

# Influence of Collaborative Learning on Mathematics Comprehension of Grade 10 Students

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**Abstract:** Mathematics comprehension continues to be a challenge among Filipino students, as reflected in recent international assessments that show low proficiency levels. This study investigated the effect of collaborative learning on the mathematics comprehension of Grade 10 students at Sto. Rosario National High School, focusing on the topic of permutations. Using a quasi-experimental design, the researchers compared two groups: 22 students engaged in collaborative learning strategies, and 22 students taught using traditional methods. Pre-tests and post-tests were administered to assess the impact of the intervention. Statistical analysis of the results showed no significant difference in the performance of both groups, suggesting that the collaborative approach did not produce measurable improvement in students' comprehension of mathematical concepts. The findings highlight the importance of evaluating not just the method, but also its implementation, duration, and alignment with student needs. The study contributes to mathematics education by offering insights into the challenges of applying collaborative learning and the importance of refining instructional approaches to enhance learning outcomes.

**Keyword:** *Collaborative Learning; Grade 10; Mathematics comprehension; and Quasi-experimental*

## Introduction

Mathematics comprehension is a fundamental skill that underpins academic success in various educational and professional fields, yet many Grade 10 students continue to face challenges in mastering this subject. According to the 2023 Programme for International Student Assessment (PISA) report by the Organisation for Economic Cooperation and Development (OECD), the Philippines showed only a slight improvement in math scores—from 353 points in 2018 to 355 in 2022. Despite this marginal increase, Filipino students remain well below the global average. Notably, only 16 percent of students achieved Level 2 proficiency, indicating that most are unable to solve basic mathematics problems without explicit guidance. These figures highlight the persistent gap in mathematical understanding among Filipino learners.

To address these challenges, previous studies have explored various interventions aimed at improving student engagement and learning outcomes in mathematics. Digital tools, for instance, have been examined for their potential to support flexible and personalized learning. Santos (2022) conducted a comparative analysis of mobile applications for college-level

mathematics, noting how features such as intuitive interfaces, real-time problem solving, and visual support contributed to students' grasp of mathematical concepts. Although promising, such technology-based strategies are typically individualized and may not address the social dimensions of learning.

Similarly, Skovsmose (2020) emphasized that while digital technologies offer procedural support and visualization, their impact is maximized when paired with pedagogical strategies that promote collaboration and discourse. Likewise, Boucheix and Schneider (2009) found that although multimedia tools improve mathematical concept retention, student interaction and verbal explanation are key in achieving deeper comprehension.

Recent work has also emphasized the influence of classroom strategies on academic performance. Effective classroom management and equitable output distribution were shown to positively affect student engagement and learning behavior, although academic outcomes were shaped by a broader set of factors beyond classroom control (Lajom et al., 2023). Similarly, peer influence, teacher quality, and learning infrastructure were identified as significant contributors to performance and motivation among senior high school students (Cordova et al., 2022).

In support of these findings, Slavin (2014) reported that cooperative learning strategies such as STAD and peer tutoring improved not only student achievement but also attitudes toward mathematics. Furthermore, Gillies (2016) highlighted that students in well-structured collaborative groups develop stronger problem-solving skills and greater persistence when working through mathematical challenges.

Building on these insights, research has shown that collaborative learning—where students work together in groups—can lead to better learning outcomes. Gray (2024) and Kumar (2017) suggest that when students share ideas and support each other in a safe and respectful environment, their understanding and thinking skills improve. Vygotsky's theory (1978), known as the Zone of Proximal Development, also supports the idea that students learn more effectively when guided by peers or more knowledgeable individuals. Despite these theoretical underpinnings and successful implementations of group-based strategies, studies focusing on collaborative learning have yet to fully explore its specific effect on mathematics comprehension, particularly within the Philippine context.

Furthermore, some researchers, such as Virgana (2019), have explored group-based methods like the Student Teams-Achievement Divisions (STAD) model and found positive effects on students' understanding of mathematics concepts. Ahmad and Dogar (2023) suggests further research on collaborative learning's effectiveness in improving learners' conceptual understanding of Mathematics, identifying best practices, and ensuring efficient resource utilization. Furthermore, Siswanto and Susetyawati (2024) recommended future researchers apply other cooperative learning models to improve students' ability to understand concepts. Therefore, the researchers came up to explore the influence of collaborative learning on the mathematics comprehension of grade 10 students.

The study is anchored to collaborative learning theory by Lev Vygotski. The survey of Sotto (2021) defines collaborative learning as an approach to teaching and learning that involves a group of learners working together. Collaborative learning builds on what we know about the social nature of learning and how students construct knowledge. The basic idea is to promote active learning in ways not possible with highly competitive or individualized learning models.

Collaborative learning allows the creation and innovation of knowledge through group interaction and the active participation of each member. In collaborative learning, the students will study as a group to solidify Mathematics comprehension by utilizing each other's knowledge and experience (Mubireek, 2021).

The intervention used a structured collaborative learning approach rooted in Lev Vygotsky's social constructivist theory, focusing on peer interaction and shared learning to strengthen Grade 10 students' understanding of Mathematics. Instead of relying on traditional, individual learning methods, students worked in small, guided groups to discuss, explain, and solve problems together, encouraging deeper comprehension through social support. A key feature of this approach was the use of pre- and post-assessments to customize activities based on students' initial understanding and to track their progress. By combining formative assessment with collaborative engagement, the strategy fostered active participation, critical thinking, and peer learning, proving more effective in reinforcing mathematical concepts than conventional lecture-based methods.

This study investigated the influence of collaborative learning on Mathematics comprehension of grade 10 students of Sto. Rosario National High School, by answering the following problems:

1. How may the Mathematics comprehension of the experimental group under collaborative learning be described in terms of:
  - 1.1. Pre-Assessment Scores; and
  - 1.2. Post-Assessment Scores?
2. How may the Mathematics comprehension of the control group under traditional learning be described in terms of:
  - 2.1. Pre-Assessment Scores; and
  - 2.2. Post-Assessment Scores?
3. Is there a significant difference between the Pre-assessment Scores and Post-assessment Scores of the experimental group?
4. Is there a significant difference between the Pre-assessment Scores and Post-assessment Scores of the control group?
5. Is there a significant difference between the Mathematics comprehension of the control group and the experimental group?
6. What action plan may be proposed to improve the Mathematics comprehension of grade 10 students?

The proposed intervention, centered on collaborative learning strategies, is designed to create a more engaging and interactive classroom environment that addresses students' difficulties in understanding mathematical concepts. While the study found no immediate significant effect, the intervention still offers potential long-term benefits. Collaborative learning encourages students to explain their thinking, ask questions, and learn from their peers, which can help deepen comprehension over time. Collaborative learning also supports the development of essential skills such as communication, critical thinking, and teamwork. These benefits may not always be reflected in short-term test scores but can lead to long-term improvement in student engagement and comprehension. For teachers, this strategy offers a flexible and student-centered method that can complement traditional instruction.

## Methods

This study employed a quasi-experimental research design to determine the causal relationship between the collaborative learning intervention (independent variable) and students' mathematics comprehension (dependent variable).

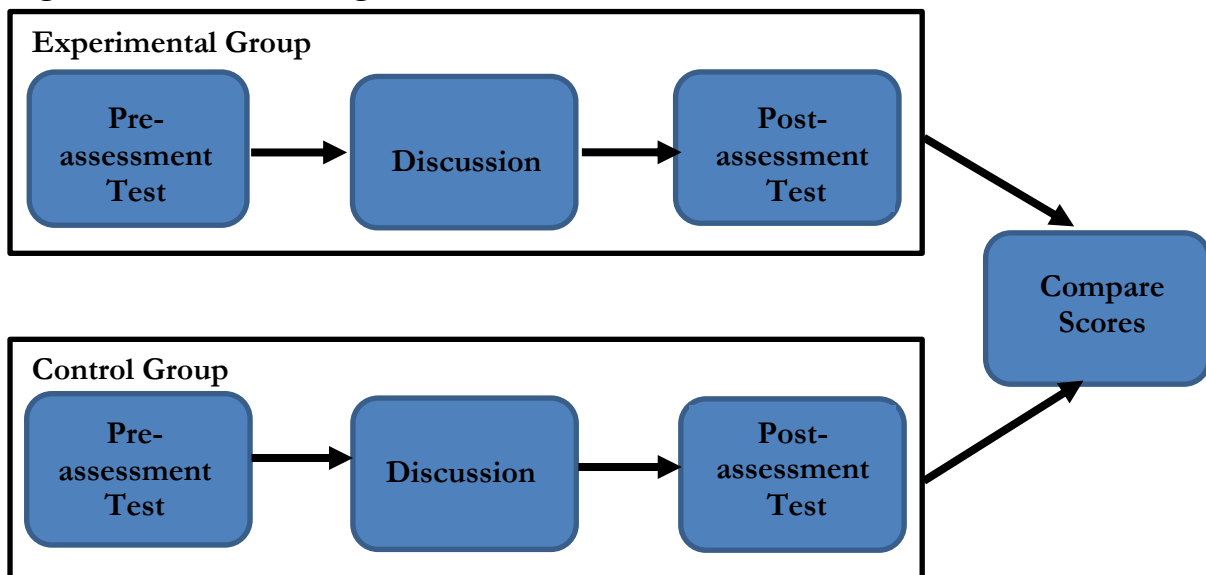
The research was conducted at Sto. Rosario National High School, located in Barangay Deepwell, Sto. Rosario, Santa Rosa, Nueva Ecija. The participants were selected from Grade 10 mathematics classes, providing a diverse academic background to assess the effectiveness of the intervention.

Using purposive sampling, two sections were selected based on comparable academic performance. The fishbowl method was then applied to randomly assign one section as the control group and the other as the experimental group. A total of 44 students participated in the study, with 22 students in each group.

Data collection involved a pre-assessment and a post-assessment test focused on the topic of permutations. The pre-test consisted of 15 multiple-choice questions designed to measure students' baseline understanding. The same set of items was administered as the post-test after the intervention to determine learning gains.

Prior to data collection, formal approval was secured from the school administration. The pre-assessment was administered to both groups to establish initial comprehension levels. The experimental group engaged in structured collaborative learning activities, while the control group received instruction followed by individual tasks. After the activities, both groups completed the post-assessment to evaluate changes in their understanding of permutations.

**Figure 1. – Data Gathering Procedure**



Quantitative data were analyzed using measures of central tendency and inferential statistics. The mean was computed to determine the average pre-test and post-test scores in Mathematics comprehension for both groups. The rating scale shown in table 2 was used to assess the students' level of Mathematics comprehension based on their mean score.

**Table 2. - Rating Scale**

<b>Verbal Description</b>	<b>Scale</b>
Excellent	12.81-15.00
Above Average	9.61-12.80
Average	6.41-9.60
Below Average	3.21-6.40
Poor	0-3.20

A paired sample t-test was used to assess whether there was a statistically significant difference in the pre-test and post-test scores within and between groups, thereby evaluating the effectiveness of collaborative learning as an intervention.

**Result And Discussion**

**Table 3- Mean Scores of the Control Group and Experimental Group**

	<b>Group</b>	<b>Mean</b>	<b>Verbal Description</b>
<i>Pre-test Scores</i>	<i>Control</i>	<i>9.227</i>	<i>Average</i>
	<i>Experimental</i>	<i>9.364</i>	<i>Average</i>
<i>Post-test Scores</i>	<i>Control</i>	<i>8.591</i>	<i>Average</i>
	<i>Experimental</i>	<i>9.000</i>	<i>Average</i>

Table 3 presents the mean pre-test and post-test scores of the control and experimental groups. Prior to the intervention, the control group had a mean score of 9.227, while the experimental group registered a slightly higher mean of 9.364. Both scores fall under the “Average” classification. Following the intervention, the control group’s mean decreased to 8.591, and the experimental group’s mean also slightly declined to 9.000—remaining within the same verbal category.

The minimal change in scores and the sustained “Average” level suggest that the collaborative learning intervention, as implemented, did not result in a significant improvement in students' mathematics comprehension. The slight decline in both groups’ scores may be attributed to external factors, such as variations in student motivation, assessment conditions, or classroom dynamics, rather than the effectiveness of the instructional method itself. This outcome aligns with the findings of Virgana (2019), who emphasized that the success of cooperative learning models depends heavily on implementation fidelity, teacher facilitation, and the learning environment.

It is important to note that not all collaborative strategies yield the same outcomes. For example, Ramadiana’s study on the Teams Games Tournament (TGT) model showed significantly better results. The TGT model, which integrates structured group activities, peer collaboration, and gamified learning, demonstrated notable improvements in students’ creativity and mathematical understanding. Students in the experimental group outperformed their peers in the control group, with the study highlighting the positive impact of competitive and interactive group work on problem-solving skills and conceptual mastery.

In contrast, the findings of the present study imply that generic collaborative activities, without strong instructional scaffolding or active facilitation, may not be sufficient to generate measurable academic gains. Future implementations may benefit from incorporating well-structured cooperative learning frameworks like TGT or STAD, accompanied by training for

teachers in group management and formative assessment strategies.

**Table 4- Paired Samples T-test Result on Comparing Pre-Test and Post-Test Scores of Experimental Group**

Variable 1	Variable 2	t-stat	p-value	Decision	Remarks
Pre-Test Score	Post-Test Score	0.601	0.554	Fail to reject $H_0$	Not Significant

Table 4 summarizes the results of the paired samples t-test conducted to compare the pre-test and post-test scores of the experimental group. The computed t-value was 0.601 with 21 degrees of freedom, and the corresponding p-value was 0.554. Since the p-value is greater than the 0.05 significance level, the difference between the pre- and post-test scores is statistically insignificant.

This result indicates that the collaborative learning intervention implemented in the experimental group did not lead to a statistically significant improvement in students' mathematical comprehension. The high p-value suggests that the observed change in scores could be due to random variation rather than the effect of the intervention.

These findings contrast with those of Virgana (2019), who reported significant improvements in student performance through the use of the Student Teams-Achievement Divisions (STAD) cooperative learning model. The difference in outcomes may be attributed to the degree of implementation fidelity, structure of group tasks, or teacher facilitation strategies. The current result highlights that the success of collaborative learning is not solely dependent on its use but also on how effectively it is designed and executed within the classroom context.

Supporting this, Wahyuni's study demonstrated that the STAD model substantially enhanced students' conceptual understanding in mathematics. Students exposed to the STAD strategy outperformed those taught using conventional methods, with gains observed among both high- and low-achieving learners. This reinforces the idea that structured and well-implemented cooperative learning models, such as STAD, can foster more equitable and meaningful improvements in mathematical comprehension and engagement.

Therefore, while collaborative learning holds promise, the results of this study underscore the critical role of instructional quality and structured facilitation in achieving measurable academic outcomes.

**Table 5.- Paired Samples T-Test Results on Comparing Pre-Test and Post-Test Scores of Control Group**

Variable 1	Variable 2	t-stat	p-value	Decision	Remarks
Pre-Test Score	Post-Test Score	1.84	0.080	Fail to reject $H_0$	Not Significant

Table 5 presents the results of the paired samples t-test for the control group, comparing their pre-test and post-test scores. The computed t-value was 1.84 with a p-value of 0.080. Although the scores showed a slight increase, the difference was not statistically significant at the 0.05 level.

This result suggests that, in the absence of any instructional intervention, students' comprehension of mathematics remained relatively stable. The lack of significant change aligns with expectations that traditional teaching methods, within a short timeframe, may not yield

substantial improvement in understanding complex topics like permutations. Notably, the  $p$ -value being close to the threshold hints at a potential trend toward improvement, which may have become statistically significant with a larger sample size, extended intervention period, or additional instructional support.

These findings are consistent with Ahmad (2023), who observed similarly non-significant pre-post score differences in control groups, reinforcing the idea that external factors or regular classroom instruction alone are insufficient for significant learning gains. In contrast, the study by Tiwow et al. (2020) found that the Student Teams Achievement Division (STAD) cooperative learning model led to substantial improvements in students' mathematical comprehension. Their findings highlighted that students exposed to STAD outperformed those in traditional settings, regardless of their initial level of interest or ability in mathematics.

This comparison underscores that while standard teaching approaches can maintain baseline comprehension levels, the integration of structured and engaging cooperative learning strategies—like STAD—may be more effective in driving meaningful academic improvement, especially in mathematical contexts.

**Table 6.- Independent Samples T-Test Results on Comparing Control Group and Experimental Group**

	<b>t-stat</b>	<b>p-value</b>	<b>Decision</b>	<b>Remarks</b>
Pre-Test Score	-0.304	0.763	Fail to reject $H_0$	Not Significant
Post-Test Score	-0.762	0.451	Fail to reject $H_0$	Not Significant

Table 6 presents the independent samples t-test results comparing the control and experimental groups both before and after the collaborative learning intervention. The pre-test yielded a t-value of -0.304 ( $p = 0.763$ ), while the post-test resulted in a t-value of -0.762 ( $p = 0.451$ ). In both cases, the  $p$ -values exceeded the 0.05 significance level, indicating no statistically significant differences between the groups.

These results suggest that the two groups had comparable mathematics comprehension at the outset and that the collaborative learning intervention did not produce a significant difference in performance post-intervention. The findings reinforce the earlier conclusion that while collaborative strategies hold theoretical promise, their effectiveness depends on multiple contextual and implementation-related factors.

This outcome aligns with studies by Virgana (2019) and Siswanto and Susetyawati (2024), which found that cooperative learning models, under certain conditions, did not significantly outperform traditional instructional approaches. Contributing factors may include the depth of teacher training, clarity of instructional design, classroom dynamics, or the degree of student participation and engagement.

By contrast, Asria's study on the Think-Pair-Share (TPS) model showed statistically significant gains in students' comprehension, particularly in trigonometry. TPS was especially beneficial for learners with low to moderate initial abilities, fostering confidence, peer interaction, and conceptual understanding. However, limitations such as group pairing challenges in odd-numbered classes were noted, indicating that even effective models require thoughtful implementation.

The results of the present study suggest that collaborative learning, as implemented here, may require further refinement—such as more structured scaffolding, differentiated instruction, or the integration of proven models like STAD or TPS—to yield measurable academic improvements in mathematics.

**Table 7- Independent Samples T-Test**

		<b>t-stat</b>	<b>p-value</b>	<b>Decision</b>	<b>Remarks</b>
Difference	Student's t	-0.304	0.763	Fail to reject $H_0$	Not Significant
	Mann-Whitney U	-0.762	0.451	Fail to reject $H_0$	Not Significant

Table 7 presents the results of both parametric and non-parametric tests used to assess the difference in score variations between the control and experimental groups. The independent samples t-test yielded a p-value of 0.763, while the Mann-Whitney U test returned a p-value of 0.451. In both cases, the p-values exceed the 0.05 significance level, indicating that the difference in performance between the two groups is not statistically significant.

The convergence of findings from both statistical approaches reinforces the conclusion that the collaborative learning strategy employed in this study did not result in a measurable improvement in students' mathematics comprehension. This outcome highlights the possibility that collaboration, as operationalized here, lacked sufficient structure or engagement mechanisms to produce a meaningful academic impact.

These findings contrast with those of Siswanto and Susetyawati (2024), who reported that specific cooperative learning models, such as Think-Pair-Share, led to significant gains in conceptual understanding—especially when implemented with fidelity and responsiveness to student needs. Similarly, Wahyuni's study emphasized the consistent effectiveness of the Student Teams Achievement Division (STAD) model, showing improved mathematics performance across students of varying ability levels. The STAD model was particularly noted for promoting active engagement and comprehension through structured peer collaboration and equitable task distribution.

The discrepancy between these studies and the present findings suggests that not all collaborative learning implementations yield equal outcomes. The effectiveness of such strategies may depend on factors such as group dynamics, task design, teacher facilitation skills, and student readiness. This emphasizes the need for thoughtful integration of cooperative models with clearly defined roles, scaffolded tasks, and supportive learning environments to maximize their potential in enhancing mathematics education.

## **Conclusion**

This study explored whether collaborative learning could make a meaningful difference in how Grade 10 students understand mathematics. While the idea of students learning together—sharing ideas, helping one another, and building understanding as a group—is compelling, the results of this study suggest that simply placing students in groups is not enough to improve their comprehension.

The collaborative learning strategy used in this research did not lead to significant gains in students' math performance. This doesn't mean that collaboration isn't effective—it means that how we implement it matters. Learning is a complex process, and meaningful improvement takes

more than good intentions. Without careful planning, structured guidance, and strong teacher support, collaboration can fall flat or become unproductive.

What became clear through this study is that collaboration must be more than a classroom routine; it must be a purposeful strategy. When implemented thoughtfully—with clear roles, engaging tasks, and strong facilitation—it can be a powerful tool. Models like STAD and Think-Pair-Share show us that when done right, collaborative learning can improve understanding, boost confidence, and engage students more deeply.

In the end, this research reminds us that teaching is not just about methods—it's about people. It's about how students connect, how teachers guide, and how we create learning environments that truly support growth. With better planning, more training, and a deeper commitment to student-centered learning, collaborative strategies can still play a meaningful role in helping students succeed in mathematics.

### **Recommendations**

For classroom application, educators are encouraged to adapt and refine collaborative learning models based on the specific needs of their students and the unique context of their school. Providing professional development focused on facilitation strategies, group dynamics, and collaborative task design can enhance the quality and effectiveness of these approaches.

The proposed action plan outlined in table 8 may serve as a practical framework for integrating structured collaborative learning strategies in mathematics instruction. Teachers may implement or adapt its components—such as the use of STAD, Think-Pair-Share, and weekly problem-solving tasks—to promote student engagement and deeper conceptual understanding.

**Table 8.- Proposed Action Plan in Collaborative Learning and Mathematics Comprehension**

Factors	Objectives	Activities	Budget	Persons in Charge	Time frame	Expected Outcome
<b>Collaborative Learning</b>	-to enhance the students' Mathematics comprehension by engaging them actively in the learning process.	-incorporate collaborative learning strategies in teaching like Students Team Achievement Division (STAD), Think-Pair-Share (TPS), or Group Investigation (GI).	3000	Teacher	August-May	-More than 80% of the students demonstrate a deeper understanding of the material and perform better on assessments.
	-to encourage students to analyze, evaluate, and synthesize information through discussion and debate with other students.	-often give activities, math problems, and projects that require students to work in groups.	2500	Teacher	August-May	-More than 80% of the students are more engaged and motivated to participate actively in learning.
<b>Mathematics Comprehension</b>	-to improve the students' ability to analyze and solve mathematical problem effectively.	-give a new problem each week for students to solve, ranging from simple to complex, and have them discussed their thought process in solving it.	2000	Parent	August-May	-More than 80% of the students are able to think critically about mathematical problems and justify their solutions.
	-to encourage students to explore mathematic topics and build strong skills in working with numbers,	-pair students to work together on solving Mathematics problems or explain concepts to one another.	2000	Students	August-May	-More than 80% of the students participates in projects and actively seeking out new mathematical challenges beyond the curriculum.

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including  
performing  
basic  
operations.

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This proposed action plan is designed to improve students' comprehension in mathematics by incorporating meaningful and structured collaborative learning strategies into classroom instruction. It emphasizes learning through teamwork, discussion, and shared problem-solving—approaches known to foster deeper understanding and engagement.

Methods such as the Student Teams Achievement Division (STAD), Think-Pair-Share (TPS), and Group Investigation (GI) provide varied and interactive formats that encourage students to process mathematical concepts socially. Group activities, weekly problem sets, and peer teaching opportunities allow students to build confidence, reinforce their understanding, and articulate their reasoning.

In addition to the recommendations, future researchers are encouraged to examine the long-term effects of collaborative learning on mathematical comprehension and critical thinking. Studies could explore its effectiveness across different grade levels, subject areas, and learner profiles, or investigate the use of technology-enhanced collaborative tools (e.g., virtual whiteboards, shared digital workspaces) to expand learning opportunities. Such research would contribute valuable insights into how collaborative learning can be more effectively integrated and sustained in diverse educational settings.

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