

An Exploration of Collaborative Learning Strategy in Mathematics: A Psychological Case Study

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Abstract:

A collaborative learning strategy improves teaching-learning and helps students learn subjects like mathematics more efficiently. This study aimed to determine the perceptions among students on collaborative learning in mathematics and how this strategy helps them achieve success in mathematics. Ten (10) elementary learners were purposively selected to participate in an interview using the semi-interview guide, focus-grouped discussion, and observation notes. Cognitive development theory and socio-cultural theory were the foundation of this study. Consequently, a collaborative learning strategy employing a descriptive single case study design and thematic data analysis was used to address the issue. The findings were that students' perceptions were the following; *collaborative learning strategy was a gateway of knowledge and supplement of learning, while academic motivation and think-pair-share dominance* were how collaborative learning strategy helped them improve their academic performance. Results indicated that the collaborative learning strategy is an effective educational strategy to help them enhance their learning about the concepts and solve problems confidently in mathematics. Through this method, teachers and school administrators can design learning tasks that promote diversity and set high-performance standards for learners' mathematical skills.

Keywords: academic performance; case study; collaborative learning; elementary learners

Introduction

Over the years, mathematics has traditionally been the most challenging subject for learners to master throughout their careers (Li & Schoenfeld, 2019). Thus, teachers used a variety of strategies and approaches to deliver the subject effectively. The collaborative learning strategy, where students work in groups to solve problems, share ideas, and construct knowledge, has been recognized as an effective pedagogical strategy across various disciplines. Collaborative learning provides students unique opportunities to engage in mathematical discourse, develop critical thinking skills, and understand mathematical concepts in-depth (Calder et al., 2021). Despite its potential benefits, there is still a need for additional research and empirical evidence regarding the efficacy of collaborative learning, particularly concerning the acquisition of fundamental mathematical concepts and skills.

In today's globally interconnected world, schools are working to improve their students' numerical literacy and analytical reasoning. Collaborative learning has recently gained attention as an effective teaching method because of its focus on student participation, peer interaction, and shared knowledge construction. According to a meta-analysis by Mendo-Lázaro et al. (2022), the cooperative learning approach positively influences student achievement performance. Following the worldwide trend toward cooperative pedagogical approaches, the Philippines is devoting more and more attention to studying collaborative learning in mathematics education. Students are encouraged to collaborate in this method, which has been shown to increase their critical thinking and math comprehension.

In the K-12 Curriculum Guide from the Department of Education (Department of Education, 2016), group learning activities in math are emphasized as a fundamental way to develop critical thinking and problem-solving skills. Both policy frameworks stress the importance of giving students different learning methods that encourage collaboration and interest, even in math. Collaborative learning in math classrooms has also been shown to work, giving students a more exciting and interactive place to learn (Ayuwanti et al., 2021). However, there are still areas for improvement, like ensuring teachers have the resources and training to set up and run these learning environments well (Barakabitze et al., 2019).

Therefore, researchers and practitioners in mathematics education must prioritize investigating collaborative learning. This research aimed to examine how students at the elementary level perceived the benefits of using a

collaborative learning strategy and how it helped improve their mathematical knowledge, problem-solving skills, and achievement. In addition, it closed the chasm by conducting an intensive study of group work in the classroom. The findings will be incorporated into the existing body of knowledge to better inform teachers, curriculum designers, and policymakers about improving mathematics education for students from various backgrounds.

Theoretical Framework

The following theories served as the study's foundation:

According to Vygotsky's socio-cultural theory of learning (1978), learning is a social process resulting from interacting with one another and their surroundings. Using this theory in the classroom, students build their mathematical knowledge through collaborative discussions and conversations. The theory is also helpful in the context of a case study investigating collaborative learning in mathematics, where it sheds light on how students' social interactions during group work can deepen their mathematical comprehension and enrich their educational experiences.

Moreover, in Piaget's theory of cognitive development, learners build knowledge through assimilation and accommodation (Lefa, 2014). When solving a problem collaboratively in math class, students must deal with various viewpoints and potentially opposing ideas, forcing them to hone their understanding of mathematical concepts. This theory is related to the study because it emphasizes the importance of collaborative learning in giving students a place to query, test, and improve their mathematical comprehension through interactive discussion and peer problem-solving.

Research Questions

This research study aimed to explore the perceptions of elementary learners on how collaborative learning strategy helped them achieve success in mathematics in one of the public schools in Tacloban City, Leyte, Philippines. It sought to answer the specific questions:

1. What are the perceptions of elementary learners on the collaborative learning strategy in mathematics?
2. How does a collaborative learning strategy help them improve their academic success in mathematics?

Review of Literature

Collaborative learning strategies, particularly in mathematics, are a broad field of study extensively researched from various perspectives (Slavin, 2011). Furthermore, the field of education is constantly evolving, seeking innovative and effective pedagogical strategies to improve learners' mathematical skills and concepts (Colomer et al., 2020). This approach is significant in mathematics because many students perceive it as complex and abstract. In mathematics, a collaborative learning strategy encourages students to work together to solve problems, promoting the development of mathematical knowledge and understanding through discourse and conversation (Gillies, 2016). Furthermore, research has looked into the advantages of collaborative learning for student development.

According to Johnson et al. (2014), students who participated in a collaborative learning strategy demonstrated improved social skills, such as conflict resolution and communication, which are critical for effective learning and overall development. Mathias et al. (2023) claim that collaborative learning strategies can improve students' attitudes toward mathematics, leading to increased motivation and engagement. Mazana et al. (2018) discovered that students who engaged in collaborative learning had a more positive attitude toward mathematics and improved self-efficacy, implying that this approach can help students develop a positive mathematical identity. Several researchers, in particular, have investigated the use of technology to facilitate collaborative learning in mathematics (Borba et al., 2017). Despite its promising implications, it is challenging to implement a collaborative learning strategy in mathematics classrooms, such as teacher readiness, group dynamics, and technology integration.

Collaborative learning strategies face implementation challenges, group dynamics, and contextual factors in the international arena (Udvari-Solner, 2012). These challenges are also evident in the context of the Philippine education system. One of the challenges is implementing a collaborative learning strategy because many teachers may need more training and support with the changes in classroom management required to facilitate group work

and manage the required noise levels (Le et al., 2018). Furthermore, collaborative learning relies on effective group dynamics, but not all students work well in groups. There are issues, particularly unequal participation, in which some students dominate the discussion while others remain passive. Ensuring that all students are actively involved and contributing can be challenging.

Several studies have proposed potential solutions to these problems and ways students can maximize the advantages of using a collaborative learning strategy (Tong et al., 2022). First, teachers must be provided with resources that help them develop expertise in collaborative learning strategies for classroom management of group activities and promoting positive group dynamics (Ku et al., 2013). Furthermore, a collaborative learning strategy is effective when activities are well-structured, highlighting clear roles and expectations for each group member. Online platforms can also facilitate collaborative learning (Kertesz, 2015). Collaborating via digital platforms and applications can be essential in larger groups or particular circumstances.

Despite the difficulty of its implementation, the collaborative learning strategy is a robust instructional approach that can improve mathematical concepts and abilities. Determining the learners' perceptions and how collaborative learning strategies aided their success in mathematics is still crucial. Mathematical collaborative learning strategy research suggests motivating strategies for more interactive, learner-centered classrooms that take advantage of social aspects of learning. The study's findings highlight the need for additional research to improve implementation tactics and gain a deeper understanding of the mechanisms that might aid the education sector in maintaining the academic success of math students.

Methodology

Research Design

This study employed a descriptive single case study design ("A Practical Guide to Using Interpretative Phenomenological Analysis in Qualitative Research Psychology," 2014), a type of qualitative research focusing on investigating and describing a specific instance in great detail. Interviews, observations, and document reviews were used to compile a thorough and detailed case report for this study. The intent is to provide a clear picture of the case, one that does justice to its complexity and individuality. This layout has the potential to shed light on the situation at hand and provide a comprehensive comprehension of the bigger picture. It is utilized to formulate questions for follow-up research.

Research Locale

This research study was conducted in one of the elementary public schools in Tacloban City, Leyte, Philippines. This school offers a curriculum encompassing mathematics, science, language arts, social studies, and physical education. Elementary learners are in a foundation phase of their educational journey, during which they are acquiring foundational academic skills and developing crucial social and emotional skills. They frequently learn to interact with peers, navigate group dynamics, manage conflicts, and build relationships in diverse and multicultural classroom environments. In addition, elementary school students in public schools represent a vibrant and dynamic aspect of the education system due to the challenges and opportunities that shape their learning experiences and outcomes.

Research Participants

Participants in this study are ten (10) elementary learners from the same class in a public school. The purposeful selection ensured a diverse representation of the class. Participants were officially enrolled in the public school for the 2022-2023 school year. These participants were chosen based on their participation in a mathematics class that actively employs collaborative learning strategies. All participating learners and their parents/guardians were informed of the study's nature, purpose, and rights. Their anonymity and the confidentiality of the results in their responses were guaranteed. Prior to the beginning of the study, parental consent and student agreement were obtained.

The selection of these ten elementary students provides a meaningful context for investigating the effectiveness of collaborative learning strategies in mathematics education. Their experiences and perspectives on how they helped them achieve academic success in mathematics, gathered through interviews, surveys, and observations,

will provide valuable insights into how collaborative learning shapes their mathematical comprehension, attitudes toward mathematics, and the development of critical and social skills.

Research Instrument and Data Collection

The first step in the data collection procedure is obtaining informed consent from participants and their parents or legal guardians. They are given comprehensive information about the study, its purpose, and their rights as participants, including the ability to withdraw at any time. Once the necessary consent has been obtained, data collection utilizes carefully crafted research instruments, such as interviews, observations, surveys, and focus group discussions. In addition, all interviews and focus group discussions are recorded with participant permission, and observations are documented in detail. With each student, semi-structured interviews were conducted. These interviews allowed us to comprehend the students' perceptions and experiences with collaborative learning in their mathematics class. In this context, the focus group discussion allows the researcher to observe the dynamics between the learners, their shared experiences, and the group's consensus or divergent perceptions of collaborative learning. Last but not least, direct observations were conducted in mathematics classes where collaborative learning strategies were implemented.

As data is collected, it is organized meticulously for subsequent analysis. This may involve transcribing recorded conversations, coding the responses, and entering data into a software application. The collected data are continuously examined for completeness and precision. Triangulation, or cross-checking multiple sources and data types, validates the collected data. In addition, data are stored securely to protect participant privacy and prepare them for the next phase of the research process: data analysis.

Data Analysis

This study employed thematic data analysis (Braun & Clarke, 2012) for identifying, interpreting, and reporting themes within a dataset. Several steps are involved in utilizing this data analysis. *1. acquainting oneself with the data; 2. coding the data; 3. identifying potential themes by grouping related codes; 4. reviewing and refining themes; 5. determining the final set of themes, and 6. writing up the findings and providing a detailed description of the themes.* The narrative presents the findings and discusses their implications in the context of the study's emphasis on collaborative mathematics learning.

Results and Discussion

This research investigated the perceptions of elementary learners toward collaborative learning strategy and how it helps improve their academic performance in mathematics. A collaborative learning strategy was of particular interest to the researcher. Findings of the results and discussions uncovered by the researchers based on the data gathered were the following:

1. Elementary learners' perceptions towards collaborative learning strategy

Theme 1: Gateway of knowledge

Nokes-Malach (2015) pointed out that collaboration is a source of learning. It is a widely held belief among academics and members of the general public that acquiring knowledge in the company of others is superior to acquiring knowledge on one's own. The process by which two or more students work together to find a joint solution to the group task that is currently being worked on is known as collaborative learning (Kaendler et al., 2014)

Significance statement 1: "Collaborating is the same as talking, so there is an exchange of ideas and feelings. This makes a bigger picture out of a single detail." Moreover, for me, being involved in class helps me come up with ideas and explain them in a way that is simple and easy to understand".

Significance statement 2: "In fact, I prefer group projects to individual ones, and I can now confidently discuss ideas with my peers because of the boost to my oral communication skills I received from working in a group".

Significant statement 3: "Since there is already a helping hand reminding you that it is important to learn and understand the concept for us to take the next step and be ready for the next

discussion; this method will help someone learn, gain confidence in participating in class activities, and retain knowledge”.

Theme 2: Supplement of learning

Collaboration, such as facilitating peer review, encouraging reflective writing, and supporting students as they transition from surface learning to deeper comprehension and the construction of knowledge, is all important (Coutinho & Junior, 2007). When students work together to solve problems and learn new skills, they cultivate a sense of belonging in the classroom and a positive learning environment. When people work in pairs to develop ideas, they can recall, process, practice, and communicate what they have learned in a setting with fewer consequences for making mistakes. It is helpful to improve the level of complexity in students’ responses, and it also increases their willingness to share their ideas with others when using this approach.

Significant statement 1: "Sometimes I prefer working alone, especially if the subject or lesson is not too complicated. To further discuss and elaborate on the concepts from the lesson, I prefer to ask for assistance if the subject is already challenging”.

Significant statement 2: “When one student helps another, it improves both students' study habits and their grasp of the material, and it also boosts the motivation of both students”.

Significant statement 3: “Group projects allow students to learn from and with one another while also benefiting from the guidance of a peer”.

2. Collaborative learning strategy improves elementary learners’ academic success in mathematics

Theme 1: Academic motivation

Collaborative learning is a method of teaching and learning that encourages students to work in groups to solve a problem, finish a task, or develop a product. This method of education can be used in various educational settings (Laal & Ghodsi, 2012). Also, every student is expected to contribute to the learning process collaboratively, so students work in pairs or small groups to complete assignments. Students develop a sense of belonging and a positive classroom climate when they work together to solve problems and learn new skills. Students' ability to think critically has been shown to improve. Students gain confidence and self-esteem when they contribute meaningfully to classroom discussions. The following are the students' actual interview answers.

Significant statement 1: "I feel more at ease with my answers and score higher on our group activities thanks to my plan to promote each other's learning by helping, sharing, and encouraging efforts to learn.”

Significant statement 2: "Through having a partner who is doing well in our class then pair with me really adds to my points, which helps my grades improve, which is great for collaborating and generating many ideas about a certain topic.”

Theme 2: Think–pair – share dominance

learners can reflect, work together, and share knowledge by responding to a question, prompt, or observation. Thinking critically about the question is made more accessible by discussing potential answers with a friend or coworker. Using their recollections or notes, they select the answers they find to be the best, most convincing, or most original. Then they meet to talk about it and give their report. Participants in this interview broached the topic of forming teams rather than operating independently. Through working together on projects, students can hone their existing abilities while also benefiting from mutual learning from interacting with peers from different disciplines (Laal & Laal, 2021).

Significant statement 1: “There is already a helping hand that will remind you that it is important to learn and understand a concept to move on to the next step and be ready for the next discussion.”

Significant statement 2: “I can also share my meanings and ideas with my partner during our collaborative activities. We put our ideas together, and I like it.”

Significant statement 3: “Sometimes, because I am too shy, I forget my words to say. Thankfully, someone in our group will help me remember things and help me to finish my task, especially during class reporting.”

The research aimed to establish whether or not the collaborative learning strategy effectively addresses the problem of low student participation in classroom discussions and activities. The collaborative learning approach involves various activities in which students of varying levels of performance work together to achieve a common objective. Students develop their social skills, harness higher-level thinking skills, and learn from one another as a result of this intervention. The researchers conducted their research among participants who were purposefully selected for participation. The interview guide and the observation notes were the two types of research instruments that were utilized in this study. The compiled information was subjected to thematic analysis, from which the following findings have been derived: The students can use and improve their communication skills while simultaneously gaining ideas from their pairs when using a collaborative learning instruction strategy. They were also comfortable speaking their minds to the other students.

The participants reported that they could learn more when a peer or a classmate assisted them, enabling them to discuss further and elaborate on the concepts presented in the lesson. When students collaborate to develop ideas, they pick up new information from their partners. As a result, the partners can collaborate, stretching their previously acquired knowledge and expanding their respective areas of expertise. Working in pairs effectively addresses the problem of low participation among students in classroom discussions and activities. It allows students to remember, analyze, apply, and share what they have learned, which helps them become more willing to share their ideas with others. As a result of their active participation in class discussions, they experienced an increase in their self-confidence and self-esteem.

Conclusion and Recommendation

The following conclusion has surfaced as a result of analyzing the data and deducing it from the findings: An efficient method of teaching, known as the collaborative learning strategy, learners working together to solve philosophical problems as part of the learning process. Additionally, the collaborative learning strategy could learn and comprehend more which helped them improve their attention spans, oral and listening skills, and oral communication skills. Students can feel less self-conscious about sharing their thoughts which is the other benefit of this strategy. In addition, by utilizing this strategy, educators can devise educational activities that promote individuality and set a rigorous achievement bar for all learners.

Following are some suggestions developed by the researcher based on the presented findings: The collaborative learning strategy can be used effectively in the classroom setting. The current educational system has room for more focus on collaborative learning. It is strongly recommended that teachers facilitate student teamwork whenever possible. The use of a variety of educational activities, rather than focusing solely on individual tasks, is something that teachers are strongly encouraged to do. The researcher suggests that collaborative learning strategy implementation of the subject of additional research is to be conducted by future researchers.

References

1. A practical guide to using Interpretative Phenomenological Analysis in qualitative research psychology. (2014). *Czasopismo Psychologiczne*, 20(1). <https://doi.org/10.14691/cppj.20.1.7>
2. Ayuwanti, I., Marsigit, M., & Siswoyo, D. (2021). Teacher-student interaction in mathematics learning. *Zenodo (CERN European Organization for Nuclear Research)*, 10(2), 660. <https://doi.org/10.11591/ijere.v10i2.21184>
3. Barakabitze, A. A., Lazaro, A. W., Ainea, N., Mkwizu, M. H., Maziku, H., Matofali, A. X., Iddi, A., & Sanga, C. (2019). Transforming African Education Systems in Science, Technology, Engineering, and Mathematics (STEM) Using ICTs: Challenges and Opportunities. *Education Research International*, 2019, 1–29. <https://doi.org/10.1155/2019/6946809>
4. Borba, M.C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., Aguilar, M.S. (2017). Digital Technology in Mathematics Education: Research over the Last Decade. In: Kaiser, G. (eds) *Proceedings of the 13th International Congress on Mathematical Education. ICME-13 Monographs*. Springer, Cham. https://doi.org/10.1007/978-3-319-62597-3_14
5. Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf, & K. J. Sher (Eds.), *APA handbook of research methods in psychology, Vol. 2. Research designs:*

- Quantitative, qualitative, neuropsychological, and biological (pp. 57–71). American Psychological Association. <https://doi.org/10.1037/13620-004>
6. Calder, N., Jafri, M., & Guo, L. (2021). Mathematics Education Students' Experiences during Lockdown: Managing Collaboration in eLearning. *Education Sciences*, 11(4), 191. <https://doi.org/10.3390/educsci11040191>
 7. Colomer, J., Serra, T., Cañabate, D., & Bubnys, R. (2020). Reflective Learning in Higher Education: Active Methodologies for Transformative Practices. *Sustainability*, 12(9), 3827. <https://doi.org/10.3390/su12093827>
 8. Coutinho, C., & Junior, J. B. (2007, June). Collaborative learning using wiki: A pilot study with master students in educational technology in Portugal. In *EdMedia+ Innovate Learning* (pp. 1786-1791). Association for the Advancement of Computing in Education (AACE). <https://tinyurl.com/46vej6sa>
 9. Department of Education. (2016, August). K to 12 Curriculum Guide MATHEMATICS. K To 12 BASIC EDUCATION CURRICULUM. https://depedbohol.org/v2/wp-content/uploads/2016/03/Math-CG_with-tagged-math-equipment.pdf
 10. Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Australian Journal of Teacher Education* (Online), 41(3), 39–54. <https://search.informit.org/doi/10.3316/informit.977489802155242>
 11. Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in University Teaching*, 25(4), 1-26. <https://tinyurl.com/yc5m3bsx>
 12. Kaendler, C., Wiedmann, M., Rummel, N. et al. Teacher Competencies for the Implementation of Collaborative Learning in the Classroom: a Framework and Research Review. *Educ Psychol Rev* 27, 505–536 (2015). <https://doi.org/10.1007/s10648-014-9288-9>
 13. Kertesz, C. (2015). Using GitHub in the classroom - a collaborative learning experience.
 14. <https://doi.org/10.1109/siitme.2015.7342358>
 15. Ku, H., Tseng, H., & Akarasriworn, C. (2013). Collaboration factors, teamwork satisfaction, and student attitudes toward online collaborative learning. *Computers in Human Behavior*, 29(3), 922–929. <https://doi.org/10.1016/j.chb.2012.12.019>
 17. Laal, M., & Ghodsi, S. M. (2012). Benefits of collaborative learning. *Procedia - Social and Behavioral Sciences*, 31, 486–490. <https://doi.org/10.1016/j.sbspro.2011.12.091>
 18. Laal, M., & Laal, M. (2012). Collaborative learning: what is it? *Procedia - Social and Behavioral Sciences*, 31, 491–495. <https://doi.org/10.1016/j.sbspro.2011.12.092>
 20. Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, 48(1), 103–122. <https://doi.org/10.1080/0305764x.2016.1259389>
 22. Lefa, B. (2014). The Piaget theory of cognitive development: an educational implications. *Educational psychology*, 1(1), 1-8. <https://tinyurl.com/2p8p5hvx>
 23. Li, Y., & Schoenfeld, A. H. (2019). Problematising teaching and learning mathematics as “given” in STEM education. *International Journal of STEM Education*, 6(1). <https://doi.org/10.1186/s40594-019-0197-9>
 24. <https://doi.org/10.1186/s40594-019-0197-9>
 25. Mathias, J., Saville, C., & Leech, S. (2023). Engaging non-mathematics students in mathematics learning through collaborative teaching. *Teaching Mathematics and Its Applications*. <https://doi.org/10.1093/teamat/hrad003>
 26. <https://doi.org/10.1093/teamat/hrad003>
 27. Mazana, M. Y., Montero, C. S., & Casmir, R. (2018). Investigating Students' Attitude towards Learning Mathematics. *International Electronic Journal of Mathematics Education*, 14(1). <https://doi.org/10.29333/iejme/3997>
 28. Mendo-Lázaro, S., Del Barco, B. L., Del Río, M. I. P., & López-Ramos, V. (2022). The Impact of Cooperative Learning on University Students' Academic Goals. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.787210>
 29. Nokes-Malach, T.J., Richey, J.E. & Gadgil, S. When Is It Better to Learn Together? Insights from Research on Collaborative Learning. *Educ Psychol Rev* 27, 645–656 (2015).
 30. <https://doi.org/10.1007/s10648-015-9312-8>

31. Slavin, R. E. (2011). Instruction based on cooperative learning. *Handbook of research on learning and instruction*, 358-374. <https://tinyurl.com/bdd4bw9x>
32. Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study
33. in teaching the conventions for coordinates in the plane. *Heliyon*, 8(12), e12657. <https://doi.org/10.1016/j.heliyon.2022.e12657>
34. Udvari-Solner, A. (2012). Collaborative Learning Strategies. In Springer eBooks (pp. 636–639).
35. https://doi.org/10.1007/978-1-4419-1428-6_818
36. Vygotsky, L. S. (1978) *Mind in Society: The Development of Higher Psychological Processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, transl.) Cambridge, MA: Harvard University Press. [p245801coll10_371908.pdf](https://doi.org/10.1016/j.heliyon.2022.e12657)