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UNDERSTANDING STUDENTS' MATHEMATICAL COMMUNICATION AND SELF-CONFIDENCE: IMPLICATIONS FOR STUDENT-CENTERED MATHEMATICS CLASSROOMS

Annisa Desti Fahjri¹, Siti Fatimah^{1*}, Tatang Herman¹

¹Universitas Pendidikan Indonesia, Jl. Dr. Setia Budi No.229, Bandung, Indonesia

*Email: sitifatihmah@upi.edu

Abstract

Mathematical communication and self-confidence are essential components of mathematics learning, yet many students still struggle to express mathematical ideas and lack confidence in communicating their opinions. This study aims to analyze students' mathematical communication skills and self-confidence and explore the pedagogical factors influencing these outcomes. A mixed-methods approach with an exploratory sequential design was employed involving eighth-grade students from a junior high school in Bandung. Data were collected through a self-confidence questionnaire, a mathematical communication test, and semi-structured interviews, and analyzed using quantitative and qualitative methods. The findings indicate that most students demonstrated moderate levels of mathematical communication (82.76%) and self-confidence (65.51%). Interviews revealed that limited classroom participation, fear of making mistakes, and teacher-centered instruction hindered the development of both skills. These findings highlight the importance of implementing more participatory, student-centered pedagogical practices to foster students' mathematical communication and self-confidence.

Keywords: *mathematical communication; self-confidence; pedagogical practices*

Abstrak

Komunikasi matematis dan kepercayaan diri merupakan komponen penting dalam pembelajaran matematika, tetapi banyak siswa masih kesulitan mengungkapkan ide matematis dan kurang percaya diri saat menyampaikan pendapat. Penelitian ini bertujuan menganalisis kemampuan komunikasi matematis dan kepercayaan diri siswa serta mengeksplorasi faktor-faktor pedagogis yang memengaruhinya. Penelitian menggunakan pendekatan *mixed methods* dengan desain *exploratory sequential* yang melibatkan siswa kelas VIII di salah satu SMP di Kota Bandung. Data dikumpulkan melalui angket, tes, dan wawancara semi-terstruktur, kemudian dianalisis secara kuantitatif dan kualitatif. Hasil menunjukkan bahwa sebagian besar siswa berada pada kategori sedang dalam kemampuan komunikasi matematis (82,76%) dan kepercayaan diri (65,51%). Wawancara mengungkap bahwa rendahnya partisipasi, ketakutan melakukan kesalahan, dan pembelajaran yang berpusat pada guru menghambat perkembangan kedua aspek tersebut. Temuan ini menegaskan pentingnya praktik pembelajaran yang lebih partisipatif dan berpusat pada siswa untuk mengembangkan komunikasi matematis dan kepercayaan diri.

Kata kunci: komunikasi matematis; kepercayaan diri; praktik pedagogik.

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INTRODUCTION

Communication is a process in which messages are conveyed from a source to a receiver with the aim of influencing the recipient. Communication serves to deliver ideas, discuss concepts, and develop deeper understandings. The ability to communicate effectively is essential in all aspects of life. Therefore, communication skills are crucial for everyone (Alimuddin et al., 2021). In the field of mathematics, communication ability is referred to as mathematical communication. This consists of two forms: oral and written mathematical communication (Hodiyanto, 2017). Students with strong mathematical communication skills are able to express their mathematical ideas and create various types of representations. As a result, they are more likely to find alternative solutions, which contributes to an improvement in their problem-solving abilities (Alimuddin et al., 2021). A study by Yani & Seobagyo (2023) revealed a significant increase in research interest related to mathematical communication from 2016 to 2021, indicating the growing importance of this topic in the development of modern mathematics education. However, international assessments such as the Programme for International Student Assessment (PISA) show that Indonesian students' mathematical communication skills remain relatively low. One contributing factor is their inability to transform abstract ideas into appropriate visual or symbolic representations, which is a key aspect of mathematical communication (Yani & Seobagyo, 2023).

One of the most critical factors influencing students' mathematical communication skills is self-confidence. In the context of mathematics education, self-confidence refers to students' belief in their ability to understand, solve, and communicate mathematical problems and ideas effectively. This psychological attribute is widely recognized as a general personality trait that significantly influences behavior and academic performance (Çiftçi & Yıldız, 2019). Students with high self-confidence tend to be more engaged in classroom discussions, unafraid to express their ideas even when unsure, and more resilient when facing complex mathematics tasks. This openness and confidence not only help them communicate their thinking more clearly but also promote deeper involvement with mathematical content. Conversely, students with low self-confidence often hesitate to participate for fear of making mistakes or being judged. This fear of failure or criticism leads them to remain silent, even when they have relevant ideas to share. Such behavior clearly impedes the development of their communication skills. Their lack of participation also limits opportunities to receive feedback and clarification, both of which are vital in the mathematics learning process.

Research by Aulia et al. (2021) supports this view, showing that students with high self-confidence are able to meet all mathematical communication indicators when solving problems such as expressing ideas with appropriate mathematical language and representing them using diagrams or symbols. On the other hand, students with low self-confidence display incomplete

communication, such as struggling to explain their reasoning or choosing the correct form of representation. A similar finding was reported by Wahyuni et al. (2024), who identified self-confidence as a significant predictor of students' success in solving geometry problems. Confident students consistently demonstrated far better performance than those lacking confidence.

However, in practice, many students still show low mathematical communication abilities, which are largely rooted in a lack of self-confidence especially in mathematics learning. A systematic review by Granello et al. (2025) found that interventions aimed at increasing math self-efficacy significantly improved academic performance and problem-solving abilities among middle school students. Additionally, Zakariya (2022) emphasized that low mathematical self-efficacy is closely linked to mathematics anxiety and reduced communication and problem-solving skills. These findings suggest that students' sense of inadequacy often leads them to remain silent, avoid discussion, and fail to utilize opportunities to develop ideas through social interaction in the mathematics classroom.

Self-confidence also has broader implications not only on individual performance, but also in fostering a collaborative and interactive learning environment. Confident students are more likely to help peers, engage in group discussions, and take an active role in cooperative learning activities, all of which significantly enhance their understanding and communication skills. Furthermore, self-confidence helps students cope with academic pressure, tackle unfamiliar problems, and take the intellectual risks necessary for high-level thinking. Lee & Stankov (2018) even noted that self-confidence is among the strongest predictors of achievement in mathematics, making it a critical factor for educators to consider when designing instructional approaches. In mathematics classrooms, students often struggle to express mathematical ideas not because they lack understanding, but because they are afraid of being wrong. Those with low confidence tend to focus more on potential negative outcomes such as embarrassment or failure than on the learning value of making mistakes. As a result, their thoughts remain unexpressed, and their ideas unexplored, creating a serious communication barrier in mathematics learning. In fact, effective communication is essential for conceptual understanding, mathematical reasoning, and collaborative problem-solving.

Pedagogical practices refer to the instructional strategies, classroom interactions, learning activities, and assessment approaches employed by teachers to facilitate students' learning and development. Effective pedagogical practices not only support students' cognitive growth but also influence affective aspects such as self-confidence, motivation, and willingness to participate in classroom discussions (Radil et al., 2023). In mathematics education, pedagogical practices that encourage interaction, exploration, collaboration, and reflection are considered essential for fostering mathematical communication and confidence in expressing mathematical ideas

(Fatmanissa et al., 2022; Planas & Pimm, 2024). Recent studies further emphasize that learner-centered and collaborative pedagogical approaches can enhance students' engagement, agency, mathematical discourse, and affective development, thereby creating more supportive environments for learning mathematics (Usmadi & Ergusni, 2025). Moreover, reflective learning activities and constructive feedback have been identified as important pedagogical elements that strengthen students' confidence and participation while promoting deeper mathematical understanding (Monteiro et al., 2021; Siller et al., 2024). Therefore, based on the discussion above, it is essential to evaluate and improve pedagogical practices in mathematics instruction not only to enhance students' mathematical communication abilities but also to foster their self-confidence. Instructional strategies should be designed to establish psychological safety, encourage student voice, and support risk-taking without fear of judgment. Approaches such as collaborative learning, peer discussions, and formative feedback can create a supportive learning environment that empowers students both cognitively and affectively, increases classroom participation, and encourages students to communicate their ideas more confidently (Gillies, 2016; Monteiro et al., 2021; Siller et al., 2024). By fostering students' belief in their mathematical abilities, educators can promote active participation, openness in expressing ideas, and meaningful engagement in the learning process. Ultimately, this will lead to more effective mathematical communication, deeper conceptual understanding, and improved academic outcomes.

Previous studies have shown that mathematical communication skills and self-confidence are important factors in students' mathematics learning (Aulia et al., 2021; Wahyuni et al., 2024). However, most studies have primarily focused on examining the relationship between these variables or measuring students' achievement levels, with limited attention given to how classroom pedagogical practices may facilitate or hinder the simultaneous development of mathematical communication and self-confidence. Furthermore, studies that combine quantitative descriptions of students' profiles with qualitative exploration of learning experiences remain limited, particularly in the context of Indonesian junior high school mathematics classrooms. Therefore, this study seeks to fill this gap by examining students' mathematical communication skills, self-confidence, and the pedagogical practices associated with these outcomes.

This study aims to describe students' levels of mathematical communication and self-confidence, identify weaknesses in instructional practices that affect these two aspects, and provide pedagogical implications for enhancing mathematical communication and fostering greater self-confidence in mathematics learning.

METHOD

Participants

The population in this study consisted of eighth-grade students at a junior high school in Bandung during the even semester of the 2024/2025 academic year. The sample was selected using a purposive sampling technique. According to Creswell & Creswell (2017), 'purposive sampling is a sampling technique in which the researcher selects participants based on specific criteria.' Based on this technique, one class was chosen as the sample, namely class VIII B, for the topic of basic geometry. The selection of this class was based on the results of discussions and interviews with the homeroom teacher and the subject teacher, who stated that class VIII B was one of the classes facing challenges in improving students' self-confidence and mathematical communication skills, particularly in learning basic geometry. Furthermore, during the learning process, students in this class often struggled to visualize geometric concepts, which are an essential and critical part of understanding the material.

Research Design and Procedures

This study employed a mixed-methods approach using an Explanatory Sequential Design. This design was selected because it allows quantitative data to be collected and analyzed in the first phase, followed by qualitative data collection to provide a deeper explanation and interpretation of the quantitative findings. The integration of both types of data enabled a more comprehensive understanding of students' mathematical communication skills, self-confidence, and the classroom factors associated with these outcomes.

In the first phase, quantitative data were collected through a self-confidence questionnaire and a mathematical communication skills test administered to all students. The quantitative results were analyzed to identify students' levels of self-confidence and mathematical communication skills. In the second phase, qualitative data were collected through semi-structured interviews with selected students and the mathematics teacher. Students were selected based on their self-confidence levels, and the interviews were subsequently conducted to explore their self-confidence and mathematical communication performance in greater depth.

The research procedures consisted of three stages: planning, implementation, and data analysis. The planning stage involved preparing and validating the research instruments and determining the research participants. During the implementation stage, students were first given a self-confidence questionnaire, and the results were used to classify them into high, medium, and low self-confidence categories. Based on these classifications, six students representing the three categories were selected for interviews regarding their questionnaire responses. Subsequently, all students completed a mathematical communication skills test consisting of five essay questions on basic geometry topics, including triangles, quadrilaterals, and the Pythagorean Theorem. Follow-

up interviews were then conducted with the selected students to explore their responses to the test in greater depth. In addition, an interview with the mathematics teacher was conducted to obtain information regarding classroom learning practices and to support data triangulation. The final stage involved analyzing and integrating quantitative and qualitative findings to draw conclusions regarding students' mathematical communication skills, self-confidence, and the pedagogical practices that may support or hinder the development of these aspects.

To ensure the credibility of the findings, source triangulation was conducted by comparing information obtained from the self-confidence questionnaire, mathematical communication skills test, student interviews, and teacher interviews. Consistency across these data sources was examined to verify emerging findings and strengthen the trustworthiness of the interpretations.

Instruments

The instruments used in this study included a self-confidence questionnaire consisting of 20 statement items, an interview guide, and a mathematical communication skills test consisting of five essay questions. The self-confidence questionnaire and the mathematical communication skills test were administered to students in class VIII B. The self-confidence questionnaire was used to classify students based on their level of self-confidence, which was categorized into three levels: high, medium, and low.

The self-confidence questionnaire consisted of 20 statements developed based on a self-confidence blueprint. This instrument was constructed using the Guttman scale, which provides two answer choices: Yes or No. The Guttman scale, in the context of questionnaire assessment, assigns scores based on the respondent's level of agreement with the statements. For favorable (positive) statements, a score of 1 is given for a "Yes" or "True" response, and a score of 0 for a "No" or "False" response. Conversely, for unfavorable (negative) statements, a score of 1 is assigned for a "No" or "False" response, and a score of 0 for a "Yes" or "True" response. A detailed scoring scheme is presented in the following Table 1.

Table 1. Scoring Rubric for the Guttman Scale

Category	Score for Correct Statement	Score for Incorrect Statement
Yes	1	0
No	0	1

The Guttman scale is an appropriate choice for measuring hierarchical or cumulative variables such as self-confidence, as this construct typically develops gradually. This scale allows for the analysis of response consistency by examining whether participants follow an ordered response pattern, making it easier to categorize the results into low, medium, or high levels of self-confidence.

In addition, the Guttman scale uses a dichotomous format (two answer choices), which simplifies the data analysis process. Researchers can directly classify students based on their level

of self-confidence without the need for complex scoring calculations. Another advantage is that this scale has been widely used in previous studies. Therefore, researchers can adapt existing instruments without having to revalidate them from scratch, saving both time and effort. The Guttman scale is also highly suitable for studies using a mixed methods approach. The categorization results from this scale can be directly used to select subjects for in-depth interviews, such as comparing students with high and low levels of self-confidence.

The indicators used in the student self-confidence questionnaire are presented in Table 2. All twenty statements in the questionnaire were developed based on these self-confidence indicators. A sample of the student self-confidence questionnaire is presented in Table 3.

Table 2. Indicator of the Self-Confidence Questionnaire

No	Dimension	Indicator	Statement Numbers		Total
			Positive	Negative	
1.	Self-Belief	Confidence in one's ability to complete assigned tasks	1	2	2
		Confidence in one's ability to overcome difficulties in task completion	3	4	2
		Confidence in one's ability to choose appropriate strategies for task completion	6	5	2
2.	Perseverance	Willingness to complete tasks until learning goals are achieved	7,8	9,10	4
		Strong belief in one's potential to complete tasks	11	12	2
3.	Hope	Viewing tasks as a means to achieve goals	13	14	2
		Commitment to completing academic tasks properly	15	16	2
4.	Social Relations	Using others' success as a benchmark for personal goal achievement	17	18	2
		Drawing from life experiences as a step toward achieving success	19	20	2
Total					20

Table 3. Sample Items from the Student Self-Confidence Questionnaire

No	Statement	Answer	
		Yes	No
1.	I am confident that I can do well on the math test because I have studied diligently.		
2.	I do not feel confident about completing all math assignments because the formulas are numerous and difficult for me to understand.		
3.	I am confident that I can do well on the math test and get good results, even with limited study time.		
4.	I do not feel confident in finding solutions when encountering problems in completing given tasks.		
5.	I copy my math homework from a friend because I am not confident in my own abilities.		
...	...		

The mathematical communication skills test instrument consists of five essay questions. The questions used in this test are based on basic geometry topics (triangles, quadrilaterals, and the

Pythagorean Theorem). The test instrument was developed based on mathematical communication indicators and is accompanied by an assessment rubric, as shown in the following Table 4.

Table 4. Indicators and Scoring Rubric for Mathematical Communication Skills

Indicator	Student Response	Score	Question Number
Connecting real objects, images, and diagrams to mathematical ideas	Correct answer, able to connect real objects, images, and diagrams to mathematical ideas.	4	No 1
	Correct answer, meets criteria with minor errors.	3	
	Correct answer but does not meet most of the criteria.	2	
	Correct answer but does not meet the criteria at all.	1	
	No answer provided.	0	
Explaining mathematical ideas, situations, and relationships in writing	Correct answer, able to explain ideas, situations, and mathematical relationships in writing.	4	No 3 and 4
	Correct answer, meets criteria with minor errors.	3	
	Correct answer but does not meet most of the criteria.	2	
	Answer is provided but does not meet the criteria at all.	1	
	No answer provided.	0	
Expressing events or ideas using mathematical language or symbols	Correct answer, able to express real-life events using mathematical language or symbols.	4	No 2 and 5
	Correct answer, meets criteria with minor errors.	3	
	Correct answer but does not meet most of the criteria.	2	
	Answer is provided but does not meet the criteria at all.	1	
	No answer provided.	0	
Maximum Score		20	

The questionnaire and test instruments used in this study were adapted from the studies conducted by Pratiwi (2021) and Hodiyanto (2017). This adaptation was carried out to utilize findings from previous research that are relevant to the current study. By adapting existing instruments, the researcher was able to save time and effort in the instrument development process, while also ensuring that the instruments used had been previously tested for validity and reliability. Furthermore, both the questionnaire and the test instruments were approved by a lecturer in mathematics education at the Universitas Pendidikan Indonesia.

Data Analysis

The analysis of the students' self-confidence questionnaire results was used to determine whether their level of self-confidence was low, medium, or high. Meanwhile, the analysis of the test results was carried out based on the indicators of mathematical communication skills, which include: (1) connecting real objects, images, and diagrams to mathematical ideas, (2) explaining

mathematical ideas, situations, and relationships in writing, and (3) expressing events or ideas in mathematical language or symbols.

The data analysis process was conducted through three stages: data reduction, data display, and conclusion drawing. In the data reduction stage, students' responses to the self-confidence questionnaire were scored using the Guttman scale. Each student's total score was then calculated and categorized into three levels of self-confidence using the mean and standard deviation criteria. Students with scores below one standard deviation from the mean were classified as having low self-confidence, students with scores within one standard deviation of the mean were classified as having moderate self-confidence, and students with scores above one standard deviation from the mean were classified as having high self-confidence.

Based on this categorization, students were purposively selected as interview participants to represent different levels of self-confidence. The researcher initially intended to select two students from each category (low, moderate, and high). However, because no students were classified in the high self-confidence category, the interview participants were selected only from the low and moderate categories.

Following the categorization process, a mathematical communication skills test consisting of five essay questions was administered to all students in Class VIII B. The test responses were analyzed based on three indicators of mathematical communication: (1) connecting real objects, images, and diagrams to mathematical ideas, (2) explaining mathematical ideas, situations, and relationships in writing, and (3) expressing situations or ideas using mathematical language and symbols.

After the test results had been analyzed, the selected students participated in a second round of interviews to explore their written responses in greater depth. The interview data were subsequently compared with the questionnaire results, written test responses, and teacher interview data to strengthen the credibility of the findings through methodological triangulation. In this study, the interpretation of students' mathematical communication skill scores was determined using the mean and standard deviation of the students' final scores in mathematical communication, as shown in the following Table 5.

Table 5. Categorization of Students' Mathematical Communication Skills

Interval	Category
$X < \text{mean} - SD$	Low
$\text{Mean} - SD \leq X \leq \text{mean} + SD$	Moderate
$X > \text{mean} + SD$	High
$X < 14,13 - 3,39 = 10,74$	
$X > 14,13 + 3,39 = 17,52$	

Note:

X = Subject score

Mean = Average score

SD = Standard Deviation

After completing the entire data collection process from the students, the researcher proceeded to the next stage by conducting a discussion and a brief interview with the subject teacher who taught in class VIII B. This interview aimed to obtain additional relevant information, deepen the understanding of the classroom context, and strengthen as well as verify the data previously obtained through questionnaires, written tests, and student interviews. Through the teacher's perspective, the researcher was able to gain a broader insight into the learning dynamics in the classroom, particularly concerning students' self-confidence and mathematical communication skills in understanding basic geometry concepts.

RESULTS AND DISCUSSION

This study employed a mixed-methods approach, combining both quantitative and qualitative data, to describe the relationship between mathematical communication skills and self-confidence among eighth-grade students in class VIII B during mathematics learning. The findings revealed that the majority of students fell into the medium category for both aspects. Specifically, 82.76% of the students demonstrated a medium level of mathematical communication skills, while 65.51% had a medium level of self-confidence.

These results are consistent with the findings of Aulia et al. (2021), which indicate that students with moderate self-confidence are generally only able to fulfill part of the indicators of mathematical communication skills. In contrast, students with high self-confidence tend to exhibit more complete and comprehensive mathematical communication abilities.

To examine the relationship between the two variables in more detail, the researcher constructed a cross-tabulation matrix based on the results of the self-confidence questionnaire and the mathematical communication skills test:

Table 6. Cross-Tabulation Matrix of Self-Confidence and Mathematical Communication Skills

Self-Confidence \ Mathematical Communication	Low	Medium	High
Low (10 students)	1	9	0
Medium (19 students)	0	15	4
High (0 students)	0	0	0

Table 6 illustrates that most students with low self-confidence fall into the medium category in terms of mathematical communication skills. Only one student demonstrated low scores in both variables, and notably, no students were classified as having high self-confidence. This finding is

particularly important because it suggests that none of the students demonstrated a strong level of confidence in their mathematical abilities.

The absence of students in the high self-confidence category may indicate that students generally experience uncertainty when expressing mathematical ideas, participating in discussions, or communicating their reasoning in front of others. Although most students were categorized as having moderate self-confidence, this does not necessarily imply that they feel fully confident in mathematics learning. Rather, it suggests that students may still hesitate to actively engage in classroom interactions and mathematical communication activities.

From a pedagogical perspective, this finding highlights the need for instructional practices that intentionally support students' confidence development. Learning environments that encourage discussion, provide constructive feedback, value students' thinking processes, and create psychological safety may help students become more confident in expressing mathematical ideas.

However, being in the moderate category does not mean students are without challenges. Based on interview results, students in this category tend to "play it safe." They cognitively understand the material but are hesitant to explain it in front of others. One student, R, expressed:

"I actually understand the problem, but when I'm asked to explain it to my friends or in front of the class, I get nervous. I'm afraid that if I explain it wrong, my classmates will laugh at me. So, I'd rather just stay quiet."

This statement reveals the presence of affective barriers that hinder students from expressing their mathematical ideas. Such barriers are closely related to the emotional and social climate in the classroom. According to Monteiro et al. (2021), a psychologically safe learning environment is essential for students to actively engage in thinking and communication.

Based on the interviews with students and the subject teacher, the learning process was generally described as teacher-centered. Students reported that classroom interactions were limited and that opportunities to ask questions or express mathematical ideas were relatively rare. One student explained that when the teacher asked whether there were any questions, most students preferred to remain silent, even when they did not fully understand the material. This suggests that two-way communication had not been effectively established in the classroom. Such conditions may hinder the development of students' mathematical communication skills and self-confidence, as active participation and open discussion are important components of meaningful mathematics learning.

"I once wanted to ask a question, but when I raised my hand, a friend next to me said, 'You don't get that?'. Since then, I've been reluctant to ask questions again. I'd rather pretend I understand."

This further supports the finding that a socially unsupportive classroom climate discourages students from participating actively, particularly in asking questions or explaining. In such a context, humanistic and reflective approaches are necessary. Siller et al. (2024) emphasize that teachers need to create a judgment-free learning atmosphere, where students feel safe to express their thoughts.

Additionally, interviews with the teacher confirmed that time for discussion was often very limited. The teacher admitted to not being familiar with collaborative learning models due to pressure to complete curriculum targets. However, as shown by Mustafa (2022), the use of collaborative learning models significantly improves students' mathematical communication skills compared to conventional methods.

It was also found that students with moderate communication skills but low self-confidence tended to complete only parts of the problems. They often lacked confidence in their answers or struggled to explain their thinking process. This aligns with the questionnaire results, in which the hope dimension of self-confidence (the belief that one can succeed in mathematics) had the lowest score, at 28.45%. One student, M, stated:

"I've always thought math is hard. I don't think I can understand it like my friends do. So whenever I get a problem, I immediately think, 'I'm going to get this wrong'."

This statement reflects a negative self-belief which, if left unaddressed, may affect how students learn and grow. In such situations, instructional strategies like Math Talk could be a viable solution. Robb-hagg (2021) explains that engaging students in small group math discussions can gradually help them express ideas without fear of being wrong. This method effectively builds self-confidence over time.

Research by Tatal & Yazar (2023) also supports active learning approaches. Their meta-analysis found that such methods significantly improve student learning outcomes ($g = 1.005$) and material retention ($g = 1.204$). This means that when students are actively involved in the learning process, they not only learn better but also gain greater confidence to keep learning.

However, in Indonesia, mathematics instruction still tends to overemphasize final results. Thinking processes, collaboration, and the ability to articulate ideas are often overlooked. Yet, according to Gillies (2016), cooperative learning that emphasizes positive interdependence and promotive interaction not only improves academic achievement but also helps students develop social skills and self-confidence.

Therefore, the teacher's role must shift from merely delivering content to becoming a facilitator of students' thinking and communication processes. Johnson & Johnson (2013) state that modern cooperative learning includes five essential elements: positive interdependence, individual accountability, face-to-face promotive interaction, social skills, group processing

(evaluation). These five elements support a more balanced learning experience that addresses both the cognitive and affective needs of students.

CONCLUSION

This study found that students' mathematical communication skills and self-confidence generally remained at the moderate level, indicating that many students still experience difficulties in expressing mathematical ideas and participating actively in mathematics learning. The findings suggest that teacher-centered pedagogical practices, limited opportunities for discussion, and insufficient support for students' participation may hinder the development of both mathematical communication and self-confidence.

An important finding of this study is that no students were categorized as having high self-confidence. This suggests that students generally lack strong confidence in expressing mathematical ideas, asking questions, and communicating their reasoning in classroom settings. The absence of students in the high self-confidence category indicates that existing classroom practices have not yet fully supported the development of students' confidence and active engagement in mathematics learning.

These findings highlight the importance of implementing more student-centered pedagogical practices that encourage discussion, collaboration, reflection, and constructive feedback. Mathematics instruction should not only focus on academic achievement but also foster a supportive and psychologically safe learning environment that helps students develop confidence alongside their mathematical communication skills. Therefore, strengthening students' self-confidence and mathematical communication should be considered an essential pedagogical goal in mathematics education.

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REFERENCES

- Ahmed, A., Pereira, L., & Jane, K. (2024). Mixed methods research: Combining both qualitative and quantitative approaches. Research Gate.(PDF) *Mixed Methods Research: Combining both qualitative and quantitative approaches*.
- Alimuddin, Talib, A., & Amin, G. (2021). Deskripsi Kemampuan Komunikasi Matematis Siswa SMK berdasarkan Tingkat Kepercayaan Diri. *Issues in Mathematics Education*, 5(1), 39–46. <https://eprints.unm.ac.id/30431/>

- Aulia, R., Rohati, & Marlina. (2021). The Students' Self-Confidence and Their Mathematical Communication Skills in Solving Problems. *Edumatika: Jurnal Riset Pendidikan Matematika*, 4(2), 90–103. <https://ejournal.iainkerinci.ac.id/index.php/edumatika/article/view/770>
- Çiftçi, K., & Yildiz, P. (2019). The effect of self-confidence on mathematics achievement: The meta-analysis of Trends in International Mathematics and Science Study (TIMSS). *International Journal of Instruction*, 12(2), 683–694. <https://doi.org/10.29333/iji.2019.12243a>
- Creswell, J. W., & Creswell, J. D. (2017). Research Design: Qualitative and Quantitative Approaches (Fifth Edition). In *Sage publications*. <https://doi.org/10.2307/328794>
- Fatmanissa, N., Yuli Eko Siswono, T., Lukito, A., & Rahaju, E. B. (2022). Collaborative Problem Solving in Mathematics : A Systematic Literature Review. *Pedagogika*, 148(4), 45–65.
- Gillies, R. M. (2016). Cooperative learning: Review of research and practice. *Australian Journal of Teacher Education*, 41(3), 39–54. <https://search.informit.org/doi/abs/10.3316/informit.977489802155242>
- Granello, F., Cuder, A., Doz, E., Pellizzoni, S., & Passolunghi, M. C. (2025). Improving math self - efficacy and math self - concept in middle school : a narrative systematic review. *European Journal of Psychology of Education*, 40(1), 1–25. <https://doi.org/10.1007/s10212-025-00939-5>
- Hodiyanto. (2017). Kemampuan Komunikasi Matematis Dalam Pembelajaran Matematika. *AdMathEdu*, 7(1), 9–18.
- Johnson, D. W., & Johnson, R. T. (2013). Cooperation and the use of technology. In *In Handbook of research on educational communications and technology*. <https://www.taylorfrancis.com/chapters/edit/10.4324/9781410609519-41/cooperation-use-technology-david-johnson-roger-johnson>
- Lee, J., & Stankov, L. (2018). Non-cognitive predictors of academic achievement: Evidence from TIMSS and PISA. *Learning and Individual Differences*, 65, 50–64. <https://doi.org/10.1016/j.lindif.2018.05.009>
- Monteiro, V., Carvalho, C., & Santos, N. N. (2021). Creating a Supportive Classroom Environment Through Effective Feedback : Effects on Students' School Identification and Behavioral Engagement. *Frontiers in Education*, 6(June), 1–14. <https://doi.org/10.3389/feduc.2021.661736>
- Mustafa, A. N. (2022). Collaborative Learning's Effect on Mathematical Communication Skill. *International Journal for Multidisciplinary Research (IJFMR)*, 4(6), 1–6. <https://www.academia.edu/download/96321745/1068.pdf>
- Planas, N., & Pimm, D. (2024). Mathematics education research on language and on communication including some distinctions : Where are we now ? *ZDM – Mathematics Education*, 56(1), 127–139. <https://doi.org/10.1007/s11858-023-01497-0>
- Pratiwi, K. H. (2021). Hubungan Antara Kepercayaan Diri dan Kemampuan Metakognitif Terhadap Prestasi Belajar Fisika Siswa Kelas X MIPA SMA Negeri 1 Baturiti. (*Doctoral dissertation, Universitas Pendidikan Ganesha*), 29, 93–265. <https://repo.undiksha.ac.id/id/eprint/7553>
- Radil, A. I., Goegan, L. D., & Daniels, L. M. (2023). Teachers' authentic strategies to support student motivation. *Frontiers in Education*, February, 1–11. <https://doi.org/10.3389/feduc.2023.1040996>
- Robb-hagg, A. (2021). *Building Mathematical Confidence : Using Math Talk in a Second Language Context* (Vol. 56, Nomor 1). [https://www.cealata.com/uploads/files/Building Mathematical Confidence.pdf](https://www.cealata.com/uploads/files/Building%20Mathematical%20Confidence.pdf)
- Siller, H., Ahmad, S., & Agheer. (2024). Analyzing the impact of collaborative learning approach on grade six students' mathematics achievement and attitude towards mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, 20(2), em2395. <https://www.ejmste.com/article/analyzing-the-impact-of-collaborative-learning-approach-on-grade-six-students-mathematics-14153>
- Total, Ö., & Yazar, T. (2023). Active Learning Improves Academic Achievement And Learning Retention In K-12 Settings: A Meta-Analysis. *i-Manager's Journal on School Educational*

- Technology*, 18(3), 1. https://www.researchgate.net/profile/Oezguer-Tutal/publication/379038306_Active_Learning_Improves_Academic_Achievement_and_Learning_Retention_in_K-12_Settings_A_Meta-Analysis/links/680b703360241d51401ae75d/Active-Learning-Improves-Academic-Achievement-and-Learning-Retention-in-K-12-Settings-A-Meta-Analysis.pdf
- Usmadi, & Ergusni. (2025). Innovative Pedagogical Models in Mathematics Education : A Systematic Review of Global Challenges, Trends, and Future Research Directions. *International Journal of Learning, Teaching and Educational Research*, 24(9), 167–191.
- Wahyuni, R., Juniati, D., & Wijayanti, P. (2024). How do Math Anxiety and Self-Confidence Affect Mathematical Problem Solving? *TEM Journal*, 13(1), 550–560. <https://doi.org/10.18421/TEM131-58>
- Yani, N. F., & Seobagyo, J. (2023). Bibliometric Analysis of Mathematical Communication Skills Using Scopus Database. *Jurnal Pendidikan Matematika dan IPA*, 14(1), 57–68. <https://jurnal.untan.ac.id/index.php/PMP/article/view/53902>
- Zakariya, Y. F. (2022). Improving students' mathematics self-e cacy : A systematic review of intervention studies. *Frontiers in Psychology*, 13, 986622. <https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.986622/full>