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Level of Effectiveness of Collaborative Learning Strategy on Mathematical Problem-Solving Among Grade 9 Students at Dapa National High School S.Y. 2025–2026

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Abstract

This study examined the effectiveness of the collaborative learning strategy on the mathematical problem-solving performance of Grade 9 students at Dapa National High School during the School Year 2025–2026. Anchored on the Collaborative Problem-Solving framework and Cooperative Learning Theory, the research employed a quasi-experimental pre-test–post-test design. A total of 83 Grade 9 students were selected using a random sampling technique, ensuring that participants were fairly represented from different sections. A researcher-made test was administered before and after the implementation of collaborative learning activities, including group discussions, peer teaching, and joint problem-solving tasks.

Descriptive statistics such as mean and standard deviation were used to describe students' performance, while the Mann-Whitney U test was applied to determine the significance of the difference between pre-test and post-test scores. Results revealed that students' mean score increased from 13.3 in the pre-test to 29.0 in the post-test, indicating substantial improvement. Statistical analysis showed a significant difference between the two sets of scores ($U = 0.00$, $p < 0.001$), leading to the rejection of the null hypothesis.

The findings concluded that collaborative learning significantly enhanced students' mathematical problem-solving skills and promoted more consistent performance. The study recommends the integration of structured collaborative learning strategies in mathematics instruction to improve academic achievement and critical thinking skills among junior high school students.

Keywords: Collaborative Learning, Mathematical Problem Solving, Quasi-Experimental Design, Grade 9 Students

INTRODUCTION

In the dynamic landscape of 21st-century education, cultivating robust problem-solving skills was paramount for student success, both academically and future professional endeavors (Johnson & Johnson,

2018). However, national and regional assessments in the Philippines have consistently revealed significant challenges in this area, particularly within mathematics education. For instance, the Programme for International Student Assessment (PISA) 2018 results showed that substantial portion of Filipino learners performed below basic proficiency levels in mathematical literacy, indicating a critical need for pedagogical interventions. At the local level, schools in regions like Surigao del Norte faced similar challenges, with Grade 9 students often struggling to apply mathematical concepts to real-world problems and lacking the deep conceptual understanding required for effective problem-solving (Davao Research Journal, 2023).

Department of Education (DepEd) press releases (2019-2020) on the Programme for International Student Assessment (PISA) showed that the Philippine ranked the lowest among 79 participating countries; however, regional results were not published. In contrast, the Caraga NAT results (National Achievement Test) were reported locally. Furthermore, PISA revealed that only 16% of Filipino students achieved at least Level 2 Proficiency in mathematics, compared to an OECD average of 69%. This indicated that the majority of the Filipino learners were significantly struggling with the basic mathematical skills necessary for full participation in society.

Traditional pedagogical approaches that favored rote memorization over conceptual understanding, were identified as a contributing factor to this deficiency (Smith, 2021). In contrast Collaborative learning, a student-centered approach rooted in sociocultural theory, offered a promising alternative.

Many students struggled with mathematical problem-solving due to traditional, teacher-centered approaches that limited active student engagement. Collaborative learning has emerged as a promising strategy to address this issue by encouraging peer interaction and teamwork in solving problems. However, at Dapa National High School, the effectiveness of this approach among Grade 9 students remained unclear. This study aimed to determine how effective collaborative learning was in enhancing the problem-solving skills of these students during the school year 2025–2026, providing insights that could help improve teaching strategies in mathematics.

The Dapa National High School, like many other secondary schools in the Philippines, recognized the importance of improving the mathematical achievement of its junior high school students. As one of the public schools in the division of Siargao, the school faced unique challenges such as limited resources, varying student preparedness, and the need to compete with national and global academic benchmarks. Ensuring that its Grade 9 students acquired strong problem-solving skills in mathematics was central to the school's mission of providing quality education and opportunities for lifelong success.

Given this context, it was essential to examine the level of effectiveness of collaborative learning strategies in enhance the mathematical problem-solving performance of Grade 9 students at the Dapa National High School. While collaborative learning had been widely studied in other contexts, its specific application and outcomes within this institution remained underexplored. By investigating this approach, the study sought to provide evidence-based insights that could inform teaching practices, curriculum development, and policy decisions in the school.

LITERATURE REVIEW

The research examined studies investigating different collaborative learning methods and their effects on student achievement in different educational settings. It took into an account factor that affected effectiveness, including group composition, instructional strategy, evaluation techniques, and particularly in mathematical topics covered. Through the comparison and contrast of findings at various geographical

levels, the review sought to uncover both similarities and differences in the effects of collaborative learning, emphasizing how cultural, socioeconomic, and educational policy variations affected student outcomes.

According to Chen and Yang (2019), study groups and collaborative learning were common in education and had been demonstrated to improve students' performance and learning. The combined and complementary abilities and expertise of a group were helpful in digesting information when addressing the intricate and complex issues that many students faced (Swanson et al., 2019). The cognitive foundations of the relationship between cooperation and learning were considered in order to comprehend how and why group work may was advantageous to students (DeChurch & Mesmer-Magnus, 2017).

We took into account the cognitive foundations of how cooperation interacted with learning in order to better understand how and why group work might assisted students (DeChurch & Mesmer-Magnus, 2017). According to this viewpoint, cooperative projects were successful for a number of reasons. The first was that they helped students who struggled to understand certain information (Zhang et al., 2016). The second was the possibility of improving metacognition and individual performance (Zheng et al., 2019). Lastly, improved students' emotional support during the learning process may aided in resolving certain information-processing problems (Hernandez-Selles et al., 2019).

According to Ahmad and Kusairi (2020) Grade 9 students who engaged in collaborative learning activities showed notable enhancement in their skills to tackle complex mathematical problems when compared to those instructed using traditional lecture approaches. The cooperative method promoted peer engagement, collective knowledge creation, and enhanced motivation, all of which led to better academic outcomes.

Similarly, Grade 11 students in cooperative learning groups outperformed their counterparts in control groups in mathematical problem-solving activities, according to a quasi-experimental study conducted in Thailand by Patarapong et al. (2022). Through peer conversation and cooperative problem-solving, collaborative learning improveda students' critical thinking and problem-solving skills, according to the study.

Furthermore, Alghamdi (2018) investigated how collaborative learning affected Saudi Arabian Grade 11 students' capacity for problem-solving. According to the results, students who were exposed to collaborative learning settings showed more perseverance and confidence when attempting mathematical problems, as well as improved performance on tests measuring problem-solving skills.

Additionally, Chatterjee and Roy (2023) investigated how collaborative learning affected the mathematical reasoning abilities of Grade 11 pupils in India. According to their research, students' conceptual grasp and application of mathematical problem-solving strategies were greatly enhanced by collaborative learning.

Collaborative learning had proven to be an effective teaching approach for enhancing students' mathematical problem-solving skills, especially in upper secondary education. Rooted in social constructivist theory, this method promoted learners to collaboratively build not help them in learning or digesting the new information presented. Additionally, they sometimes lose track of their own questions and the difficulties they were facing with the subject at hand because knowledge through significant interactions with classmates, facilitating a deeper grasp of concepts and improved problem-solving abilities.

Recent studies underscored the global relevance and effectiveness of collaborative learning in mathematics classrooms. A 2024 meta-analysis by Zhang, Stylianides, and Stylianides examined 26 intervention studies focused on mathematical problems posing a skill closely linked to problem-solving.

Their findings revealed that the effectiveness of collaborative strategies was significantly influenced by the structure and duration of the intervention, as well as the learning context, highlighting the need for tailored implementation (Zhang et al., 2024).

In a separate study, Lin et al. (2024) examined the effects of teacher interventions on cooperative problem-solving in high school mathematics in a different study. According to their research, verbal scaffolding such as prompting, questioning, and feedback significantly increased student engagement and higher-order thinking, particularly when it came to challenging group projects. This supported the findings of Zhao et al. (2024), who stressed that sustaining group concentration and ensuring all students contributed significantly depended on effective teacher facilitation.

Moreover, research from Chinese collaborative classrooms revealed that the makeup of a student group affected its performance. While imbalanced academic groups frequently resulted in higher performers dominating, balanced groups typically produced more egalitarian participation (Yang, 2024). Given the prevalence of academic diversity in different Grade 11 classes, this realization was particularly pertinent when implementing collaborative learning.

It had also been demonstrated that structured cooperative tactics, including Team-Assisted Individualization (TAI), improved students' cognitive and problem-solving abilities. TAI showed moderate to high effectiveness in improving working memory and processing speed, according to a study done in the Philippines with Grade 9 students (Lucido & Ubaldo, 2023). Even though the sample consisted of younger pupils, the results indicated that these models could be applied to Grade 11 classes.

Furthermore, a recent book edited by Yeo and Nathan (2024) provided a broad overview of how collaborative problem-solving unfolded in secondary mathematics settings. The book emphasized that cognitive engagement, reflection, and peer feedback were key drivers of group success, particularly when students were encouraged to negotiate meanings and explain their reasoning.

According to Casita (2023), some students found it tiresome to stay focused when studying in a group. Sometimes the conversation shifted away from studying and redirected to casual topics and current events, which affected some students' focus and steered them off track. In this case, studying alone was helpful, especially when students needed to dedicate your undivided attention to the materials at hand.

In addition, group work hindered creativity and efficiency and when activities or exams were approaching efficiency needed to be prioritized. Studying alone gave students time and space to do conduct personalized studying. Also, when alone, could focus freely on certain part because they knew they needed to, and skip other parts that they had already mastered. This allowed them to manage their time wisely and prioritize your tasks.

Additionally, students studied at someone else's pace, whether it was too fast or too slow in a group setting, which did not aid their ability to acquire or assimilate newly introduced material. Furthermore, because most students did not want to break away from the group, they sometimes lose sight of your own ienquiries and any challenges they were experiencing with the material. For students who preferred following a plan and timetable, creating customized study plans usually saved a lot of time.

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personalized studying. Also, when alone, students could focus freely on a certain part because they knew they needed to, and skip other parts that they have already mastered. This allows you to manage your time wisely and prioritize your tasks.

Furthermore, when studying in a group, you might have studied at someone else's pace, whether it is too fast or too slow, which probably did students mostly did not want to diverge from the group. Creating personalized study plans for future references tended to save time, especially if the student preferred to follow plan and a schedule while studying.

Another noteworthy strategy was Collaborative Rotation Learning. Palisbo, Pilvera, and Baluyos (2025) implemented this approach in geometry instruction for lower secondary students and observed significant post-test performance gains, improved engagement, communication skills, time management, confidence, and a more positive classroom atmosphere. These benefits served as indicators of how rotational collaboration could foster robust mathematical reasoning in Grade 11 learners.

Collectively, these recent global studies provided strong evidence that collaborative learning when supported by thoughtful group composition, teacher facilitation, and well-designed tasks, significantly enhanced mathematical problem-solving among Grade 11 students.

In the Philippine educational landscape, a growing body of recent research affirmed the effectiveness of collaborative learning strategies especially peer tutoring and cooperative learning in enhancing mathematical problem-solving. Evidence from Cebu City (SY 2021–2022) demonstrated that one-on-one peer tutoring substantially improved Grade 10 students' post-test performance, with students reporting enhanced comprehension and skill development (Macapayad et al., 2021–2022).

Complementary findings in Mati, Davao Oriental (2025) revealed that junior high peer tutors exhibited high academic motivation, with tutors' engagement strongly linked to their motivation in mathematics (Ompad & Jacobe, 2025).

Collaborative learning approaches have demonstrated encouraging outcomes in enhancing the mathematical problem-solving skills of secondary students in the Philippine education system, especially when they aligned with modern teaching requirements and the use of technology.

A study involving Grade 9–10 learners in Zambales confirmed that cooperative learning led to significantly improved performance on mathematics assessments (Dimatacot & Parangat, 2022). Even at the elementary level, teacher-supported peer tutoring between Grade 6 pupils yielded notable gains in problem-solving performance (Siano, 2025). Collectively, these studies suggested that structured collaborative strategies, including peer tutoring and cooperative learning, not only enhanced academic performance but also bolstered motivation and peer engagement. Timely application and adaptation of these models to Grade 11 classrooms may similarly foster improved mathematical problem-solving competencies.

The choice of collaborative learning activity varied depending on the grade level, classroom dynamics, and specific learning objectives. Teachers often adapted and modified these activities to suit the needs of their students and create an engaging and interactive math learning environment.

Synthesis of the Review: The literature examined indicated that purposeful and contextual implementation of collaborative learning can greatly enhanced Grade 9 students' skills in solving mathematical problems. The findings showed that successful collaboration required not just group engagement but also careful planning regarding instructional methods, alignment of assessments, and fair group dynamics. This synthesis endorsed the incorporation of collaborative learning as an educational strategy appropriate for various learning contexts.

The literature review examined the Level of Effectiveness of Collaborative Learning Strategy on Mathematical Problem-solving among Grade 9 Students in Dapa National High School, with a focus on the student's level of effectiveness, mathematical problem-solving, collaborative learning strategy.

The reviewed literature established that collaborative learning, rooted in social constructivism, significantly improved students' mathematical achievement and problem-solving by promoting peer interaction, critical thinking, and shared responsibility. Studies conducted both internationally and locally confirmed that structured group strategies enhanced accuracy, reasoning, and confidence in mathematics. In the Philippine context, collaborative approaches were shown to increase engagement and mastery of competencies, though most research is focused on junior high levels.

Despite these positive findings, there was limited evidence specifically addressing Grade 9 students in junior high school settings like Dapa National High School. Thus, this study was essential as it bridged the gap by assessing the level of effectiveness of collaborative learning strategies on mathematical problem-solving among Grade 9 learners.

FRAMEWORK OF THE STUDY

The present study was anchored on two major learning theories that highlighted the importance of collaboration in developing students' mathematical problem-solving skills. First, the Collaborative Problem-Solving (CPS) framework, emphasized in the OECD's 2019 PISA assessment, highlighted that learning was enhanced when students actively co-constructed knowledge, shared strategies, and solved problems together through social interaction Second, Johnson and Johnson's Cooperative Learning Theory stressed the five essential elements of effective collaboration, namely: positive interdependence, individual accountability, promotive interaction, social skills, and group processing.

These elements provided a structured learning environment where students supported each other, thereby fostering higher-order reasoning and persistence in so living mathematical tasks (Laal & Ghodsi, 2020; Tran, 2021). This sharing of responsibility allowed students to devote more attention to comprehension and strategy development, particularly in solving complex mathematical problems. Collectively, these theories provided the foundation of the study, showing that collaborative learning enhanced student engagement, cognitive performance, and mathematical reasoning.

This study was anchored on the idea that teaching strategies significantly influenced the development of students' problem-solving skills in mathematics. In particular, the study compared the effectiveness of the traditional learning strategy with that of the collaborative learning strategy to enhance mathematical problem-solving among Grade 9 students at Dapa National High School.

The independent variable of the study was the collaborative learning strategy, which included approaches such as group discussions, peer teaching, joint problem-solving tasks, and cooperative learning activities. These strategies aimed to foster active participation, peer interaction, and shared responsibility in learning.

The dependent variable was the level of effectiveness in solving mathematical problem-solving skills. This was measured based on students' ability to: (1) understand the problem, (2) devise a plan, (3) carry out the plan, and (4) evaluate the solution. These components reflected the systematic process of mathematical problem-solving as described by Polya's framework.

Although the focus of the study was on the influence of collaborative learning, it was acknowledged that several factors may have intervened in the teaching-learning process. These include student motivation, quality of peer interaction, teacher facilitation, and group dynamics. Such elements may have enhanced or hindered the effectiveness of collaborative learning strategies.

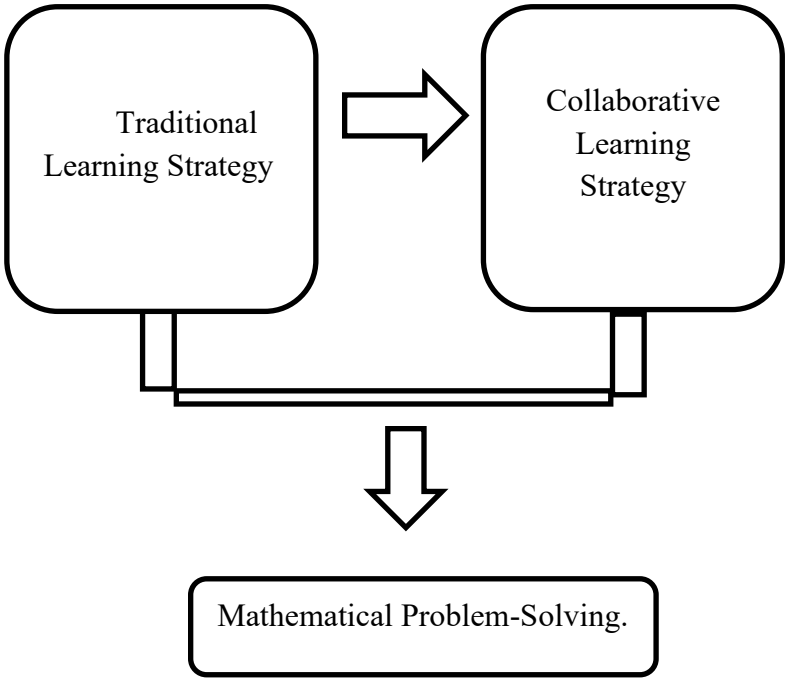
The schematic diagram (Figure 1) illustrated the flow of the study. The first box, Traditional Learning Strategy, represented the conventional method of teaching where the teacher delivered the lesson directly, and students were mostly passive recipients of knowledge. In this study, its function was to serve as the baseline or point of comparison to determine whether collaborative learning strategies provided greater effectiveness in developing mathematical problem-solving skills.

The second box, Collaborative Learning Strategy, illustrated the main focus of the research. It involved interactive methods such as group discussions, peer teaching, cooperative activities, and joint problem-solving tasks. The function of this box was to determine the use of collaborative techniques in fostering active student participation and shared responsibilities in learning. Through these strategies, the study sought to find out whether students could perform better in solving mathematical problems compared to when they were taught using traditional methods.

On the third box, Mathematical Problem-Solving, served as the core of the study since it was through problem-solving activities that both strategies were applied. This box functioned as the stage where students demonstrated their ability to understand the problem, devise a plan, execute the plan, and evaluate the solution. It was in this process that the effectiveness of the chosen instructional approach was tested.

The fourth box, is the Pre-test/Post-test, functioned as the measurement tool of the study. A pre-test is administered before the collaborative learning strategy was implemented in order to establish the students' initial level of problem-solving skills. After the intervention, a post-test was given to determine any improvement in their performance. The results of both tests provided quantifiable evidence of whether collaborative learning was more effective than the traditional strategy.

Finally, the fifth box is the Recommendation, represented the outcome of the research. Based on the findings from the pre-test and post-test results, recommendations were formulated by the researchers. The function of this box was to provide practical and evidence-based suggestions that may enhanced the teaching of mathematics, particularly in the application of collaborative learning strategies to improve problem-solving skills.



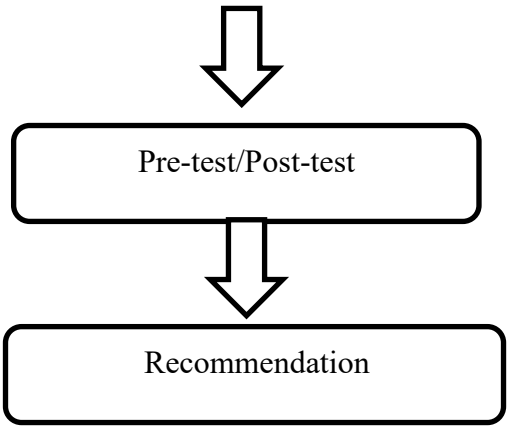


Figure 1. The Schematic Diagram of the Study

RESEARCH QUESTION:

This study aimed to determine the level of effectiveness of the collaborative learning strategy on the mathematical problem-solving performance of Grade 9 students at Dapa National High School. Specifically, it sought to answer the following questions:

1. What is the pre-test performance of Grade 9 students in mathematical problem-solving before the use of the collaborative learning strategy?
2. What is the post-test performance of Grade 9 students in mathematical problem-solving after the use of the collaborative learning strategy?
3. What is the level of learning performance of grade 9 students in teaching mathematics into collaborative learning and traditional lecture based on their post-test and pre-test?
4. Is there a significant difference in the mathematical problem-solving performance of Grade 9 students before and after the implementation of the collaborative learning strategy?

METHODOLOGY:

This chapter presented the research design, research environment, respondents, research instrument, experimental procedure, and data analysis employed during the investigation.

Research Design

This study employed a quasi-experimental design, specifically the pre-test–post-test design, to determine the effectiveness of collaborative learning strategies on the mathematical problem-solving performance among Grade 9 students. Two different strategies were conducted for this study: one served as the experimental group, which learned through collaborative activities such as group problem-solving and idea-sharing, while the other served as the control group, which continued with the usual method of teaching.

Before the intervention, the students took the same pretest to assess their initial level of performance. After days of instruction, the groups took a post-test to determine any improvements. The scores from the pre-test and post-test were compared to establish whether the students in the collaborative learning group performed better than those in the traditional class. This design will help the researchers measure the effect of collaborative learning while ensuring that the results were fair and reliable.

Respondents of the Study

This study involved Grade 9 students who were officially enrolled at the Dapa National High School for the school year 2025–2026. To ensure that the sample truly represented the diversity of the population,

the researcher employed a random sampling technique. Through this method, participants were carefully selected from different groups within the Grade 9 level, allowing each section to be fairly represented in the study.

Table 1. Distribution of Respondents

Respondent	Frequency (n=83)	Percentage (%)
Hawking	43	52%
Calvin	40	48%
TOTAL	83	100%

The table presents the distribution of the respondents involved in the study. Out of the total sample size of 83 Grade 9 students, 43 students or 52% were from the Hawking section, while 40 students or 48% were from the Calvin section.This distribution shows that the two groups were nearly equal in number, with only a minimal difference of three respondents. Such a balanced grouping is important in a quasi-experimental study, as it helps ensure fairness and comparability between the groups exposed to different instructional strategies.The almost equal proportion of respondents from both sections suggests that the data gathered are reliable and not biased toward one group. This balance strengthens the validity of the comparison between collaborative learning and traditional teaching approaches, allowing for a more accurate assessment of their effects on students' mathematical problem-solving performance.**Research Environment**The Dapa National High School served as the environment of this study. The school stood as a vital educational institution in the province, committed to providing quality education that nurtured both academic excellence and character formation. Situated in Barangay 6, poblacion Dapa, Surigao del Norte, the school played a significant role in shaping future leaders, particularly in the fields of science, technology, and education. Its strong dedication to improving teaching and learning practices made it an ideal environment for research on innovative strategies such as collaborative learning. By serving as a research site, the institution contributed to advancing knowledge in mathematics education but also strengthened its reputation as an institution that fosters creativity, problem-solving, and lifelong learning skills essential for success in the 21st century.**Research Instrument**This study utilized two instructional approaches-traditional teaching and collaborative learning strategy--to assess the effectiveness of collaborative learning strategy on mathematical problem-solving. The instrumentation in this study included a pre-test and post-test. The post-test was parallel to the pre-test and was administered to measure whether students' performance changed over time as a result of the treatment, particularly the implementation of the collaborative learning strategy. The primary aim of this test is to reveal the level of learning achievement of the students. The test results were to determine the level of learning achievement of the students. The test results from the different periods were compared to identify improvements in mathematical problem-solving skills.The instructional materials consisted of two (2) semi-detailed lesson plans covering two (2) different topics. For each topic, instruction was delivered using two approaches: one lesson plan applied collaborative learning strategy, while the other applied traditional method of teaching.**Data Gathering Procedure**The following steps were undertaken for the experimentation of this study:First, the researchers sent a formal letter of request to the principal and Grade 9 Math subject teacher of Dapa National High School seeking permission to conduct the study on the effectiveness of collaborative learning strategy in enhancing students' mathematical problem-solving skills.

Upon approval of the request, the researchers conducted the instructional intervention. Two of the researchers served as a teacher during the implementation of the lessons to control potential variability in teaching style and instructional delivery.

Prior to the conduct of the study, the researchers visited the research site to coordinate and finalize the schedule administering the pre-test, delivering the instructional treatments, and conducting the post-test. The schedule for the class discussions and testing sessions was arranged in coordination with the subject teacher to ensure minimal disruption to regular academic activities.

Table 2. Grant Chart

List of Activities	Date	Class	Lesson	Teaching Strategy
Preparation of Materials	November 2025			
Sending letter of Request	November 2025			
First Session	December 01,2025	Hawking	Direct Variation	Traditional Teaching
Second Session	December 01,2025	Calvin	Direct Variation	Collaborative Strategy
Third Session	December 02,2025	Calvin	The sum and the product of roots of quadratic equations	Traditional Teaching
Fourth Session	December 02,2025	Hawking	The sum and the product of roots of quadratic equations	Collaborative Strategy

The table presents the schedule of activities conducted during the implementation of the study from November to December 2025. It begins with the sending of the letter of request in November 2025, which served as the initial step to secure permission and coordinate with the school administration prior to the conduct of the research.

The instructional sessions were carried out on December 1 and 2, 2025, involving two Grade 9 sections, Hawking and Calvin. During the first session on December 1, 2025, the Hawking section was taught the topic on Direct Variation using the traditional teaching approach, while the Calvin section was taught the same topic using the collaborative learning strategy. This parallel implementation ensured that both groups were exposed to the same content but through different instructional methods.

On December 2, 2025, the instructional strategies were alternated. The Calvin section received instruction on the topic "Sum and Product of the Roots of Quadratic Equations" using the traditional teaching method, while the Hawking section was taught the same topic using the collaborative learning strategy. This rotation of teaching strategies helped control possible group bias and ensured that both sections experienced both instructional approaches.

Overall, the schedule demonstrates a systematic and balanced implementation of the experimental procedure. By alternating the teaching strategies across topics and groups, the researchers were able to maintain consistency, fairness, and reliability in comparing the effectiveness of collaborative learning and traditional teaching on students' mathematical problem-solving performance.

At the initial stage of the experimental 10-item researcher-made covering both traditional and collaborative instructional was administered to the two sections of students as pre-test. The pre-test aimed to determine the students' prior knowledge and readiness for the course of study.

After the administration of pre-test, the researchers implemented the instructional interventions anchored on the designated teaching strategies. The post-test was administered after the discussion of session covering the two set of topics. The topics and instructional strategies-traditional and collaborative teaching-were alternately administered to the two sections of Regular Grade 9 students in Dapa National High School.

During the first session, instruction was conducted in section (Section Hawking) using the traditional teaching approach for the topic on direct variation. The teacher introduced the lesson and elicited students' prior knowledge by asking guide questions related to Direct Variation. The discussion activated students' prior knowledge, incorporated real-life situations, and localized activities to make the lesson more meaningful and contextualized.

After the implementation of the traditional strategy in the first section, the collaborative learning strategy was implemented in the second section to determine differences in students' mathematical problem-solving performance. The same procedure was followed in the subsequent sets of lessons to maintain consistency in the experimental process.

Under the traditional teaching approach, the teacher applied a conventional method of instruction characterized primarily by lecturing and a question-and-answer format. This approach was teacher-centered, wherein students listened to the discussion of the lesson with limited interaction until conclusion.

Both instructional strategies-traditional teaching and collaborative learning-were alternately implemented in the two sections of the Grade 9 Regular class. The lessons covered during the intervention included Direct Variation and the Sum and Product of the Roots of Quadratic Equations.

Finally, after the completion of the experimentation, the researchers collected, tailed, analyzed, and interpreted the results of the pre-test and post-test to determine the effectiveness of the two instructional strategies on students' mathematical problem-solving performance.

Data Analysis

The researchers utilized the following statistical tools in analyzing the data gathered from the study:

Mean & Standard Deviation. These descriptive statistical measures were used to summarize and describe the students' performance in both the pre-test and post-test. The mean determined the average score of the students, while the standard deviation measured the variability or dispersion of the score.

T-test. The t-test was employed to determine whether there was a statistically significant difference in learning performance between the collaborative learning strategy and the traditional method of teaching. This test helped assess whether the observed differences in mean scores were significant.

Mann–Whitney U Test. This was used to determine whether there is a significant difference in the level of learning performance between the two independent groups. This nonparametric test compares the scores of the groups without assuming a normal distribution, providing a reliable measure of differences in their performance.

RESULTS AND DISCUSSION

This chapter presents the results and discussion of the study. The presentations based on how the problem is arranged and stated in chapter one.

Table 1. Pre-test and post-test performance of Grade 9 students in mathematical problem-solving before and after the use of the collaborative learning strategy.

	Group	N	Mean	Median	SD	SE
Performance of the Students	Post-test	83	29.0	30.0	1.37	0.150
	Pre-test	83	13.3	15.0	3.72	0.408

The results in Table 1 showed a clear difference between the pre-test and post-test performance of Grade 9 students in mathematical problem-solving after the use of the collaborative learning strategy. The pre-test mean score of 13.3 indicated that students initially had a low level of problem-solving proficiency, suggesting difficulty in understanding and applying mathematical concepts. This supports the findings of Chen and Yang (2019), who stated that students often struggle with complex tasks when learning individually due to limited cognitive support.

In contrast, the post-test results demonstrated a significant improvement in student performance. The mean score increased dramatically to 29.0, more than double the pre-test mean, with a median of 30.0, showing that most students performed very well after the implementation of the collaborative learning strategy. The post-test standard deviation of 1.37 was much smaller than that of the pre-test, indicating that the students' scores became more consistent. The smaller standard error of 0.150 further suggested that the post-test mean was a reliable indicator of overall student performance. This finding is consistent with Ahmad and Kusairi (2020), who found that students engaged in collaborative learning showed notable improvement in solving mathematical problems compared to those taught using traditional methods.The data implied that the collaborative learning strategy had a substantial positive impact on the students' mathematical problem-solving skills. The increase in the mean and median, along with the reduced variability in scores, indicated not only an overall improvement but also that the strategy helped students achieve a more uniform level of understanding. Students likely benefited from peer discussions, shared problem-solving approaches, and collaborative engagement, which enhanced their comprehension and application of mathematical concepts.These findings had important implications for teaching practice. They suggested that incorporating collaborative learning strategies in mathematics classrooms could significantly improve students' problem-solving abilities. Teachers could consider using group-based problem-solving sessions, structured peer discussions, and collaborative exercises to foster critical thinking and conceptual understanding. Additionally, the consistent improvement across most students indicated that collaborative learning helped bridge gaps in understanding, making it an effective instructional approach for enhancing performance in challenging subject areas like mathematics. The results revealed a significant improvement in the mathematical problem-solving performance of Grade 9 students after the implementation of the collaborative learning strategy. The increase in the mean score from 13.3 in the pre-test to 29.0 in the post-test indicates that students developed better understanding and application of mathematical concepts through collaborative activities. This finding supports the study of **Ahmad and Kusairi (2020)**, who reported that students exposed to collaborative learning demonstrated enhanced ability to solve complex mathematical problems compared to those taught using traditional methods.Similarly, the improvement in students' performance aligns with the findings of **Patarapong et al. (2022)**, who found that learners in cooperative learning groups performed significantly better in

mathematical problem-solving tasks due to active engagement and peer interaction. The collaborative environment allowed students to exchange ideas, clarify misconceptions, and develop effective problem-solving strategies.Moreover, the reduced standard deviation in the post-test scores suggests more consistent performance among students. This supports the claim of **Chen and Yang (2019)** that collaborative learning helps students process complex information more effectively through shared cognitive support, leading to improved and more uniform learning outcomes The statistically significant difference ($U = 0.00$, $p < 0.001$) further confirms that the observed improvement was not due to chance. This result is consistent with the findings of **Chatterjee and Roy (2023)**, who emphasized that collaborative learning significantly enhances students' conceptual understanding and mathematical reasoning skills.In addition, the results are supported by **Hernandez-Selles et al. (2019)**, who highlighted that collaborative learning promotes metacognition and problem-solving abilities by encouraging students to reflect, explain, and justify their answers during group interactions. This process likely contributed to the improved performance observed in the post-test. Overall, the findings of this study are strongly supported by both local and international literature, confirming that collaborative learning is an effective instructional strategy for enhancing mathematical problem-solving skills among students.

II. Comparative analysis between pre-test and post-test performance of grade 9 students in mathematical problem-solving before the use of the collaborative learning strategy.

Independent Samples T-Test

Table 2. Independent Samples T-Test on the performance of Grade 9 students in mathematical problem-solving before and after the use of the collaborative learning strategy.

Variable	Statistical Test	Statistic	p
Performance of the Students	Mann-Whitney U	0.00	Less than 0.001

Note. H_a $\mu_{Post\text{-}test} \neq \mu_{Pre\text{-}test}$

The results in Table 2 showed the statistical analysis of the performance of Grade 9 students in mathematical problem-solving before and after the use of the collaborative learning strategy. The Mann-Whitney U test was employed to compare the pre-test and post-test scores, yielding a U value of 0.00 and a p-value of less than 0.001. This indicated a statistically significant difference between the students' performance before and after the implementation of the collaborative learning strategy. The result supported the alternative hypothesis that the mean post-test score was not equal to the mean pre-test score.The extremely low p-value suggested that the improvement in performance was highly unlikely to have occurred by chance. This confirmed that the collaborative learning strategy effectively enhanced the students' mathematical problem-solving skills. The use of a non-parametric test like the Mann-Whitney U was appropriate, as it accounted for any potential non-normal distribution of the data, ensuring that the comparison between the two sets of scores was valid.These findings implied that collaborative learning had a significant impact on student achievement. The statistical significance aligned with the observed improvement in mean scores from the pre-test to the post-test, indicating that students benefited from the strategy in a measurable way. It suggested that collaborative learning facilitated better understanding, problem-solving techniques, and engagement among students, contributing to a higher level of academic performance.The results also had implications for instructional practice. Teachers were encouraged to incorporate collaborative learning activities in their mathematics classrooms to improve student

performance. The clear statistical evidence supported the integration of group-based problem-solving, peer collaboration, and discussion-driven learning as effective pedagogical tools. Additionally, the findings suggested that structured collaborative learning could be a reliable strategy to enhance the overall academic proficiency of students in mathematical problem-solving.

CONCLUSION AND RECOMMENDATION

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

1. Grade 9 students initially demonstrated low proficiency in mathematical problem-solving prior to the implementation of the collaborative learning strategy.
2. The implementation of collaborative learning strategies significantly improved students' mathematical problem-solving performance.
3. There is a statistically significant difference between the pre-test and post-test scores; therefore, the null hypothesis is rejected.
4. Collaborative learning is an effective instructional approach for enhancing mathematical reasoning, engagement, and overall academic performance among Grade 9 students.
5. Based on these conclusions, collaborative learning may be considered a viable and evidence-based pedagogical strategy in teaching mathematics at Dapa National High School

Recommendations

Based on the findings, the following are recommendations:

1. Mathematics teachers are encouraged to integrate structured collaborative learning strategies such as group problem-solving, peer teaching, cooperative activities, and guided discussions into their classroom instruction to enhance students' mathematical problem-solving skills.
2. School administrators may provide professional development programs, seminars, and workshops focused on effective implementation of collaborative learning strategies in mathematics instruction.
3. Curriculum planners may incorporate collaborative learning approaches into the mathematics curriculum to promote active learning, critical thinking, and higher-order reasoning skills.
4. Students are encouraged to actively participate in collaborative activities to strengthen their communication skills, teamwork, confidence, and analytical abilities.
5. Future researchers may conduct similar studies with larger samples, extended duration of intervention, or across different grade levels and subject areas to further validate and expand the findings of this study.

REFERENCES:

1. Ahmad, A., & Kusairi, S. (2020). The effect of collaborative learning on mathematical problem-solving among Grade 9 students. *International Journal of Learning, Teaching and Educational Research, 19*(8), 78–92. https://doi.org/10.26803/ijlter.19.8.5
2. Alghamdi, A. (2018). The impact of collaborative learning on mathematical problem-solving performance among Saudi secondary students. *International Education Studies, 11*(5), 98–108. https://doi.org/10.5539/ies.v11n5p98
3. Casita, L. (2023). The benefits and drawbacks of group versus individual study among college students. *Philippine Journal of Education Research, 12*(2), 155–162.
4. Chandler, P. (2023). Cognitive load and collaborative learning: Revisiting theory and practice. *Educational Psychology Review, 35*(1), 45–60. https://doi.org/10.1007/s10648-022-09701-4

5. Chatterjee, A., & Roy, S. (2023). Collaborative learning and mathematical reasoning skills: An experimental study with Indian high school students. *Journal of Educational Research and Practice, 13*(4), 112–125.
6. Chen, X., & Yang, Y. (2019). Collaborative learning and student achievement: A review of literature. *International Journal of Instruction, 12*(3), 977–994. https://doi.org/10.29333/iji.2019.12359a
7. Davao Research Journal. (2023). Performance gaps in mathematics education in Caraga Region: A review of NAT results. *Davao Research Journal, 15*(2), 67–74.
8. DeChurch, L. A., & Mesmer-Magnus, J. R. (2017). The cognitive underpinnings of effective teamwork: A meta-analysis. *Journal of Applied Psychology, 102*(7), 1081–1103. https://doi.org/10.1037/apl0000185
9. Department of Education (DepEd). (2019–2020). *Press release: Results of PISA 2018*. Department of Education Philippines.
10. Dimatacot, G. T., & Parangat, K. B. (2022). Effectiveness of cooperative learning on the academic performance in mathematics of junior high school students in the Philippines. *International Journal of Computer Engineering in Research Trends, 9*(2), 51–58. https://ijcert.org
11. Hernandez-Selles, N., Gonzalez-Sanmamed, M., & Muñoz-Carril, P. C. (2019). The impact of collaborative learning on metacognition and problem-solving skills. *Educational Technology Research and Development, 67*(2), 289–306. https://doi.org/10.1007/s11423-018-9626-y
12. Johnson, D. W., & Johnson, R. T. (2018). *Joining together: Group theory and group skills* (12th ed.). Pearson.
13. Kalyuga, S., & Sweller, J. (2021). Cognitive load theory: A special issue of *Educational Psychology Review*. Springer. https://doi.org/10.1007/s10648-020-09571-1
14. Laal, M., & Ghodsi, S. M. (2020). Benefits of collaborative learning. *Procedia – Social and Behavioral Sciences, 31,* 486–490. https://doi.org/10.1016/j.sbspro.2011.12.091
15. Lin, F., Zhao, D., & Zhang, L. (2024). Collaborative problem solving in mathematics classrooms: The role of teacher intervention. *Behavioral Sciences, 15*(3), 377. https://doi.org/10.3390/bs15030377
16. Lucido, R., & Ubaldo, R. A. (2023). The effectiveness of cooperative learning in the course of mathematic problem solving. *ResearchGate*.
17. Macapayad, G. L., Lapinid, E. L., Valmoria, G. P., Colis, K. V., & Bacalso, L. (2021–2022). Efficacy of one-on-one peer tutoring in improving the problem-solving performance among Grade 10 learners. *European Journal of Education Studies*.
18. Ompad, L. C., & Jacobe, D. O. (2025). The relationship between peer tutoring experience and the academic motivation of junior high school students in mathematics. *Asian Journal of Education and Social Studies, 51*(6), 934–949.
19. Organisation for Economic Co-operation and Development (OECD). (2019). *PISA 2018 assessment and analytical framework: Mathematics, reading, science and financial literacy*. OECD Publishing. https://doi.org/10.1787/b25efab8-en
20. Palisbo, J. T., Pilvera, E. D., & Baluyos, G. R. (2025). Implementing collaborative rotation strategy in teaching geometry to enhance class engagement. *International Journal of Research and Innovation in Social Science, 8*(12), 1254–1265.
21. Patarapong, N., Saengpakdeejit, R., & Jirasatjanukul, K. (2022). Collaborative learning and problem-solving in Thai high school mathematics: A quasi-experimental study. *Journal of Education and Practice, 13*(18), 55–64.

22. Smith, J. (2021). Rote memorization versus conceptual understanding in math classrooms. *Journal of Mathematics Education, 14*(3), 201–215.
23. Swanson, E., Vaughn, S., & Roberts, G. (2019). The role of group collaboration in reading and mathematics interventions. *Journal of Learning Disabilities, 52*(3), 212–224. https://doi.org/10.1177/0022219418821029
24. Tran, V. D. (2021). Cooperative learning: A pathway to effective teaching. *International Journal of Higher Education, 10*(2), 27–35.
25. Yang, M. (2024). Interaction patterns in heterogeneous math groups: A study of equitable participation. In J. Yeo & M. Nathan (Eds.), *Students' collaborative problem solving in mathematics classrooms* (pp. 123–142). Springer. https://doi.org/10.1007/978-981-99-7386-6_8
26. Yeo, J., & Nathan, M. (Eds.). (2024). *Students' collaborative problem solving in mathematics classrooms*. Springer. https://doi.org/10.1007/978-981-99-7386-6
27. Zhang, L., Stylianides, G. J., & Stylianides, A. J. (2024). A meta-analysis of interventions to enhance students' mathematical problem posing competence. *International Journal of STEM Education, 11*(10). https://doi.org/10.1186/s40594-024-00507-1
28. Zhang, Y., Ding, L., & Chen, X. (2016). Cooperative learning and low-achieving students: Benefits and challenges. *Asia Pacific Education Review, 17*(4), 637–650. https://doi.org/10.1007/s12564-016-9458-6
29. Zhao, D., Lin, F., & Huang, R. (2024). Facilitating high-level group interactions: Teacher guidance in collaborative problem solving. In J. Yeo & M. Nathan (Eds.), *Students' collaborative problem solving in mathematics classrooms* (pp. 199–214). Springer. https://doi.org/10.1007/978-981-99-7386-6_10
30. Zheng, B., Niiya, M., & Warschauer, M. (2019). Collaborative learning and metacognition: Investigating online discussion forums. *Journal of Educational Computing Research, 57*(8), 1996–2018. https://doi.org/10.1177/0735633118820382