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The Role of Mathematical Communication Through Think-Pair-Share in Developing Problem-Solving Skills

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Abstract**:** *This Mathematics Education develops critical thinking, logical reasoning, and problem-solving—skills essential for academic and professional success. In the Philippines, students often struggle to apply math to real-world problems due to limited strategic learning methods and weak communication skills, which hinder their ability to explain and justify reasoning. This contributes to poor performance in international assessments. This study investigates the role of the Think-Pair-Share (TPS) strategy in enhancing students' mathematical communication within the Philippine educational context. Specifically, it examines how TPS facilitates mathematical idea exchange, promotes collaborative learning, and explores improvement to students' problem-solving skills. The study compares the performance of students who actively engage in TPS activities with those who do not, focusing on both their communication and problem-solving outcomes. This study employs a qualitative research design, specifically a case study approach, to explore the perspectives and experiences of Grade 10 students at Mindanao, Philippines, regarding mathematical communication through the Think-Pair-Share (TPS) strategy. Data collection involved multiple sources to capture a comprehensive view of the students' experiences. This includes in-depth interviews with students, their journals documenting their reflections on the TPS activities, observational scoring, and individual and paired output scores. The study will involve 8 students selected to provide insights into their experiences with the Think-Pair-Share (TPS) strategy in mathematics. Findings reveal that peer interaction through TPS improves students' confidence and ability to articulate mathematical concepts. While active participation enhanced mathematical communication, non-participating students demonstrated relatively stronger individual problem-solving skills. Notably, students' overall scores increased during paired activities, although their specific strengths and weaknesses remained consistent. These results highlight the potential of TPS as a collaborative learning tool for improving mathematics education.*

Keywords: *Think-Pair-Share, Mathematical Communication, Problem-Solving Skills.*

I. INTRODUCTION

Mathematics education plays a vital role in developing cognitive skills such as critical thinking, logical reasoning, and problem-solving, all of which are essential for both academic and professional success. However, Ababon et al. in 2024 highlighted that students in the Philippine educational system encounter considerable difficulties in applying mathematical concepts to real-world problems, largely due to the absence of effective strategic learning methods. Additionally, Aisyah in 2024 and Alghamdi in 2024 both emphasized that the lack of effective mathematical communication, which is essential for expressing thought processes and problem-solving strategies, further impedes students' ability to demonstrate their understanding. Alsmadi et al. in 2023 identified a major issue in mathematics education: the gap in students' mathematical communication skills, which restricts their ability to explain and justify their reasoning, ultimately affecting their problem-solving capabilities and overall understanding of mathematics. Ababon et al. in 2024 pointed out that in the Philippines, this communication barrier plays a role in the country's poor performance in international assessments like the Programme for International Student Assessment (PISA), emphasizing the urgent need for enhanced pedagogical strategies. This research intends to investigate how well the Think-Pair-Share (TPS) method improves students' abilities in math communication and problem-solving. Alghamdi in 2024 explained that Think-Pair-Share (TPS) involves individual reflection, paired discussion, and whole-class sharing, all of which encourage active participation and promote collaborative learning. By examining the impact of TPS, the study seeks to provide insights into how this learner-centered approach can improve mathematical communication and problem-solving in the Philippine context.

The findings of this study are expected to contribute to educational practices by offering evidence on the effectiveness of TPS in improving mathematical communication and problem-solving abilities. The insights gained can inform teaching strategies, curriculum development, and educational policies aimed at enhancing student performance in mathematics. Aulia et al. in 2023 affirmed that the study aligns with the Department of Education's (DepEd) ongoing educational reforms aimed at fostering critical thinking, collaboration, and communication skills within the classroom.

II. METHODOLOGY

The objective of this study is to explore students' mathematical communication through the Think-Pair-Share (TPS) technique. TPS is an active learning strategy designed to encourage student engagement, collaboration, and communication. In the Think-Pair-Share process, students first think individually about a problem or concept, then pair up with a partner to discuss their thoughts, and finally share their findings with the entire class. This technique can provide valuable insights into how students articulate their

mathematical reasoning and collaborate with peers to refine their understanding of mathematical concepts.By focusing on mathematical communication, the study aims to understand how the TPS technique facilitates the expression of mathematical ideas, the development of logical reasoning, and the ability to justify solutions. It also offers a way to observe how students explain their thinking, listen to others, and engage in dialogue that can strengthen their comprehension of mathematical content.

Moreover, this study could contribute to the broader conversation on improving mathematical instruction by highlighting the importance of communication in the learning process. Effective mathematical communication is not only about expressing answers but also about reasoning and justifying the steps taken to arrive at a solution. It helps students develop a deeper understanding of the material, makes learning more interactive, and enhances problem-solving skills.

Ultimately, this study could provide useful insights for educators on the potential benefits and challenges of using the Think-Pair-Share strategy in fostering mathematical communication. It could also suggest ways to integrate this technique more effectively in classrooms to improve student engagement and mathematical proficiency.

This study employed a qualitative case study design to investigate how the Think-Pair-Share (TPS) strategy influences students' mathematical communication and problem-solving skills. Conducted with four pairs or eight Grade 10 students from one of the public high schools in Tubod, Lanao del Norte. The participants were strategically paired, those who are average performing students to low performing students in mathematics based from the recent quarter of their class. The selection of participants was based on the teacher's record of her students' grade in mathematics from the recent quarter. Data were collected through semi-structured interviews and student daily journals. These instruments captured students' verbal and written mathematical reasoning, engagement in peer discussions, and problem-solving approaches. The implementation covered three weeks. The first and second week was a pure non-participatory observation to lessen the Hawthorne effect. Data were collected in the third week, specifically four days. Thematic analysis was applied to qualitative data. Ethical protocols, including informed consent and confidentiality, were strictly followed to ensure responsible and respectful research practice.

III. RESULTS AND DISCUSSION

Students' Mathematical Communication Through the Think-Pair-Share Technique

A. Thematic Analysis in the Interview and Journal of Pair A

Helping with the Struggle. Student 1A sees the importance of communication in math class for the class. There are times when she struggles to understand a problem, leading to questioning her answer. She sees the need for a partner to be able to ask and share ideas with. That way, they can figure out the answer faster.

"Sometimes, when it's just us or just me, I really struggle to understand the problem because I keep questioning myself." Is this right?Or what is this?Is this right or not?So I really need a partner to ask questions like this and that.so we can share our ideas, you know.We will immediately know the answer.And sometimes we also ask about other things.

Commonly, her partner also has struggles in doing mathematical problems. Student 2A dislikes math as he does not understand how to solve mathematical problems. He often asks himself how he can solve a problem if he doesn't even understand it. He doesn't know how to figure out what is being asked. But when it's just equations or numbers, he can understand. However, he still asks himself why he cannot get a certain problem.

"I don't really understand those things, like, what they're looking for, you know, like that. But those like, just equations, numbers, I understand those, but not all the time because I really ask myself, why can't I do it, I would understand it but, I really get confused only in problem solving."

It's well known that math is a subject that many students detest and struggle with. A lot of equations and rules need to be committed to memory, which can be extremely discouraging for many pupils. Mastering math involves more than just memory. Grasping the reasons why something works is far more crucial than just committing it to memory. Gamblinx in 2021 noted that mathematical thinking can be cultivated at any age, and many games offer enjoyable and engaging ways to support this development. One of the many reasons people talk to themselves is to solve problems. Cherry in 2023 explained that speaking aloud to oneself can support healthy and productive thinking by helping to process ideas, reflect, stay motivated, recall information, and navigate problem-solving more effectively.

Step-by-step Communication. When student 1A communicates with her partner, she first asks what formula she used. If they used the same one, they would share answers. But if her partner was wrong, student 1A will ask more questions to understand why and make her defend her answer. These questions made it easier for them to understand.

"I asked her if this is it, what formula do you have?So that if we have the same formula, we can share the answer.But if his formula is wrong, I immediately look at it and ask, how did you do this?I'll ask some questions to see if he can defend his answer."

However, she shared in her journal on the first day of review, they got the correct answer with a wrong formula. They did discuss their answers and finalized it through discussion, but admitted that both of them are not that good in math.

"Yes, we arrive at a correct answer but wrong formula. We were just discussing about our answer and that's all. Well the ways we did to finalize were discussing, solving it at our best, whatever, we know we are not good in math."

Kangaroo Math in 2023 emphasized that the initial step in solving a math problem is to carefully read and understand it. This understanding enables students to develop a plan and determine the appropriate formula to use. They should then practice applying the formula and verify their solution to ensure its accuracy.

B. Thematic Analysis in the Interview and Journal of Pair B

Complication Leads to Communication. Student 1B does not always communicate nor discuss answers with others during math class. She only participates in discussions when it is needed. There are times when the problem is complicated, and the class is struggling. During these times, they need to communicate and help each other as a group.

"When faced with challenging problems, especially difficult ones, it's essential for us to communicate and support one another as a collective."

Student 2B and his partner share an equal amount of right and wrong answers. There are times when he is right, and times when his partner is right. They analyze both sides, discuss them, and figure out the next step together. He will be more confused if he is alone. But with a partner, they can explain, and he listens until he is ready to speak.

"It also helps, sir, to share because sometimes, on their side, I also share my side. For example, in my case, there are things that are right and there are things that are wrong. On their side, sometimes they are right and I am wrong.His mistake is my right.So I talked to him about my side, he listened, we both looked at it, then we analyzed it, discussed it, and figured out what to do with it, how to handle it, and that was it, sir."

In day 1, the participant shared in his journal that they chose to combine their knowledge to get the correct answer.

"…we compared what formula she use and also I use and then we discuss whether her answer is right or my answer is right. We choose to combine our knowledge and try and try until we get the correct answer."

Proença et al. in 2024 highlighted that during the TPS pairing phase, students were encouraged to discuss their answers, share ideas, and gain a deeper understanding of the challenges they were facing. As students were prompted to defend their arguments to their partners, this peer interaction not only strengthened their mathematical communication but also fostered a sense of responsibility and ownership. Math With Friends in 2022 explained that students' learning experiences are enriched when they work through math problems with a partner. This setup allows them to converse and engage in a supportive environment. In addition to learning from their peers and the teacher, students also expand their vocabulary as they must articulate their answers clearly. Ultimately, this approach makes the lesson more engaging and exciting.

Easier with Companion. Solving a complicated problem is easier for student 1B to do when she is discussing in a group. Just like having a problem in the family, it is hard to solve it alone. Letting others know your thoughts can help ease the difficulty. She shared a time when her partner knew the formula but was confused about cumulative frequency and she had to explain it to her partner.

"It's better to rely on others than just yourself, even when it comes to your own family."For example, if you have a problem in your family, will you solve it all by yourself?It's really hard to solve, so it's better to share your idea with more people."

Hatisaru in 2024 noted that social interaction in group settings enhanced students' critical and logical thinking skills, as they had to consider and integrate multiple viewpoints before reaching a solution. This approach also boosted students' confidence in their ability to tackle challenging situations, while further developing their problem-solving abilities.

C. Thematic Analysis in the Interview and Journal of Pair C

Math is Essential. Student 1C describes communication in math class as something that is not only applicable in the classroom, but in everything that he does. He gave an example where people cannot sell things or do everyday tasks without it. People cannot avoid math even if they don't like it or find it hard.

"For me, sir, it's important because, like math, no matter where you go, you can't really avoid math."Just like me, I really don't like math...Just like me, I really don't like math…"

Early Education in 2022 highlighted that math is an integral part of everyday life and not limited to the classroom. People encounter numerous significant mathematical situations daily, and there are various ways to support the development of their arithmetic skills. Everyday tasks, such as measuring washing powder, preparing the right number of sandwiches for lunch, or dividing a cake into equal pieces, all require the use of numbers, shapes, measurements, and problem-solving abilities.

Questioning Own Solution. During the "think" part of the approach, student 2C asks questions to herself to better understand the problem, such as whether she wrote the right formula or solved it correctly. She doesn't normally do this before the review session. She usually just goes with whatever comes out from her mind without reflecting it.

"... did I put it correctly or did I solve it correctly... Whatever came out, that's it...Is what I put correct or is my solution correct... Whatever comes out, that's it...I didn't communicate much before."

On the last day, she shared in her journal how she wasn't sure about her solution. She kept doubting herself, thus was not able to explain her answer properly to her partner. She feels guilty as she might have given the wrong solution.

"What we did was answer, and I was really unsure about what the correct thing to put was and how to explain it."I was happy but at the same time very hesitant because my partner might blame me since my answer was different, and I changed our initial answer because I was really confused and I feel guilty about it.

Cherry in 2023 explained that one of the many reasons individuals talk to themselves is to solve problems. Experts suggest that speaking aloud to oneself can promote healthy and effective thought processing. It also supports introspection, self-motivation, memory recall, and provides guidance in problem-solving.

D. Thematic Analysis in the Interview and Journal of Pair D

Simpler Ways. Student 1D finds that sharing with others makes things simpler for her. However, there are still times when she gets more confused as there are a lot of different opinions. This makes her question which is right or wrong. They use smart people as their guide to the correct answer.

"Because it's better if it's simpler, right? No more, no more confusion..."sometimes we get confused because others have so many of their own things, we don't know what's right, oh it's

wrong.

Asking for opinions from others can help a person make decisions and solve problems. Seeking input from different individuals can provide a range of perspectives. However, receiving too many opinions can become overwhelming. According to Bellehumeur in 2022, over-consensus may result in delays in problem-solving and a reduction in critical thinking.

Buddy System. Student 2D prefers working with a partner rather than working alone. He felt nice since his partner offered an idea. He realized how a certain problem should be answered. He also prefers to work with a partner rather than a whole class as it deepens his understanding of the problem more.

"Kanang kuan sya nice, kay kung icompare bitaw nako na naa syay ihatag nga idea then marealize nako na ing anion diay. Mas nice jud magcommunicate jud sa partner nimo."

translation:"That thing is nice, because when I compare it, it gives an idea and then I realize that it's like this."It's really nice to communicate with your partner.

Just like on day 3 where he shared in his journal that he and his partner helped each other to figure out the solution to the given problem. They exchanged ideas and united as a team.

"We helped each other out, like figuring out how to get the answer, then I gave an idea and he did too, and we did alright because we united ourselves."

Amilin and Ariola in 2023 emphasized that mathematical communication enhances the relevance and usefulness of the learning process. When students present their arguments and solutions, they are required to reflect on fundamental mathematical concepts and establish clear connections between different ideas. This process not only improves their conceptual understanding but also enables them to apply their mathematical knowledge to a variety of new situations.

E. Synthesis

The importance of mathematical communication in enhancing learners' comprehension, problem-solving, and confidence was demonstrated by the thematic analysis of student interviews and journals. One theme ran through all of the pairs: organized conversation promoted reflective thinking and increased understanding through collaborative learning.

When dealing with math, students frequently reported that having a group or partner helped them understand challenging problems and reduced their sense of isolation. For example, Pair A reinforced metacognitive skills by stressing the importance of posing questions and defending one's response. Pair B showed how communication was facilitated by complexities, where dealing with challenging issues led to thoughtful conversations and collaborative problem-solving. Pair C demonstrated how self-questioning developed through supervised peer interactions and emphasized the fundamental role that arithmetic plays in daily life. Last but not least, Pair D emphasized the need for balance in group conversations by pointing out that although peer collaboration frequently made learning easier, having too many opposing viewpoints may be confusing.

When encouraged to clarify their reasoning and expand on their partner's ideas, the students' experiences demonstrated increased involvement, ownership, and confidence in solving arithmetic issues. In addition to strengthening their mathematical reasoning, students gained valuable social and communication skills through journaling and partnered conversations.

Amilin and Ariola in 2023, Proença et al. in 2024, and Cherry in 2023 all align with educational literature suggesting that mathematical communication strengthens conceptual understanding, promotes critical thinking, and fosters more meaningful learning experiences. The study demonstrates how peer dialogue and cooperative learning environments can bridge the gap in mathematical communication, thereby enhancing students' problem-solving abilities in authentic and reflective ways.

IV. CONCLUSION

Annisak and Wandini in 2023, as well as Pourdavood and Wachira in 2016, found that students recognize the importance of mathematical communication and discussing answers and ideas in class. They understand that math is applied in everyday life, which helps them share ideas and appreciate the role of communication in achieving success. This process not only supports their learning but also allows them to compare ideas with peers and verify their own answers. Previously, students might not have questioned their responses, but now they are more likely to seek help or compare answers with others.

Experiences with mathematical communication using the Think-Pair-Share approach were asked of the participants. Some students shared that they were hesitant to share answers with other students at first, as they thought it was a form of cheating, tried to resolve mistakes alone, had nothing to share, and doubted that their answer was correct. The students communicate with their partner by following a step-by-step communication, giving way for the partner, asking the partner to take down notes, asking other groups if both of them does not understand the problem, repeats a concept to understand, being patient with the partner, staying calm, follows partner's steps in solving, asking for next step, using both ideas, correcting each other, and sharing individual answer. The students feel that a new perspective opens to them, builds trust, and it is easier to solve problems when discussing with their partner. On the other hand, some students don't feel pressured, while others feel anxious and embarrassed, and see an improvement when sharing with the whole class.

When the students solve a problem with a partner during the grouping, they make sure that both of them understands the problem and solution by thinking independently first, practicing in advance, asking for help of others if they do not understand, reading and assessing the problem together, having faith with their answer, trying to recall formulas, through trial and error, and comparing their answer to other groups. Zunarni et al. in 2022 emphasized that discussing problems with a partner helps students better understand both the problem and its solution. Through these discussions, students can clarify topics, correct each other's mistakes, and learn from one another. The study also highlighted that students' ability to solve math problems improves when they communicate their ideas with others. This process eliminates the fear of embarrassment before reviewing,

prevents conflicts with partners, and enhances both communication and critical thinking skills. Additionally, it encourages students to share credit for solutions, apply their learning to real-life situations, ask questions, listen to others' ideas, and follow instructions effectively.

V. RECOMMENDATION

To enhance students' mathematical communication and problem-solving skills, teachers should continue using the Think-Pair-Share (TPS) approach and foster peer support to build confidence and deepen understanding through discussion. Emphasis should be placed on improving students' clarity of explanation and accuracy in solving problems, as these were noted areas of weakness. The mathematics curriculum should strengthen instruction on systems of linear equations and embed strategies that support both communication and problem-solving. Teachers are encouraged to provide clear, step-by-step reasoning rather than focusing solely on correct answers to help students identify and learn from their mistakes. Education policymakers should integrate structured communication strategies like TPS into the curriculum, alongside teacher training for effective implementation. Future research is recommended to examine how classroom participation influences accuracy in problem-solving to better understand the broader impact of TPS.

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