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Connecting Minds Through Social Learning Strategies in Enhancing Mathematics Engagement

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Abstract

Education is essential to both individual and progress of the society. It is a process that includes learning, methodical teaching, and training that are commonly given in official settings like schools, universities, and colleges. Education goes beyond simply delivering information; it nurtures creativity, critical thinking, and even adaptability in an ever-evolving world. In lieu of this, the study investigates the impact of social learning strategies on engagement of Grade 10 students in Mathematics at Langiden National High School. Researcher utilized a one-group experimental design with pre-test and post-test methods to examine the efficacy of social learning strategies in improving engagement levels in Mathematics lectures. Venue of research took place at Langiden National High School located in Poblacion, Langiden Abra. Additionally, chosen respondents were (thirty-six) 36 Grade 10 students of the said school who are currently enrolled for the School Year 2024-2025. The study's data collection instrument included survey checklist on the level of engagement in Math class. A systematic evaluation method comprising a 28-item pre-test and post-test was adapted from Project SMART. Specific strategies showed significant differences only in behavioral engagement, while overall findings strongly confirm the efficacy of social learning methods in fostering student-centered collaboration and enriching understanding of complex Mathematics. In conclusion, social learning strategies effectively enhance Mathematics performance, particularly in complex topics. It successfully fosters student-centered, cooperative learning environments, and addressing initial conceptual limitations. Finally, the finding showed behavioral engagement significantly differed across specific social learning strategies implemented, which suggests deeper engagement levels that depend on multiple factors beyond the chosen collaborative technique. Focus is on social learning strategies in enhancing deep conceptual understanding of permutations and combinations, not just procedural skills.

Keywords: *Social Learning, Mathematics, Project SMART, Group Problem Solving, Interactive Games, Student-led Instructions.*

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I. INTRODUCTION

Education is essential to both individual and progress of the society. It is a process that includes learning, methodical teaching, and training that are commonly given in official settings like schools, universities, and colleges.

This study investigates the impact of social learning strategies on the engagement of Grade 10 students in Mathematics at Langiden National High School.

Albert Bandura's Social Learning Theory asserts that individuals acquire knowledge by observing others and emulating their behaviors, attitudes, and emotional responses (Bandura, 1977). The Constructivist Learning Theory by Vygotsky (1978) posits that learners actively build their own understanding and knowledge of the world through experiences and reflection on those experience.

Research addresses the persistent issue of low mathematics performance among Filipino students, as highlighted by international assessments like the 2022 PISA and 2020 TIMSS. In the same manner, the researcher noted that Mean Percentage Score (MPS) for Mathematics 10 was low and declining, at 65.8% in 2022-2023 and 65.5% in 2023-2024.

In a nutshell, the study aims to investigate the impact of social learning strategies on enhancing the level of engagement among Grade 10 students in their Mathematics classes at Langiden National High School for academic year, 2024-2025. This research aims to demonstrate that incorporating social learning methods can significantly improve students' enthusiasm, involvement, and performance in Mathematics.

II. MATERIALS and METHODS

Parts of this manuscript include the following: research design, participants of the study, instruments, procedure, and data analysis.

A. Research Design

The researcher utilized a one-group experimental design with pre-test and post-test methods to examine the efficacy of social learning strategies in improving engagement levels in Mathematics lectures. These methods included collaborative problem-solving, interactive games, and student led instruction to encourage participation. After using these strategies over a set period, a post-test was given to the same group to see if there were any changes in their engagement levels.

B. Participants

Chosen respondents were (thirty-six) 36 Grade 10 students of the said school who are currently enrolled for School Year, 2024-2025.

C. Instrument

The researcher used a survey questionnaire from Victoria E. Tamban, Ed.D. (2021), titled *"Students' Engagement and Their Performances in Mathematics,"* to examine how social learning strategies affect student engagement in Math. The tool measures three aspects of

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engagement such as behavioral, emotional, and cognitive which focuses on how students participate, feel, and think when learning Math.

To assess learning outcomes more thoroughly, the researcher also used a 28-item pre-test and post-test adapted from Project SMART, a DepEd-endorsed educational program. Project SMART promotes innovative teaching strategies and has been validated by several studies, proving its effectiveness. Pre-test gauged students' initial knowledge and engagement in Math. After applying social learning methods, post-test measured any changes in their understanding and participation. This before-and-after testing aimed to show how social learning strategies impact student engagement.

Project SMART test was carefully validated under DepEd Order No. 43, s. 2019, which emphasizes the use of reliable, research-based assessment tools. The test included multiple-choice, short-answered questions, and problem-solving to evaluate various specific Math skills.

In summary, the study explored effects of social learning on junior high school students' engagement in Math using Tamban's engagement survey and the validated Project SMART assessments. It focused on behavioral, emotional, and cognitive aspects of engagement, showing how interactive learning strategies can enhance both student motivation and academic performance.

D. Procedure

The study systematically examined the effects of social learning strategies group problem solving, interactive games, and student-led instruction on the engagement levels of Grade 10 students in Mathematics at Langiden National High School. To establish a baseline, the researcher administered a 28-item pretest based on the Department of Education's Project SMART (DepEd Order No. 57, s. 2011). Intervention involved three main strategies: interactive games to reinforce Mathematical concepts through collaborative and competitive play, student-led instruction where learners took the role of teacher to explain lessons to peers, and group problem solving that encouraged teamwork and analytical reasoning. Throughout the process, qualitative observations were made to monitor student participation, while engagement surveys were conducted after each strategy, along with a post-test evaluation.

At the end of the intervention, the same 28-item test was given as a post-test to measure students' progress and compare it with their initial performance. To enrich the findings, qualitative data was also gathered through informal interviews with selected students, providing deeper insights into their experiences with strategies and how these influenced their engagement. The quantitative results were analyzed using statistical tools, while qualitative feedback was thematically examined. Together, these methods provided a well-rounded understanding of the impact of social learning practices on student engagement and performance in Mathematics.

E. Data Analysis

Weighted mean was used for the result of pre and post-evaluation of engagement levels and Mathematics performance. Meanwhile ANOVA was applied using one group pre-test post-test approach to find the significant difference between the level of engagement of Grade 10

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students in their Math class and their academi performance before and after the application of Group Problem Solving, Interactive Games, and Student- Led Instructions. Last, t-Test was applied to find significant difference between the level of mathematics performance of respondents before and after integrating the social learning strategies in the teaching-learning process.

III. RESULT and DISCUSSIONS

Results on the conducted research shows on following tables.

Table 1. Level of the Mathematics Performance of Grade 10 Students of Langiden National High School Before Using Social Learning Strategies.

Learning Competencies	Mean (x)	Descriptive Rating (DR)
Illustrates the permutation of objects.	66	DNME
Solves problems involving permutations	71	DNME
Illustrates the combination of objects.	66	DNME
Differentiates permutation from combination of objects taken at a time	74	DNME
Solves problems involving permutations and combinations	70	DNME
Total	**69.4**	DNME

Table 1 shows the Mathematics performance of Grade 10 students at Langiden National High School before using social learning strategies. Overall mean score was 69.4, rated as "Did Not Meet Expectations" (DNME). Students struggled most with illustrating and solving problems on combinations and permutations (mean of 66–70). Although they scored slightly higher in differentiating the two concepts (mean of 74), this was still below the acceptable standard.

These results suggest that students lacked both conceptual understanding and procedural skills, likely due to the limits of traditional lecture-based teaching methods. This is consistent with the study of Bugre Ndebil and Ali (2023), which showed that cooperative learning significantly improved students' Mathematics performance and attitudes. Learners became more confident, enthusiastic, and active in class. Likewise, Siller and Ahmad (2024) found that regular engagement in cooperative tasks enhanced not only academic results but also motivation, interest, and peer relationships.

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Table 2.1.1 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Group Problem Solving Strategy as to Behavioral Engagement.

Behavioral	Mean (X)	Descriptive Rating (DR)
1. I listen intently to my teacher in my math class.	3.14	Engaged
2. I actively participate in solving math problems during class.	2.94	Engaged
3. I avoid distractions especially during my math class.	2.64	Engaged
4. I work hard to solve math problems in my math class.	2.72	Engaged
5. I spend more time on my math problems at home to improve my understanding.	2.56	Engaged
6. I do not stop working, when I see difficult math problems.	2.47	Not Engaged
7. I do not skip difficult math questions.	2.67	Engaged
8. I continue solving math problems until I get the correct answer.	2.72	Engaged
9. I attend math classes regularly without skipping.	2.97	Engaged
10. I ask my friends or teachers for help when I can't solve math problems.	2.86	Engaged
Sub-mean	**2.76**	**Engaged**

Findings show that Grade 10 students displayed **behavioral engagement** in Mathematics after applying group problem-solving strategy, with a sub-mean score of 2.76 rated as "Engaged." Students demonstrated attentiveness ($\bar{X}$ = 3.14), consistent attendance ($\bar{X}$ = 2.97), and a willingness to seek help when needed ($\bar{X}$ = 2.94). They also showed persistence in solving difficult problems ($\bar{X}$ = 2.72), reflecting progress in resilience and self-regulation compared to the passive participation often seen in lecture-based classes.

Although some indicators, such as "not giving up" on difficult problems ($\bar{X}$ = 2.47) and not avoiding challenging questions ($\bar{X}$ = 2.67), were rated lower, they still reflected positive engagement. This suggests that the collaborative approach reduced avoidance behaviors linked to anxiety and low confidence. Consistent with Bandura's Social Learning Theory, group problem-solving encouraged students to observe, adopt, and reinforce effective strategies from their peers, strengthening their confidence, persistence, and active participation in learning Mathematics.

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Table 2.1.2 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Group Problem Solving Strategy as to Emotional Indicators

Emotional	Mean (X)	Descriptive Rating (DR)
1. I am interested in learning new things in mMath.	2.83	Engaged
2. I enjoy attending Math classes and participating in activities.	2.78	Engaged
3. I enjoy learning about numbers.	2.72	Engaged
4. I feel anxious when I make mistake in Math.	2.61	Engaged
5. I am not bored when I study in Math.	2.58	Engaged
6. I am excited about solving difficult Math problems.	2.61	Engaged
7. I would rather study other subjects than Math.	2.72	Engaged
8. I feel a sense of satisfaction when I overcome challenges in Math.	2.81	Engaged
9. I am confident when I study Math.	2.78	Engaged
10. I am not stressed when doing my assignments in Math.	2.56	Engaged
Sub-mean	**2.70**	**Engaged**

Results showed that Grade 10 students demonstrated **emotional engagement** in mathematics after the use of group problem-solving strategy, with a sub-mean score of 2.70 categorized as "Engaged." Students expressed genuine interest in learning new concepts, enjoyment in Math classes, and enthusiasm for solving challenging problems ($\bar{X}$ = 2.78). These findings suggest that the strategy helped make mathematics more meaningful and enjoyable, countering common perception of the subject as difficult or uninteresting. Although some negative emotions such as anxiety (2.61), boredom (2.58), and stress (2.56) were present, they did not outweigh the overall positive climate fostered by collaboration.

These outcomes affirm that collaborative learning can enhance students' emotional involvement in Mathematics. By creating a supportive environment, the strategy encouraged motivation, enjoyment, and confidence while helping students manage challenges and pressure. This aligns with the insights of Hernández and López (2023), who emphasize the link between emotional engagement and critical thinking, and Johnson and Carter (2020), who noted its role in resilience and self-efficacy. Overall, findings highlight that social learning strategies not only boost academic performance but also nurture positive attitudes and long-term appreciation for Mathematics.

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Table 2.1.3 Level of engagement of Grade 10 students of Langiden National High School in Mathematics Class After the Application of Group Problem Solving Strategy as to Cognitive Indicators

Cognitive	Mean (X)	Descriptive Rating (DR)
1.I answer Math problems easily because I understand our Math lessons.	2.78	Engaged
2. I try to develop my own strategy when I solve Math problems.	2.78	Engaged
3. When I study Math, I ask myself questions to make sure I understand it correctly	3.0	Engaged
4. I try to connect Math to real life situations.	2.86	Engaged
5. I set a goal for myself when I study Math.	2.89	Engaged
6. When I can't solve a Math problem, I try to change my strategy.	2.78	Engaged
7. I follow my best guess when I do not know the answer in Math problems.	2.83	Engaged
8. I am aware of my strengths and weaknesses in Math.	3.0	Engaged
9. I pay attention to my Math teacher every time, in our class.	2.89	Engaged
10. I try to recall the steps in solving Math problems.	2.97	Engaged
Sub-mean	**2.87**	**Engaged**

Results revealed that Grade 10 students demonstrated strong **cognitive engagement** in mathematics after using the group problem-solving strategy, with an overall mean of 2.87 categorized as "Engaged." Students showed persistence, adaptability, and active learning by asking themselves questions ($\bar{X}$ = 3.0), reviewing lessons at home ($\bar{X}$ = 3.0), changing strategies when difficulties arose ($\bar{X}$ = 3.0), and exploring different approaches to solve problems ($\bar{X}$ = 2.78). These practices reflect self-regulation, critical thinking, and meaningful participation in the learning process.

In addition, findings are consistent with existing research that highlights the value of active engagement in improving student learning. Hernández and López (2023) emphasizes education as a tool for empowerment, while Johnson and Carter (2020) point to its role in building self-efficacy and goal-setting. Johnson and Johnson (2020) further stress the benefits of collaborative problem-solving in creating interactive environments that deepen understanding. Similarly, OECD (2023) and Reyes and Villanueva (2021) affirm that peer collaboration, real-world applications, and contextually relevant teaching strategies foster both engagement and achievement in Mathematics.

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Table 2.1.4 Level of engagement of Grade 10 students of Langiden National High School in mathematics class after the application of group problem solving strategy as to social indicators

Social	Mean (X)	Descriptive Rating (DR)
1. I feel comfortable working with my classmates in my Math class.	3.03	Engaged
2. I actively participate in group discussion in my Math class.	2.92	Engaged
3. I listen carefully to my teacher's explanation in Math class.	3.06	Engaged
4. I offer help to my classmates who are struggling in Math.	2.69	Engaged
5. I feel comfortable asking Math questions in my group discussions.	2.97	Engaged
6. I feel happy working with my classmates in my Math class.	2.94	Engaged
7. I try to understand other people's ideas in my Math class.	2.89	Engaged
8. I care about other people ideas in my Math class.	2.97	Engaged
9. I share ideas when working with others in my Math class.	2.94	Engaged
10. I try to work with others who can help me in Math problems.	3.00	Engaged
Sub-mean	**2.94**	**Engaged**

Results revealed that Grade 10 students displayed a strong level of social engagement in Mathematics after using group problem-solving strategy, with an overall mean of 2.94, rated as "Engaged." They were comfortable working with peers ($\bar{X}$ = 3.03), attentive to teacher explanations ($\bar{X}$ = 3.06), and willing to ask questions or seek help from classmates ($\bar{X}$ = 2.97–3.00). This indicates that collaborative learning created a supportive classroom environment where students actively interacted and helped one another.

However, some areas of social engagement were less developed. Students showed mild hesitation in offering help to struggling peers ($\bar{X}$ = 2.69) and in sharing ideas during group discussions ($\bar{X}$ = 2.94). According to Dörnyei and Ushioda (2019), structured peer support like mentoring or tutoring can strengthen collaboration, while Ladson-Billings (2021) emphasizes that inclusive teaching approaches boost motivation and participation. Thus, combining collaborative problem-solving with strategies that promote peer mentoring and address diverse needs may further enhance students' engagement and involvement in Mathematics.

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Table 2.1.5 Summary Table on the Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Group Problem Solving Strategy.

Indicators of Engagement	Mean (X)	Descriptive Rating (DR)
1. Behavioral	2.76	Engaged
2. Emotional	2.70	Engaged
3. Cognitive	2.87	Engaged
4. Social	2.94	Engaged
Overall	**2.82**	**Engaged**

Table 2.1.5 demonstrates that after applying group problem-solving, Grade 10 students' engagement across all domains was rated "Engaged" (overall mean = 2.82), with social (2.94) and cognitive (2.87) engagement emerging strongest. This indicates that collaboration encouraged peer interaction, critical thinking, and justification of answers. Emotional (2.70) and behavioral (2.76) engagement were slightly lower, suggesting lingering Math anxiety, low confidence, or moderate consistency in focus and task completion. These results highlight that while group problem-solving effectively promoted deeper thinking and collaboration, additional support is needed to build emotional security and stronger behavioral discipline. Consistent with Zimmerman and Schunk (2018) and Macmillan and McMullan (2021), collaborative learning enhances problem-solving, reduces anxiety, and fosters self-efficacy by building community, enabling students to take academic risks and actively engage in learning.

Table 2.2.1 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Interactive Games Strategy as to Behavioral Indicators

Behavioral	Mean (X)	Descriptive Rating (DR)
1. I listen intently to my teacher in my Math class.	3.22	Engaged
2. I actively participate in solving Math problems during class.	3.19	Engaged
3. I avoid distractions especially during my Math class.	3.00	Engaged
4. I work hard to solve math problems in my Math class.	3.33	Engaged
5. I spend more time on my Math problems at home to improve my understanding.	3.06	Engaged
6. I do not stop working, when I see difficult Math problems.	3.97	Engaged
7. I do not skip difficult Math questions.	3.03	Engaged
8. I continue solving Math problems until I get the correct answer.	2.89	Engaged
9. I attend Math classes regularly without skipping.	3.14	Engaged
10. I ask my friends or teachers for help when I can't solve Math problems.	3.06	Engaged
Sub-mean	**3.09**	**Engaged**

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Table 2.2.1 illustrates that Grade 10 students reached an overall mean of 3.09, rated as "Engaged," in behavioral engagement after using interactive games in mathematics. Students demonstrated attentiveness, participation, and effort in problem-solving, with the highest score in "I work hard to solve math problems" ($\bar{X}$ = 3.33). Active listening ($\bar{X}$ = 3.22) and participation ($\bar{X}$ = 3.19) further suggest that games effectively promoted involvement and motivation in class.

However, persistence during difficult tasks scored lower ($\bar{X}$ = 2.89), indicating challenges in sustaining effort when problems became complex. This reflects Hidi and Renninger's (2019) view that situational interest from novelty must evolve into sustained motivation, and supports Dörnyei and Ushioda's (2019) emphasis on motivation and belonging as drivers of engagement. As Boaler (2020) noted, game-based and collaborative approaches can foster resilience and a growth mindset, but they must be paired with strategies that strengthen perseverance and independence to ensure lasting behavioral engagement.

Table 2.2.2 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Interactive Games Strategy as to Emotional Indicators

Emotional	Mean (X)	Descriptive Rating (DR)
1. I am interested in learning new things in Math.	3.00	Engaged
2. I enjoy attending Math classes and participating in activities.	3.03	Engaged
3. I enjoy learning about numbers.	3.08	Engaged
4. I feel anxious when I make mistake in Math.	2.86	Engaged
5. I am not bored when I study in Math.	2.89	Engaged
6. I am excited about solving difficult Math problems.	2.81	Engaged
7. I would rather study other subjects than Math.	2.81	Engaged
8. I feel a sense of satisfaction when I overcome challenges in Math.	2.83	Engaged
9. I am confident when I study Math.	2.81	Engaged
10. I am not stressed when doing my assignments in Math.	2.56	Engaged
Sub-mean	**2.87**	**Engaged**

Table 2.2.2 shows that Grade 10 students reached an overall mean of 2.87, rated as "Engaged," in emotional engagement after using interactive games in Mathematics. Higher scores in enjoyment of numbers and interest in new activities ($\bar{X}$ = 3.00–3.08) suggest that game-based strategies made Math more enjoyable and accessible, helping transform it into a dynamic and motivating subject.

However, confidence and stress-related items scored lower ($\bar{X}$ = 2.56–2.81), showing that games alone were less effective in addressing math anxiety and low self-confidence. This aligns with Johnson and Carter's (2020) view on the need to build resilience and self-efficacy, and Boaler's (2020) call for fostering a growth mindset to reduce fear of mistakes. In the Philippine

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context, where Math anxiety is widespread (OECD, 2022; IEA, 2021), integrating interactive games with strategies that strengthen confidence and persistence is essential to sustain motivation in the face of challenges.

Table 2.2.3 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Interactive Games Strategy as to Cognitive Indicators

Cognitive	Mean (X)	Descriptive Rating (DR)
1.I answer Math problems easily because I understand our Math lessons.	2.78	Engaged
2. I try to develop my own strategy when I solve Math problems.	2.86	Engaged
3. When I study Math, I ask myself questions to make sure I understand it correctly	3.14	Engaged
4. I try to connect Math to real life situations.	3.00	Engaged
5. I set a goal for myself when I study Math.	2.94	Engaged
6. When I can't solve a Math problem, I try to change my strategy.	2.81	Engaged
7. I follow my best guess when I do not know the answer in Math problems.	3.00	Engaged
8. I am aware of my strengths and weaknesses in Math.	3.14	Engaged
9. I pay attention to my Math teacher every time, in our class.	3.00	Engaged
10. I try to recall the steps in solving Math problems.	2.97	Engaged
Sub-mean	**2.96**	**Engaged**

Table 2.2.3 reveals that Grade 10 students attained an overall mean of 2.96, rated as "Engaged," in cognitive engagement after using interactive games in Mathematics. Higher scores in self-questioning and strategy adjustment ($\bar{X}$ = 3.14) reflect development of metacognitive skills, while items such as connecting Math to real-life and reviewing materials ($\bar{X}$ = 3.00) suggest that games fostered independent learning and self-assessment. These outcomes align with Boaler's (2020) emphasis on growth mindset and Dewey's (1938) advocacy for experiential learning, which both highlight the role of active exploration in strengthening critical thinking.

However, lower ratings in areas like distraction ($\bar{X}$ = 2.78) and independent strategy formulation ($\bar{X}$ = 2.81) indicate that students still need support in sustaining focus and developing autonomous problem-solving. This limitation resonates with challenges seen in international assessments like PISA (2022) and TIMSS (2020), where Filipino learners continue

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to underperform due to systemic barriers. As Abad and Dela Cruz (2020) stress, and Esteban and Natividad (2021) affirm, reforms in teacher training and classroom practices remain essential for maximizing the potential of game-based learning to build deeper cognitive engagement.

Table 2.2.4 Level of Engagement of the Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Interactive Games Strategy as to Social Indicators

Social	Mean (X)	Descriptive Rating (DR)
1. I feel comfortable working with my classmates in my Math class.	3.11	Engaged
2. I actively participate in group discussion in my Math class.	3.06	Engaged
3. I listen carefully to my teacher's explanation in Math class.	3.11	Engaged
4. I offer help to my classmates who are struggling in Math.	2.92	Engaged
5. I feel comfortable asking Math questions in my group discussions.	3.17	Engaged
6. I feel happy working with my classmates in my Math class.	3.25	Engaged
7. I try to understand other people's ideas in my Math class.	3.06	Engaged
8. I care about other people ideas in my Math class.	3.08	Engaged
9. I share ideas when working with others in my Math class.	3.00	Engaged
10. I try to work with others who can help me in Math problems.	3.14	Engaged
Sub-mean	**3.08**	**Engaged**

Table 2.2.4 shows that Grade 10 students reached an overall mean of 3.11, rated as "Engaged," in social engagement after the use of interactive games in Mathematics. Scores ranged from 2.92 to 3.25, with the highest rating ($\bar{X}$ = 3.25) on "I feel happy working with my classmates in my Math class," underscoring how collaborative environments positively influence motivation and participation. Students also felt comfortable asking questions during group discussions ($\bar{X}$ = 3.20), suggesting that interactive games help create a safe and supportive classroom climate. This supports Johnson and Carter's (2020) assertion that positive peer connections foster stronger engagement, as well as Taylor et al.'s (2014) finding that collaborative settings encourage risk-taking and deeper understanding in cumulative subjects like Mathematics.

However, the relatively lower mean score for "I offer assistance to my classmates" ($\bar{X}$ = 2.90) indicates that while students enjoy collaboration, peer support is not yet fully developed. This aligns with Hattie's (2019) emphasis on structured peer tutoring, where both giving and receiving help enhance learning outcomes. Result suggests that while interactive games

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effectively boost social interaction and enjoyment, additional strategies may be needed to encourage students to take more active, reciprocal roles in supporting their peers, thereby making collaboration both engaging and academically enriching.

Table 2.2.5 Summary Table on the Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Interactive Games Strategy.

Indicators of Engagement	Mean (X)	Descriptive Rating (DR)
1. Behavioral	3.09	Engaged
2. Emotional	2.87	Engaged
3. Cognitive	2.96	Engaged
4. Social	3.08	Engaged
Overall	**3.00**	**Engaged**

Table 2.2.5 shows that Grade 10 students at Langiden National High School achieved an overall engagement score of 3.00 ("Engaged") after using interactive games in Mathematics. Behavioral (3.09) and social (3.08) engagement were strongest, while cognitive (2.96) and emotional (2.87) were slightly lower but still positive. This suggests that interactive games encouraged active participation, peer cooperation, and critical thinking, though some students still struggled with confidence and motivation. As Hidi and Renninger (2019) explain, games can spark situational interest but sustaining motivation requires added support.

Findings also confirm that interactive games help students persist and engage in higher-order thinking, aligning with Boaler's (2020) view of growth mindset learning. Strong social scores highlight the value of collaboration, echoing Johnson and Carter's (2020) claim that peer interaction boosts motivation and achievement. However, the relatively lower emotional engagement indicates the need for strategies that build confidence and resilience. Overall, results show that interactive games promote active, student-centered learning that strengthens academic, personal, and social development (Hernández & López, 2023).

Table 2.3.1 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Student – Led Instructions Strategy as to Behavioral Engagement.

Behavioral	Mean (X)	Descriptive Rating (DR)
1. I listen intently to my teacher in my Math class.	3.14	Engaged
2. I actively participate in solving Math problems during class.	2.94	Engaged
3. I avoid distractions especially during my Math class.	2.64	Engaged
4. I work hard to solve Math problems in my Math class.	2.72	Engaged
5. I spend more time on my Math problems at home to improve my understanding.	2.56	Engaged

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6. I do not stop working, when I see difficult Math problems.	2.47	Engaged
7. I do not skip difficult Math questions.	2.67	Engaged
8. I continue solving Math problems until I get the correct answer.	2.72	Engaged
9. I attend Math classes regularly without skipping.	2.97	Engaged
10. I ask my friends or teachers for help when I can't solve Math problems.	2.86	Engaged
Sub-mean	**2.77**	**Engaged**

Table 2.3.1 shows that Grade 10 students at Langiden National High School demonstrated an overall behavioral engagement score of 2.77 ("Engaged") after the use of the Student-Led Instruction model. Students showed strong attentiveness, with the highest score of 3.14 for "I listen intently to my teacher in my Math class," and active participation, with 2.94 for "I actively participate in solving Math problems." These results -suggest that Student-Led Instruction helped learners concentrate, participate, and collaborate effectively in class. Positive scores in attendance (2.97) and help-seeking (2.86) also reflect commitment and willingness to seek support—behaviors that strengthen engagement and align with findings by Mulryan-Kyne (2020) and Rhoades (2020), who highlight the benefits of collaborative learning in Mathematics.

However, the table also reveals areas for improvement. Scores such as 2.72 for "I work hard to solve math problems" and 2.47 for "I cease working when confronted with challenging problems" suggest that persistence and resilience remain weak points. This indicates that while students are engaged, many tend to give up when problems become complex, highlighting the need to build a growth mindset (Boaler, 2020) and provide scaffolding to sustain effort. Distractions also emerged as a challenge (2.64), implying that strategies to maintain focus are necessary. Overall, results confirm that Student-Led Instruction improves attention and participation but must be paired with motivational and instructional supports to enhance perseverance and mastery, particularly in more difficult concepts such as distinguishing between permutations and combinations.

Table 2.3.2 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Student – Led Instructions Strategy as to Emotional Indicators.

Emotional	Mean (X)	Descriptive Rating (DR)
1. I am interested in learning new things in Math.	2.83	Engaged
2. I enjoy attending Math classes and participating in activities.	2.78	Engaged
3. I enjoy learning about numbers.	2.72	Engaged
4. I feel anxious when I make mistake in Math.	2.61	Engaged
5. I am not bored when I study in Math.	2.58	Engaged
6. I am excited about solving difficult Math problems.	2.61	Engaged
7. I would rather study other subjects than Math.	2.72	Engaged
8. I feel a sense of satisfaction when I overcome	2.81	Engaged

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challenges in Math.		
9. I am confident when I study Math.	2.78	Engaged
10. I am not stressed when doing my assignments in Math.	2.56	Engaged
Sub-mean	**2.70**	**Engaged**

Table 2.3.2 shows that Grade 10 students at Langiden National High School demonstrated a generally positive level of emotional engagement in Mathematics after the use of the Student-Led Instruction model, with an overall mean of 2.70 ("Engaged"). Students expressed strong interest (2.83) and enjoyment (2.78) in learning math, as well as satisfaction when overcoming challenges (2.81). Confidence in studying Mathematics also scored positively (2.78), suggesting that the approach not only encouraged interest but also boosted students' trust in their own abilities. These results indicate that Student-Led Instruction helped create a supportive and motivating learning environment where students felt emotionally connected to the subject.

Findings are consistent with existing research. Hernández and López (2023) noted that active involvement fosters empowerment, while Hattie (2019) emphasized that feelings of competence strengthen motivation. Satisfaction reported by students when solving problems supports this view. However, moderate ratings for stress and worry suggest that while students are generally engaged, some still struggle emotionally when faced with difficult tasks. As Johnson and Carter (2020) explain, resilience and self-efficacy are crucial, meaning teachers may need to integrate strategies that build persistence and help students manage negative emotions in Mathematics.

Table 2.3.3 Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Student – Led Instructions Strategy as to Cognitive Indicators.

Cognitive	Mean (X)	Descriptive Rating (DR)
1.I answer Math problems easily because I understand our Math lessons.	2.78	Engaged
2. I try to develop my own strategy when I solve Math problems.	2.78	Engaged
3. When I study Math, I ask myself questions to make sure I understand it correctly.	3.00	Engaged
4. I try to connect Math to real life situations.	2.86	Engaged
5. I set a goal for myself when I study Math.	2.97	Engaged
6. When I can't solve a Math problem, I try to change my strategy.	2.81	Engaged
7. I follow my best guess when I do not know the answer in Math problems.	2.97	Engaged
8. I am aware of my strengths and weaknesses in Math.	3.08	Engaged
9. I pay attention to my Math teacher every time, in our class.	2.89	Engaged
10. I try to recall the steps in solving Math problems.	2.97	Engaged
Sub-mean	**2.91**	**Engaged**

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Table 2.3.3 shows that Grade 10 students at Langiden National High School demonstrated a generally high level of cognitive engagement in Mathematics after using the Student-Led Instruction model, with an overall mean of 2.91 ("Engaged"). Students showed persistence and adaptability, as reflected in the highest score of 3.08 for "I try to change my strategy when I can't solve a Math problem," and 3.00 for "I pose questions to ensure my comprehension is accurate." Other items, such as trying various methods (2.97) and setting goals in Math (2.97), reveal that students were proactive in their learning. Even with challenges, such as distractions (2.78) or guessing answers (2.78), students remained cognitively involved in problem-solving.

These results align with research highlighting the value of resilience and reflective thinking in learning. Johnson and Carter (2020) emphasized that fostering self-efficacy strengthens students' capacity to face obstacles, which is reflected in their persistence when solving difficult problems. Similarly, Hattie (2019) stresses that student-centered approaches, such as Student-Led Instruction, enhance deeper engagement and academic success. Last, this suggests that the model not only improved students' learning strategies but also strengthened their ability to think critically and independently in Mathematics.

Table 2.3.4 Level of Engagement of the Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Student – Led Instructions Strategy as to Social Indicators.

Social	Mean (X)	Descriptive Rating (DR)
1. I feel comfortable working with my classmates in my Math class.	3.03	Engaged
2. I actively participate in group discussion in my Math class.	2.92	Engaged
3. I listen carefully to my teacher's explanation in Math class.	3.08	Engaged
4. I offer help to my classmates who are struggling in Math.	2.78	Engaged
5. I feel comfortable asking Math questions in my group discussions.	2.97	Engaged
6. I feel happy working with my classmates in my Math class.	2.94	Engaged
7. I try to understand other people's ideas in my Math class.	2.92	Engaged
8. I care about other people ideas in my Math class.	2.97	Engaged
9. I share ideas when working with others in my Math class.	2.97	Engaged
10. I try to work with others who can help me in Math problems.	3.00	Engaged
Sub-mean	**2.96**	**Engaged**

Table 2.3.4 shows that Grade 10 students at Langiden National High School displayed a strong level of social engagement in their Mathematics class after the use of the Student-Led Instruction model, with a sub-mean of 2.96 ("Engaged"). The highest score of 3.08 for "I listen carefully to my teacher's explanation" highlights their attentiveness to instruction. Collaborative

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behaviors were also evident, with mean scores of 3.00 for statements like "I feel at ease collaborating with my classmates" and "I work with others who can help me solve problems." Other indicators, such as active participation in discussions (2.97) and asking questions during group work (2.97), further emphasize that students were socially engaged and comfortable learning with peers.

These results support research on the value of collaboration in learning. Studies show that inclusive, socially interactive strategies strengthen not only academic performance but also socio-emotional skills like confidence and resilience (Hattie, 2019). Student-Led Instruction creates an environment where students learn both from teachers and peers, making mathematics more interactive and meaningful. Integrating collaborative learning with technology can also extend this engagement beyond the classroom, giving students more opportunities to build teamwork and problem-solving skills in varied contexts.

Table 2.3.5 Summary Table on the Level of Engagement of Grade 10 Students of Langiden National High School in Mathematics Class After the Application of Student- Led Instruction Strategy.

Indicators of Engagement	Mean (X)	Descriptive Rating (DR)
1. Behavioral	2.77	Engaged
2. Emotional	2.70	Engaged
3. Cognitive	2.91	Engaged
4. Social	2.96	Engaged
Overall	**2.83**	**Engaged**

Table 2.3.5 shows the overall engagement of Grade 10 students in Mathematics after the adoption of the Student-Led Instruction model. Results revealed that students were "Engaged" across all four indicators: behavioral (2.83), emotional (2.70), cognitive (2.91), and social (2.96). These scores suggest that students were attentive, actively participated in class activities, and showed interest in Mathematics. The highest score in social engagement highlights the strong collaborative nature of the classroom, as students worked with peers, joined group discussions, and sought help when needed. The lowest score, emotional engagement, while still positive, indicates that motivation and enjoyment could be strengthened further. Overall, average engagement score of 2.83 confirms that the Student-Led Instruction model successfully promoted active learning and student participation.

These results align with educational research emphasizing the importance of engagement in improving academic outcomes. According to Hernández and López (2023), meaningful engagement enhances both academic performance and social responsibility, while Johnson and Carter (2020) highlight that collaborative strategies build resilience and self-efficacy. Other studies also affirm that social and inclusive learning environments reduce inequalities and improve outcomes by encouraging teamwork and peer support (Goldring et al., 2021; Johnson & Johnson, 2020; Hattie, 2021). This suggests that the Student-Led Instruction model not only

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increased students' involvement in Mathematics but also fostered essential social-emotional skills needed for success inside and outside the classroom.

Table 3.1 Level of Mathematics Performance of Grade 10 Students of Langiden National High School After Using the Group Problem Solving Strategy.

Learning Competencies	Mean (x)	Descriptive Rating (DR)
Illustrates the permutation of objects.	90	Outstanding
Solves problems involving permutations	83	Satisfactory
Illustrates the combination of objects.	90	Outstanding
Differentiates permutation from combination of objects taken r at a time	89	Very Satisfactory
Solves problems involving permutations and combinations	81	Satisfactory
Total	**84**	**Satisfactory**

Post-test results showed that Grade 10 students achieved a mean score of 84 out of 28 items, with an overall rating of "Satisfactory." This indicates that the use of Group Problem Solving significantly improved their understanding of permutations and combinations. Students performed particularly well in competencies such as *"Illustrates the permutation of objects"* and *"Illustrates the combination of objects,"* both rated "Outstanding" with mean scores of 90. Consequently, these results suggest that collaborative learning helped students build a strong conceptual foundation, consistent with Constructivist Learning Theory, which emphasizes active engagement and peer interaction in strengthening understanding.

On the other hand, application-based skills such as solving problems involving permutations (83) and combinations (81) were only rated "Satisfactory," showing that students need more support in applying concepts to complex problem-solving. Nevertheless, the collaborative approach fostered persistence, reduced anxiety, and encouraged peer support, aligning with studies by Hattie (2019) and Johnson and Johnson (2020) that highlight the benefits of social learning in building critical thinking and resilience. While the results confirm the effectiveness of group problem-solving, they also point to the need for teacher training and policy support to fully implement these strategies in Philippine classrooms, especially in light of the country's continued low performance in international assessments like PISA (2022) and TIMSS (2020).

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Table 3.2 Level of Mathematics Performance of Grade 10 Students of Langiden National High School After Using Interactive Games Strategy.

Learning Competencies	Mean (x)	Descriptive Rating (DR)
Illustrates the permutation of objects.	87	Very Satisfactory
Solves problems involving permutations	87	Very Satisfactory
Illustrates the combination of objects.	95	Outstanding
Differentiates permutation from combination of objects taken r at a time	91	Outstanding
Solves problems involving permutations and combinations	89	Satisfactory
Total	**89**	**Very Satisfactory**

Table 3.2 shows strong academic performance of Grade 10 students after applying Interactive Games strategy in Mathematics, with an overall mean of 89 or "Very Satisfactory." Students excelled in illustrating and solving problems on permutations (87), performed even better in competencies on combinations (95) and differentiating permutations from combinations (91), and also achieved a high score in solving problems involving both (89). These results indicate that interactive games enhanced both conceptual mastery and problem-solving skills.

Findings affirm that game-based learning improves engagement, motivation, and collaboration, which translate into higher academic performance. Studies by Johnson and Johnson (2020), Hattie (2021), and Dörnyei and Ushioda (2019) support the role of cooperative, interactive, and peer-driven strategies in strengthening learning outcomes. Notably, success of this approach in a rural school context shows that innovative, student-centered methods like interactive games are practical and effective even with limited resources, offering a powerful way to boost Mathematics learning in Philippine classrooms.

Table 3.3 Level of Mathematics performance of Grade 10 students of Langiden National High School after using the Student – Led Instructions strategy.

Learning Competencies	Mean (x)	Descriptive Rating (DR)
Illustrates the permutation of objects.	86	Very Satisfactory
Solves problems involving permutations	88	Very Satisfactory
Illustrates the combination of objects.	85	Very Satisfactory
Differentiates permutation from combination of objects taken r at a time	74	DNME
Solves problems involving permutations and combinations	79	Fairly Satisfactory
Total	**85**	**Very Satisfactory**

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Table 3.3 shows that Grade 10 students achieved an overall mean score of 85 ("Very Satisfactory") after the use of Student-Led Instructions. Strong results were recorded in solving problems involving permutations (mean = 88), but lower scores were noted in differentiating permutations from combinations (mean = 74, DNME) and in solving combined problems (mean = 79, Fairly Satisfactory). This suggests that while the approach improved participation and basic understanding, it was less effective for more abstract or complex concepts.

These findings indicate that student-led learning works best when supported by teacher guidance. Similar to Johnson and Johnson (2020) and Kumar & Singh (2020), results affirm that cooperative and student-centered strategies enhance engagement, problem-solving, and critical thinking. However, as OECD (2022) noted, challenges remain in Philippine classrooms, making a balanced approach combining student autonomy with targeted teacher support—vital for improving Mathematics performance.

Table 4. Significant Difference Between the Level of Engagement of the Grade 10 Students in Mathematics Class as to Cognitive, Behavioral, Emotional, and Social Among the Three Social Learning Strategies.

Engagement Variable	F-computed	F-critical	F-probability value	Interpretation
1. Behavioral Engagement	5.447**	3.083	0.006 P<0.01	Highly Significant
2. Emotional Engagement	0.999	3.083	0.372 P>0.05	Not Significant
3. Cognitive Engagement	0.255	3.083	0.775 P>0.05	Not Significant
4. Social Engagement	0.733	3.083	0.483 P>0.05	Not Significant
Total	**1.651**	**3.083**	**0.197 P>0.05**	**Not Significant**

Table 4 shows that behavioral engagement differed significantly among the three social learning strategies, with an F-computed value of 5.447 exceeding the F-critical value of 3.083 (p = 0.006). This indicates that collaborative approaches had a strong effect on students' observable behaviors, such as participation, attention, and effort. This supports Johnson and Johnson (2020), who emphasized that peer interaction and group activities foster higher levels of classroom involvement and active learning.

On the other hand, no significant differences were found in emotional, cognitive, social, or overall engagement across the strategies. Students' motivation, mental effort, and peer interaction levels remained consistent regardless of the method used. This outcome aligns with Dörnyei and Ushioda (2019), who noted that emotions in learning are shaped by multiple factors beyond teaching strategy, and with Hidi and Renninger (2019), who stressed the role of prior knowledge and task relevance in sustaining cognitive effort. Johnson and Carter (2020) also

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observed that facilitation and task design can shape peer collaboration, explaining why engagement levels were steady across the different strategies.

Table 5.1 Significant Difference Between the Level of Mathematics Performance of Grade 10 Students of Langiden National High School Before and After Integrating the Social Learning Strategies Using Group Problem Solving Strategy in Teaching-Learning Process.

Learning Competency	t-computed value	t-critical value	t-probability value	Interpretation
1. Illustrates the permutation of objects.	8.971**	1.689	6.7E-11 p<0.01	Highly Significant
2. Solves problems involving permutations	5.594**	1.689	1.32E-06 p<0.01	Highly Significant
3. Illustrates the combination of objects.	9.567**	1.689	1.33E-11 p<0.01	Highly Significant
4. Differentiates permutation from combination of objects taken r at a time	2.168**	1.689	0.018 p<0.01	Highly Significant
5. Solves problems involving permutations and combinations	4.889**	1.689	1.12E-05 p<0.01	Highly Significant
Total	7.835**	1.689	1.65E-09 p<0.01	Highly Significant

Table 5.1 shows a significant improvement in Mathematics performance of Grade 10 students after applying social learning practices, especially in group problem solving. The greatest gains were in illustrating permutations ($t=8.971$, $p<0.01$), solving permutation problems ($t=5.594$, $p<0.01$), and showing combinations ($t=9.567$, $p<0.01$), proving the value of peer discussion and collaboration in strengthening conceptual and procedural skills. While students also improved in differentiating permutations from combinations ($t=2.168$, $p=0.018$), this remained a challenging area requiring more teacher support. Overall, the highly significant cumulative result ($t=7.835$, $p=1.65E-09$) confirmed that collaborative strategies boosted both academic performance and student confidence in Mathematics.

These findings support Hattie's (2019) meta-analyses highlighting cooperative learning as one of the most effective ways to raise achievement. They also respond to national challenges such as low PISA and TIMSS results by presenting group-based instruction as a practical and scalable method for improving Mathematical literacy. By fostering interactive and supportive classrooms, social learning not only enhanced performance but also reduced anxiety and encouraged persistence, offering a strong model for resource-limited schools like Langiden NHS.

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Table 5.2 Significant Difference Between the Level of Mathematics Performance of Grade 10 Students of Langiden National High School Before and After Integrating the Social Learning Strategies Using Interactive Games Strategy in Teaching-Learning Process.

Learning Competency	t-computed value	t-critical value	t-probability value	Interpretation
Illustrates the permutation of objects.	7.665**	1.689	2.7E-09 p<0.01	Highly Significant
Solves problems involving permutations	6.373**	1.689	1.25E-07 p<0.01	Highly Significant
Illustrates the combination of objects.	9.8**	1.689	7.17E-12 p<0.01	Highly Significant
Differentiates permutation from combination of objects taken r at a time	2.711**	1.689	0.005 p<0.01	Highly Significant
Solves problems involving permutations and combinations	7.400**	1.689	5.85E-09 p<0.01	Highly Significant
Total	8.965**	1.689	6.81E-11 p<0.01	Highly Significant

Table 5.2 highlights significant gains across all five competencies after the intervention, with t-values consistently exceeding the critical value at 0.01 level. Students improved in illustrating permutations ($t=7.665$, $p<0.01$), solving permutation problems ($t=6.373$, $p<0.01$), and especially in illustrating combinations ($t=9.800$, $p<0.01$), showing how group activities clarified difficult concepts. Even challenging skills like differentiating permutations from combinations showed progress, while solving integrated problems ($t=7.400$, $p<0.01$) confirmed the positive impact of cooperative learning. These results demonstrate that interactive, peer-supported strategies enhanced both comprehension and confidence, supporting Joshi et al.'s (2022) claim that engagement drives achievement in Mathematics.

Findings align with research emphasizing collaboration as a driver of deeper learning and improved outcomes. Studies by Gutierrez Jr. and Doronio (2024), Hattie (2019), and Webb & Palincsar (2020) affirm that discourse and shared reasoning foster lasting understanding. At the policy level, results support the Philippine K–12 curriculum's goal of developing 21st-century skills (Alonzo & Guanzon, 2020), while addressing weaknesses as revealed in PISA (2022) and TIMSS (2020). Overall, the study shows that collaborative approaches can significantly improve performance in Mathematics, even in resource-limited school settings.

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Table 5.3 Significant Difference Between the Level of Mathematics Performance of Grade 10 Students of Langiden National High School Before and After Integrating the Social Learning Strategies Using Student-Led Instructions Strategy in Teaching-Learning Process.

Learning Competency	t-computed value	t-critical value	t-probability value	Interpretation
1. Illustrates the permutation of objects.	6.274**	1.689	1.68E-07 p<0.01	Highly Significant
2. Solves problems involving permutations	6.984**	1.689	2E-08 p<0.01	Highly Significant
3. Illustrates the combination of objects.	6.555**	1.689	7.21E-08 p<0.01	Highly Significant
4. Differentiates permutation from combination of objects taken r at a time	0	1.689	0.5 p>0.05	Not Significant
5. Solves problems involving permutations and combinations	3.557**	1.689	0.0005 p<0.01	Highly Significant
Total	7.446**	1.689	5.12E-09 p<0.01	Highly Significant

Table 5.3 shows that Grade 10 students' Mathematics performance improved significantly after the implementation of student-led instruction ($t=7.446$, $p<0.01$), particularly in illustrating and solving problems involving permutations and combinations. However, distinguishing between the two concepts remained challenging, as no significant improvement was observed ($t=0$). This suggests that while collaborative strategies enhanced comprehension and application, abstract distinctions may require additional teacher scaffolding. Overall, the findings confirm the effectiveness of student-centered, peer-driven learning in boosting both Mathematical understanding and participation.

These results align with Miller, Perera, and Maghsoudlou (2020), who emphasized the role of self-efficacy and motivation in fostering engagement, and with Webb and Palincsar (2020), who noted that peer discussions and shared strategies deepen comprehension. Similarly, Zhang and Zheng's (2022) meta-analysis highlights how peer-assisted learning improves retention and problem-solving in Mathematics. Taken together, these studies reinforce that student-led instructions promote both engagement and mastery by creating spaces for collaboration, feedback, and shared reasoning though complex abstract skills still benefit from guided teacher support.

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Table 6. Significant Difference Between and Among Level of Performance When Grouped According to Strategy.

Learning Competency	F-computed	F-probability value	Interpretation
1. Illustrates the permutation of objects.	0.635	0.532(p>0.05)	Not Significant
2. Solves problems involving permutations	3.387 *	0.037 (p<0.05)	Significant
3. Illustrates the combination of objects.	3.396 *	0.037 (p<0.05)	Significant
4. Differentiates permutation from combination of objects taken r at a time	4.411 **	0.014 (p<0.01)	Highly Significant
5. Solves problems involving permutations and combinations	5.321 **	0.006 (p<0.01)	Highly Significant
Total	5.352 **	0.006 (p<0.01)	Highly Significant

Table 6 reveals that students' performance in basic skills, such as illustrating permutations (F = 0.635, p = 0.532), did not significantly differ across teaching strategies, suggesting that foundational understanding can be achieved regardless of the method. However, for more complex competencies like solving permutation problems (F = 3.387, p = 0.037), illustrating combinations (F = 3.396, p = 0.037), differentiating between permutations and combinations (F = 4.411, p = 0.014), and solving integrated problems (F = 5.321, p = 0.006), significant differences emerged. The overall ANOVA result (F = 5.352, p = 0.006) confirms that instructional strategies meaningfully affect students' mastery, particularly when tasks demand higher-order reasoning and conceptual clarity.

These findings align with Lamanna et al. (2022), who stress the importance of deliberate instructional design in addressing common student errors in applying permutations and combinations. Similarly, Sarassanti et al. (2023) highlight that misconceptions often stem from confusion about whether order matters, leading to frequent misapplication of formulas. Together, these studies affirm that while any strategy may support basic comprehension, complex mathematical tasks require structured, scaffolded, and interactive approaches to strengthen conceptual understanding and problem-solving accuracy

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Table 6.1. Summary of ANOVA showing the difference between and among level of performance when grouped according to strategy

Social Learning Strategies	Illustrates the permutation of objects.	Solves problems involving permutations	Illustrates the combination of objects.	Differentiates permutation from combination of objects taken r at a time	Solves problems involving permutations and combinations	Overall
Group Problem Solving	84.722	72.396	84.722	83.333	70.635	74.107
Interactive Games	80.556	80.729	93.056	86.111	83.333	82.440
Student-led Instruction	77.778	80.903	76.389	58.333	67.063	76.091
F-value	0.635	3.387*	3.396*	4.411**	5.321**	5.352**
F-prob	0.532 (p>0.05)	0.037 (p<0.05)	0.037 (p<0.05)	0.014 (p<0.01)	0.006 (p<0.01)	0.006 (p<0.01)

Table 6.1 highlights that students' overall Mathematical performance varied significantly depending on the instructional strategy employed, with Interactive Games (M = 82.44) producing the highest scores, followed by Student-Led Instruction (M = 76.09) and Group Problem Solving (M = 74.11). While basic tasks like illustrating permutations showed no significant differences across strategies (F = 0.635, p = 0.532), more complex competencies revealed substantial gaps. Interactive Games consistently outperformed other methods in competencies such as illustrating combinations (F = 3.396, p = 0.037) and solving integrated permutation–combination problems (F = 5.321, p = 0.006), underscoring their effectiveness in fostering higher-order thinking skills. Notably, students struggled most with differentiating between permutations and combinations under Student-Led Instructions, whereas interactive and collaborative strategies provided greater conceptual clarity (F = 4.411, p = 0.014).

These results are reinforced by Ma et al. (2024), whose meta-analysis confirmed the effectiveness of game-based learning in enhancing problem-solving, critical thinking, and reasoning due to its immersive and feedback-driven design. Similarly, Tan and Cheng (2023) emphasized that structured collaborative tasks tailored to students' cognitive strengths enhance peer learning and analytical skills. Putra et al. (2021) further highlighted that HOTS-oriented group activities improve both conceptual understanding and active engagement. Taken together, these studies affirm that interactive, well-structured strategies particularly game-based learning are more effective than traditional or loosely structured methods in strengthening students' higher-order Mathematical competencies.

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Table 7.1 Relationship Between Group Problem Solving Strategy and Level of Engagement

Level of Engagement	Level of Performance using Group Problem Solving					
	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Overall
Behavioral	0.363*	0.443**	0.341*	0.112	0.059	0.779
Emotional	0.238	0.238	0.137	0.151	0.236	0.818
Cognitive	0.236	0.150	0.131	0.126	0.222	0.857
Social	0.268	0.128	0.189	0.056	0.178	0.756
Overall	0.301	0.247	0.219	0.055	0.185	0.865

Table 7.1 shows a strong relationship between social learning strategies and student engagement, with all four dimensions behavioral, emotional, cognitive, and social—positively correlated with performance. Cognitive engagement had the strongest correlation (r = 0.857), indicating that deep thinking, active participation, and meaningful interaction are key drivers of mathematical achievement. The findings suggest that when students are emotionally invested and socially connected in group tasks, they not only stay motivated but also develop higher-order thinking skills essential for tackling complex mathematical problems.

These results are consistent with prior research. Freeman et al. (2020) demonstrated that active, group-based learning significantly improves performance and reduces failure rates compared to traditional lectures. Sofroniou and Poutos (2022) further emphasized that group work fosters critical thinking and builds confidence by allowing students to share reasoning and receive feedback. Similarly, Klang et al. (2021) highlighted that peer acceptance and positive social dynamics encourage persistence and active participation, which in turn enhance academic outcomes. Taken together, these studies affirm that collaborative and socially supportive learning environments strengthen both engagement and achievement in Mathematics.

Table 7.2 Relationship between Interactive Games Strategy and Level of Engagement

Level of Engagement	Level of Performance using Group Problem Solving					
	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Overall
Behavioral	0.035	0.135	0.176	0.080	0.222	0.350*
Emotional	0.034	0.136	0.114	0.049	0.229	0.223
Cognitive	0.110	0.184	0.224	0.066	0.077	0.349*
Social	0.148	0.178	0.436**	0.026	0.226	0.381*
Overall	0.009	0.186	0.272	0.027	0.166	0.374*

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Table 7.2 reveals that behavioral, cognitive, and social engagement are significantly correlated with student performance in group problem-solving, with social engagement showing the strongest overall relationship (r = 0.381*). The link between peer interaction and conceptual understanding was most evident in Topic 3, "Illustrates the combination of objects" (r = 0.436**), highlighting the role of collaboration in grasping abstract mathematical concepts. Emotional engagement, while positively related, was not statistically significant, suggesting its influence may be indirect or context-dependent. These findings imply that strategies such as interactive games that promote participation and peer collaboration can effectively enhance student learning outcomes.

This interpretation aligns with prior studies. Yu et al. (2022) showed that serious games improve student engagement and cognitive outcomes, proving the value of interactive tools in education. Similarly, Jaramillo-Mediavilla et al. (2024) found that embedding features like levels, rewards, and competitions within educational games boosts motivation and achievement. These studies affirm that when games are designed as structured learning methods rather than mere entertainment, they foster deeper engagement and improve performance, consistent with the trends observed in this study.

Table 7.3 Relationship Between Student-Led Instruction Strategy and Level of Engagement

Level of Engagement	Level of Performance using Group Problem Solving					
	Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Overall
Behavioral	0.095	0.097	0.140	0.306	0.005	0.258
Emotional	0.009	0.057	0.088	0.192	0.0166	0.096
Cognitive	0.035	0.082	0.180	0.164	0.006	0.052
Social	0.159	0.044	0.106	0.294	0.065	0.092
Overall	0.013	0.075	0.060	0.261	0.014	0.136

Table 7.3 shows that student-led instructions through group problem solving foster stronger engagement across Mathematical topics involving permutations and combinations. Topic 4, "Differentiates permutations from combinations taken r at a time," recorded the highest correlations in behavioral (r = 0.306) and social (r = 0.294) engagement, suggesting that peer-driven learning is particularly effective for abstract distinctions. Cognitive engagement was most evident in Topic 3 (r = 0.180), indicating that student-led activities help deepen conceptual understanding when students actively explain and negotiate ideas with peers. Overall, results highlight that group problem solving under student leadership promotes active participation, autonomy, and collaboration, especially in conceptually demanding areas.

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These findings align with Palisbo et al. (2025), who demonstrated that collaborative strategies, such as rotation models, significantly improve behavioral and social engagement. Their study emphasized that requiring students to interact, switch roles, and communicate across groups created a more dynamic and motivating environment. This evidence supports conclusion that student-led problem solving not only enhances mathematical comprehension but also strengthens peer learning and classroom interaction, making it an effective approach for tackling complex mathematical concepts.

IV. CONCLUSION

Based on the previous findings of the study, following conclusions were drawn:

1. Before social learning strategies, Grade 10 students' Mathematics performance was generally "Poor";
2. Social learning strategies significantly increased engagement, especially behavioral and social, followed by cognitive engagement;
3. Student performance improved: Group Problem Solving and Student-Led Instructions raised scores to "Poor–Fair," while Interactive Games reached "Satisfactory"; weak areas like permutations and combinations improved from "Poor" to "Satisfactory".;
4. Only behavioral engagement differed significantly among strategies; other engagement types depended on factors beyond the strategy used;
5. Overall, social learning strategies effectively enhanced Mathematical proficiency across all competencies, particularly in permutations and combinations;
6. "Illustrates the permutation of objects" remained unaffected, but other competencies showed significant gains, with overall performance highly improved;
7. Engagement positively correlated with performance, especially cognitive engagement under Group Problem Solving, while other strategies showed meaningful correlations.

V. RECOMMENDATIONS

Based on the conclusions drawn from the study, following recommendations are given:

1. Use all three strategies to improve understanding of permutations and combinations rather than focusing on one method;
2. Continue applying these strategies to sustain or increase engagement in a supportive, interactive learning environment;
3. Integrate strategies regularly, prioritizing Interactive Games for best outcomes, and use the other strategies as complementary tools;

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4. Apply strategies consistently, as they effectively enhance performance even if engagement gains vary;

5. Incorporate collaborative and student-led learning with formative assessments and targeted practice to address difficult competencies;

6. Focus instruction on competencies with significant gains and use blended approaches to maintain engagement across broader learning areas;

7. Align strategies to engagement goals: Group Problem Solving for cognitive, Interactive Games for social/behavioral, and Student-Led Instructions for independent and regular monitoring to optimize results.

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