporate gamified elements into study materials to enhance students' problem-solving and critical-thinking capacities. Gamification may also be experimented with over the long term in future studies to determine its potential to enhance student's learning capacity and to explore the feasibility of integrating it across curricula.
2. As gamification had a strong impact on self-efficacy, anxiety reduction, and motivation in math problem-solving, learning strategies such as games can be applied in schools to develop a more empathetic and engaging classroom. Teachers need to be trained to develop gamified lessons that strike a balance between challenge and comfort, allowing students to gain confidence rather than feeling overwhelmed. Furthermore, other techniques, such as peer-to-peer dialogue, scaffolding issues, and individually designed learning paths, can also be used to aid student motivation. Future research will investigate the in-depth psychological basis of gamification for math, with an emphasis on the long-term persistence and motivation of students.
3. The findings that validate the positive effects of gamification on mathematics ability and confidence levels also validate the demand for more usage in schools. School administrators must encourage gamified learning courses and professional development training that habituates teachers to use such methods effectively. Studies on how to tailor gamification according to student's learning styles and skill levels can also shed light on how best to tap its potential. Extending the application of gamification to other challenging subjects beyond mathematics can also equip students with more favorable learning attitudes and academic resilience.
4. With the research evidence that gamification increases participation, engagement, and math confidence, schools can look to adopting gamified methods into their structures. Policymakers can also look towards the adoption of game-based methods into the national curriculum structures to enable more interactive and student-centered learning. Schools can also partner with edtech developers to create localized gamification platforms tailored to students' needs. Subsequent research can explore the long-term sustainability of gamification's effects on students over prolonged study periods and its potential to boost higher-order mathematics thinking abilities.

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