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Problem-Based Learning and Social Emotional Analysis of Students' Written Math Communication

Evita Nasuwa Mufidah[1], Yus Mochamad Cholily[2*], Alfiani Athma Putri Rosyadi[3], Akhsanul In'am[4]

[1,2*,3,4]**Mathematics Education, Universitas Muhammadiyah Malang**
Jalan Raya Tlogomas No.246 Lowokwaru, Malang, East Java, Indonesia
[1]*evitanasuwa@gmail.com*; [2*]*yus@umm.ac.id*; [3]*alfi_rosyadi@umm.ac.id*;
[4]*akhsanul@umm.ac.id*

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Abstrak

Penelitian ini bertujuan untuk menganalisis komunikasi matematika tertulis siswa kelas VIII SMP terhadap materi kongruensi konstruksi segitiga. Pengumpulan data dilakukan melalui dua metode, yaitu tes tertulis untuk mengukur komunikasi matematis dan observasi untuk menilai aspek sosial-emosional siswa dengan menggunakan model pembelajaran berbasis masalah. Penelitian ini menggunakan metode deskriptif dengan pendekatan kualitatif. Teknik analisis data dilakukan melalui reduksi data, penyajian data, dan penarikan kesimpulan, dengan klasifikasi berdasarkan kategori tinggi, sedang, dan rendah dalam indikator komunikasi matematis. Berdasarkan hasil analisis, siswa dengan tingkat sosial-emosional yang tinggi menunjukkan komunikasi matematis yang tinggi, memungkinkan mereka untuk mengekspresikan dan menafsirkan ide matematika secara tertulis serta menggunakan simbol matematika dalam pemecahan masalah. Sebaliknya, siswa dengan tingkat sosial-emosional rendah menunjukkan kesulitan dalam mengekspresikan ide-ide matematika secara tertulis. Simpulan dari penelitian ini menunjukkan bahwa terdapat hubungan antara tingkat sosial-emosional dengan kemampuan komunikasi matematis siswa. Implikasinya, guru perlu mempertimbangkan integrasi pendekatan sosial-emosional dalam pembelajaran untuk meningkatkan komunikasi matematis siswa secara optimal dan merata.
Kata Kunci: komunikasi matematis; pembelajaran berbasis masalah; sosial emosional

Abstract

This study aims to analyze the written mathematical communication of eighth-grade junior high school students regarding the topic of triangle construction congruence. Data collection was conducted through two methods: a written test to measure mathematical communication and observation to assess students' socio-emotional aspects using a problem-based learning model. This study employed a descriptive method with a qualitative approach. Data analysis techniques were carried out through data reduction, data presentation, and drawing conclusions, with classification based on high, medium, and low categories in mathematical communication indicators. Based on the analysis results, students with high socio-emotional levels demonstrated strong mathematical communication, enabling them to express and interpret mathematical ideas in writing and use mathematical symbols in problem-solving. Conversely, students with low socio-emotional levels showed difficulty in expressing mathematical ideas in writing. The conclusions of this study indicate a relationship between socio-emotional levels and students' mathematical communication abilities. Consequently, teachers need to consider integrating socio-emotional approaches into learning to optimally and equitably improve students' mathematical communication.
Keywords: mathematical communication; problem-based learning; socio-emotional

I. INTRODUCTION

Students' mathematical communication skills are critical and can affect the learning process of students, considering that mathematical communication is a student's skill in conveying mathematical information and ideas through discussion, presentation, and expressing them using graphs, pictures, tables, equations, or their language into mathematical models orally and in writing (Qirom et al., 2023). The National Council of Teachers of Mathematics (NCTM) states that the purpose of mathematics learning includes five basic skills, namely problem-solving, communication skills, connection capability, reasoning skills, and representational abilities (Maulyda, 2020; Pradiarti & Subanji, 2022). NCTM clearly states that one of the goals of mathematics learning is that students must have mathematical communication skills.

Students who have good mathematical communication skills will tend to adapt more easily to others (Ikhsan & Afriansyah, 2023). Wherever they are, this ability is considered very important to have, especially by students, because students need mathematical communication skills to carry out mathematics learning and solve problems in daily life.

To create learners with good mathematical communication skills, of course, efforts are needed, especially for those who are considered not to have developed their communication skills. These efforts are called approaches. The approaches that can be taken can be various, including a social-emotional approach to arouse students' social sensitivity (Avandra et al., 2023). The social-emotional approach can be applied using a problem-based learning model, which requires students to get used to solving a problem from a case and be active in learning (Ardiansyah & Wahyuningrum, 2022; Fadhil et al., 2023; Rahayu, Puspitasari, & Luritawaty, 2024). Previous research has shown that the activeness and learning outcomes of a student can be increased through the process of implementing problem-based learning, so that it is hoped that their communication skills will also begin to appear, improve, and ultimately develop (Putri & Sundayana, 2021; Mayasari et al., 2022; Nofriyandi et al., 2024).

Students with low social and emotional skills tend to pay less attention to others, have less pleasant interactions, lack confidence, rarely communicate with others, and feel uncomfortable during the learning process (Aurelia, et al. 2024). Good emotional management can help students be more open to difficulties, more confident when communicating, and better able to collaborate with their peers (Kintoko et al., 2023). Therefore, emotional and social factors are very influential in achieving optimal learning outcomes (Hidayatullaily et al., 2023).

In general, students' math skills are often tested through a written form. Therefore, students need to have good mathematical communication skills in order to be able to convey their ideas clearly through writing. Even so, the results of previous research show that students' written mathematics communication skills are still relatively low and need to be improved (Hanisah & Noordyana, 2022). Other research shows that students' math

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communication skills in writing are lower than in oral.(Sari et al., 2021). Because students' written mathematics communication skills are still relatively low, it is necessary to conduct a more in-depth analysis to find out the indicators that are still obstacles and the types of difficulties faced. Therefore, this research will specifically focus on the aspect of mathematical communication in written form.

This study explores students' written mathematical communication using a social-emotional approach and examines the challenges they face in expressing mathematical ideas in writing. The insights gained can guide teachers in selecting appropriate strategies to support students' communication skills, enabling differentiated instruction that promotes equity. Such efforts help create fair and inclusive mathematics learning environments, improving access and outcomes for all students while addressing social disparities in education (Swari et al., 2021).

The importance of this research lies in its effort to explore the relationship between students' written mathematical communication skills and their social-emotional competencies an area that has received limited attention in mathematics education studies. Most instructional approaches tend to focus primarily on cognitive development and conceptual mastery, often neglecting the affective factors that influence how students express their understanding in writing.

The novelty of this study lies in the integration of a social-emotional approach with the Problem-Based Learning (PBL) model to analyze students' written mathematical communication skills. This study not only qualitatively assesses students' written communication outcomes but also connects them to their social-emotional levels observed throughout the learning process. By combining two essential domains cognitive and affective this research offers a new contribution to a more comprehensive understanding of how written mathematical communication skills develop within an emotionally and socially student-centered learning environment.

II. METHOD

This study uses a descriptive qualitative research method to describe or explain students' written mathematical communication skills through a social-emotional approach (Waruwu, 2023).

The subjects of this study consisted of 14 students in grade VIII of SMPN 3 Satap Karangploso on Wednesday, February 5, 2025, and Friday, February 7, 2025. Data were obtained through students' written math tests and student observations. The research instruments used were mathematical problems with triangular congruence material and observation sheets to measure students' social-emotional performance. Before the test questions are given to students, they are first checked by experts (validators) to see if they are valid and suitable for measuring students' mathematical communication skills.

Table 1 shows the indicators of students' mathematical communication

adapted from (Sukmawati & Siswono, 2021). Moreover, Table 2 shows the student's written mathematical communication assessment guidelines. The assessment guidelines for students' mathematical communication are adapted from (Aulia et al., 2024). Each indicator was used to categorize students into three levels of mathematical communication ability. Since the study focused specifically on written mathematical communication, the analysis relied solely on students' responses in their written answer sheets. As a result, no interviews were conducted.

Table 1.
Mathematical Communication Indicators

No	Written Mathematical Communication Indicators	Indicators of Verbal Mathematical Communication
1	Present mathematical ideas, present and describe them visually (*Drawing*).	Presenting mathematical ideas orally (*Drawing*).
2	Expressing mathematical ideas in writing (*Written Text*).	Expressing mathematical ideas orally (*Written Text*).
3	Using mathematical terms or notations and their structure to present ideas (*Mathematical Expression*).	Using mathematical terms or notations and their structures to present ideas orally (*Mathematical Expression*).

(Sukmawati & Siswono, 2021)

Table 2.
Mathematical Communication Categories and Assessment

No	Value Scale	Category
1	$75\% < x \leq 100\%$	Tall
2	$60\% < x \leq 75\%$	Keep
3	$0\% < x \leq 60\%$	Low

(Aulia et al., 2024)

The observation sheet is first checked by experts (validators) to see if it is valid and suitable for measuring students' social-emotional levels. Table 3 shows the components of the social-emotional approach and the problem-based learning stages adapted from (Kisandi, 2023) and (Miranda et al., 2024).

Table 3.
PBL Stage with a Social Emotional Approach

No	Problem-Based Learning Stage	Components of the Social Emotional Approach	Student Activities
1	Introduction	Self-awareness	Students expressed their news when the teacher asked
			Students write down their feelings before starting learning on sticky notes or memos.
			Students understand the learning objectives conveyed by the teacher.
			Students understand their abilities when taking diagnostic test quizzes.
		Relationship-building skills	Students do questions and answers with the teacher at the beginning of learning.
		Self-management	Students are motivated when the teacher conveys the importance of learning the congruence of geometric shapes and builds using meaningful

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No	Problem-Based Learning Stage	Components of the Social Emotional Approach	Student Activities
			understanding.
2	Stage 1 Student orientation on the problem	Social Awareness	Students appreciate the teacher by paying attention when the teacher explains.
		Self-awareness	Students understand the problems shown on the PowerPoint as discussion material in the LKPD
3	Stage 2 Organizing students to learn	Self-management	Students try to complete the assignment given by the teacher
		Relationship-building skills	Students work together in groups to complete LKPD.
4	Stage 3 Guiding individual and group investigations	Responsible decision-making	Students divide the assignment for each group member
		Social Awareness	Students value their friend's point of view when their friend has an opinion.
5	Stage 4 Develop and present works	Self-awareness	Students dare to volunteer to make presentations
		Relationship-building skills	Students asked questions and received answers from the group that performed the performance.
6	Stage 5 Analyze and evaluate the problem-solving process	Self-awareness	Students are able to express their feelings when they understand the material.
7	Cover		Students convey material conclusions from the learning process.
			Students provide reflections on the learning that has been carried out.

Data were collected using two primary instruments. The first was a written test based on triangle congruence material, designed to assess students' written mathematical communication skills. The test items were validated by experts to ensure their appropriateness for measuring the intended competencies. The second instrument was an observation sheet used to evaluate students' social-emotional behaviors throughout the learning process, developed based on social-emotional components and the stages of problem-based learning (PBL).

The data analysis technique in this study consisted of three stages: data reduction, data display, and conclusion drawing. Data reduction was carried out by selecting and focusing the raw data according to the research objectives. Data display involved organizing the information into tables and descriptive narratives to facilitate interpretation. Finally, conclusions were drawn based on the classification of students' written mathematical communication skills into three levels high, moderate, and low which were analyzed descriptively and linked to each student's observed social-emotional level.

III. RESULT AND DISCUSSION

A. Result

Observation of the social-emotional approach was carried out during learning using a problem-based learning model, where five stages of learning begin with an

introduction and end with a conclusion. Observations were carried out on 14 students with three observers, and 15 activities were observed. The data below are found.

Learning Stages	Component PSE	Student Activities	No. Participant																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14	
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Introduction	Self Awareness	Activity 1	√		√		√		√		√		√		√		√		√		√		√		√		√		√	
		Activity 2	√		√		√		√		√		√		√		√		√		√		√		√		√		√	
	Relationship Skill	Activity 3	√		√		√		√		√		√		√		√		√		√		√		√		√		√	
	Self Awareness	Activity 4	√		√		√		√		√		√		√		√		√		√		√		√		√		√	
	Self Managemen	Activity 5	√		√		√		√		√		√			√	√		√		√		√		√					√

Figure 1. Results of Observation of Students' Social-Emotional Approach in the Introduction.

In the preliminary stage, 14 students did activity one by expressing their news, such as saying "healthy", which showed the existence of social-emotional activities in the self-awareness component. In activity 2, 14 students wrote their feelings on sticky note memos, which showed the existence of social-emotional activities in the self-awareness component. In activity 3, 14 students answered questions when the teacher asked about the congruence of building a triangle, which showed the existence of social-emotional activities in the component of relationship-building skills. In activity 4, 14 students listened when the teacher explained the learning objectives on the PowerPoint by answering "understand" when the teacher asked about the learning objectives to be implemented, which shows the existence of social-emotional activities in the self-awareness component. In activity 5, 12 students were motivated by raising their hands, which showed the spirit of learning congruence in building a triangle, where this showed the existence of social-emotional activities in the self-management component. There were two students with jersey numbers 7 and 14 who just kept silent and did not raise their hands.

Learning Stages	Component PSE	Student Activities	No. Participant																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14	
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Step 1. Student Orientation to the	Self Awarness	Activity 6	√			√	√		√		√		√			√	√		√		√			√	√			√		√
	Social Awarness	Activity 7	√		√		√		√		√		√		√		√		√		√		√		√		√		√	

Figure 2. Observation of Students' Social-Emotional Approach Phase 1.

At the stage of student orientation to the problem, there are two activities, namely activity six and activity 7. In activity 6, 9 students listened and discussed with the teacher regarding the problems shown on the PowerPoint by doing questions and answers, which showed that there were social-emotional activities in the self-awareness component, and there were five students who remained silent and did not answer when the teacher asked questions. In activity 7, 14 students appreciated the teacher by paying attention to the teacher when the teacher explained the material, which showed the existence of social-emotional activities in the social awareness component.

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Learning Stages	Component PSE	Student Activities	No. Participant																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14	
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Step 2. Organizing Students	Relationship Skill	Activity 8	√			√	√		√		√		√			√	√		√		√		√		√		√			√

Figure 3. Observation of Phase II Students' Social-Emotional Approach.

At the stage of organizing students, 11 students carried out activity 8, namely, students working together in groups to complete LKPD, which showed social-emotional activities in the relationship-building skills component, and three students just kept silent and did not contribute to the LKPD.

Learning Stages	Component PSE	Student Activities	No. Participant																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14	
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Step 3. Guiding Individual and Group Investigations	Responsible Decition Making	Activity 9	√		√		√		√		√		√		√		√		√		√		√		√		√		√	
	Social Awarness	Activity 10	√		√		√		√		√		√		√		√		√		√		√		√		√		√	

Figure 4. Observation of Phase III Students' Social-Emotional Approach.

In the stage of guiding individual and group investigations, there are two activities, namely activity nine and activity 10. In activity 9, 14 students fairly divided the tasks for each group member during the TSTS activity, which showed the existence of social-emotional activities in the responsible decision-making component. In activity 10, 14 students respected each other's opinions when their friends spoke/explained their respective points of view, which showed the existence of social-emotional activities in the social awareness component.

Learning Stages	Component PSE	Student Activities	No. Participant																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14	
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Step 4. Develop and Present the Results of the	Self Awareness	Activity 11		√		√		√		√		√	√			√		√	√		√			√		√		√		√
	Relationship Skill	Activity 12	√			√	√		√		√		√			√	√		√		√		√		√		√			√

Figure 5. Observation of Phase IV Students' Social-Emotional Approach.

At the stage of developing and presenting the work, there are two activities, namely activity 11 and activity 12. In activity 11, three students dared to volunteer by raising their hands to make a presentation. This shows that there is a social-emotional activity in the self-awareness component, and there were 11 students who remained silent and did not raise their hands when the teacher offered a presentation in front of the class. In activity 12, 11 students asked questions. They answered the group who were making presentations, which shows that there were social-emotional activities in the relationship-building skills component. Three students did not participate in the question-and-answer session during the presentation.

Learning Stages	Component PSE	Student Activities	No. Participant																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14	
			Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Langkah 5. Analyze and Evaluate the Problem Solving Process	Self Awareness	Activity 13	√			√	√		√		√		√			√	√		√		√		√		√		√			√

Figure 6. Observation of Phase V Students' Social-Emotional Approach.

In the stage of analyzing and evaluating the problem-solving process, 11 students carried out activity 13, namely students expressed feelings When understanding the material by shaking their heads, which showed that there were social-emotional activities in the self-awareness component, and there were three students who were silent and did not express that they understood the material.

Learning Stages	Component PSE	Student Activities	No. Participant																											
			1		2		3		4		5		6		7		8		9		10		11		12		13		14	
			Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T	Y	T
Closing	Self Awareness	Activity 14	√		√		√		√		√		√		√		√		√		√		√		√		√		√	
	Self Management	Activity 15	√		√		√		√		√		√		√		√		√		√		√		√		√		√	

Figure 7. Observation of Students' Social-Emotional Approach in the Closing Stage.

In the closing stage, there are two activities, namely activity 14 and activity 15. In activity 14, 14 students reflected on the learning that had been carried out by lifting emoji sticks and drawing conclusions from their understanding, which showed the existence of social-emotional activities in the self-awareness component. In activity 15, 14 students tried to complete the assignment independently given by the teacher, which showed the existence of social-emotional activities in the self-management component.

Students with a jersey number 1 have a high social-emotional score of 93%. Students with a jersey number 2 have low social-emotional skills, with a percentage of 66%. Students with a jersey number 3 have a high social-emotional score, with a percentage of 93%. Students with the number 4 have a high social-emotional score, with a percentage of 93%. Students with a jersey number 5 have a high social-emotional score of 93%. Students with jersey number 6 have a high social-emotional status with a percentage of 100%. Students with a jersey number 7 have low social-emotional skills, with a percentage of 60%. Students with the number 8 have a high social-emotional level, with a percentage of 93%. Students with the number 9 have high social-emotional skills, with a percentage of 100%. Students with a jersey number of 10 have a high social-emotional level, with a percentage of 100%. Students with a jersey number of 11 have a high social-emotional level, with a percentage of 86%. Students with a jersey number of 12 have a high social-emotional level, with a percentage of 93%. Students with a jersey number 13 have a high social-emotional level, with a percentage of 86%. Students with a jersey number of 14 have low social-emotional skills, with a percentage of 60%.

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The provision of test questions with the discussion of congruence material is given after students have applied a social-emotional approach using a problem-based learning model. With the application of a social-emotional approach using a problem-based learning model, the mathematical communication of SMPN 03 Satu Atap Karangploso students is relatively high. This is proven after analyzing the total score of the student score divided by the number of students, the percentage of 64.30% (High) was obtained, resulting in the following categories:

Table 4.
Written Mathematical Communication Skills

No	Written Mathematical Communication Skills	Frequency	Presentation
1	Low	3	21,42%
2	Keep	2	14,28%
3	Tall	9	64,30%
4	Sum	14	100%

Table 4 shows the number of students who are in the high category, which is nine students (64.30%), the number of students who are in the medium category, which is two students (14.28%), and the number of students who are in the low category is three students (21.42%). Mathematical communication of grade VIII students of SMPN 03 Satu Atap Karangploso includes three indicators, based on the results of the test analysis that has been carried out, obtained by students who are included in the category of low, medium, and high communication skills, with one subject selected in each category.

1) Subject Jersey Number 7

Subject number 7 completed the questions given, but the answers presented were still incorrect. The results of the test for mathematical communication questions written in the number 7 are presented in Figure 8 below.

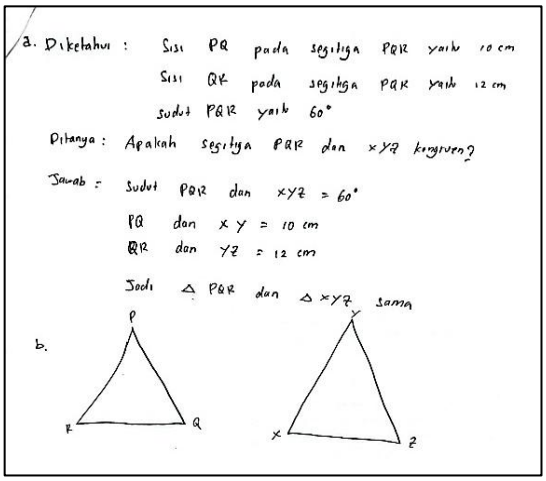

Figure 8. Mathematical Communication Test Write Subject No. 7.

Based on the results of the mathematical communication analysis on subjects with jersey number 7 presented in Figure 8, several findings were found related to the three indicators analyzed. The first indicator, which measures the ability to express mathematical ideas in writing (Written Text), shows that the subject number 7 writes down mathematical ideas or concepts in the form of written sentences that are less clear and poorly structured. This indicates the need for additional explanations so that the idea can be better understood. The second indicator, which relates to the use of mathematical terms or notations and their structure to present ideas (Mathematical Expression), reveals that the subject of jersey number 7 writes down mathematical ideas or concepts in the form of symbols or notations that are not clear enough, with some errors and incompleteness in the structure of their presentation. The third

indicator, which measures the ability to present mathematical ideas as well as present and depict them visually (Drawing), shows that the subject of the number 7 depicts two triangles. However, there is a discrepancy between the two images, or the picture presented is incomplete.

2) Subject Jersey: 11

Subject number 11 succeeded in completing the questions given, but the answers presented still need to be explored more deeply in the explanation. The results of the test for mathematical communication questions written in the number 11 are presented in Figure 9 below.

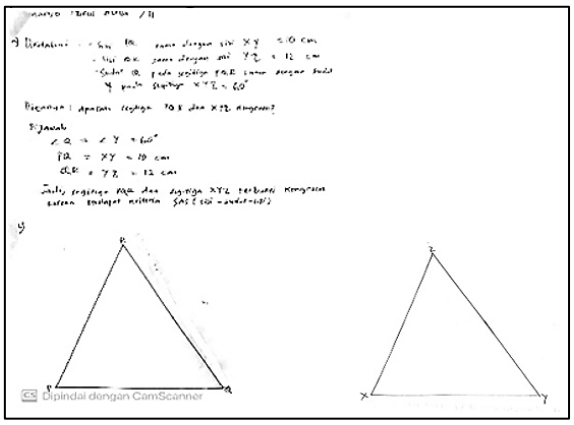

Figure 9. Mathematics communication test written by the subject number 11.

Based on the results of the analysis of mathematical communication in subjects with the jersey number 11 presented in Figure 9, several findings were found related to the three indicators analyzed. The first indicator, which measures the ability to express mathematical ideas in writing (Written Text), shows that subject number 11 is able to write down mathematical ideas or concepts in clear and structured sentences. However, there are slight deficiencies in delivery that do not interfere with overall comprehension. The second indicator, which measures the use of mathematical terms or notations and their structure to present ideas (Mathematical Expression), reveals the subject number.

On the back of 11, it can write down mathematical ideas or concepts in the form of symbols or notations that are pretty clear and structured, although there are several elements. Which is not accurate. The third indicator, which measures the ability to present mathematical ideas, present them, and visually depict them (Drawing), shows that the subject of the number 11 shirt is able to depict two triangles of the same size and shape, although there are slight drawbacks.

3) Subject Jersey: 9

Subject no. 9 successfully solved the questions given systematically, as well as the mathematical communication test results.

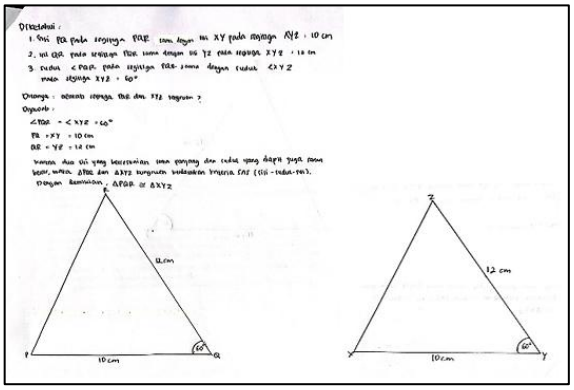

Figure 10. Written Mathematical Communication Test Subject Jersey: 9.

Based on the results of the analysis of mathematical communication on subjects with the jersey number 9, shown in Figure 10, several findings were found related to the three indicators analyzed. The first indicator, which measures the ability to express mathematical ideas in writing (Written Text), indicates that the subject of

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jersey number 9 can write down mathematical ideas or concepts in clear, structured, and easy-to-understand written sentences. The second indicator, which measures the ability to use mathematical terms or notations and their structure to present ideas (Mathematical Expression), shows that the subject of jersey number 9 is able to write down mathematical ideas or concepts with clear and structured symbols or notations. The third indicator, which measures the ability to present mathematical ideas, present them, and depict them visually (Drawing), shows that the subject of the number 9 shirt can clearly and correctly depict two triangles of the same size and shape, according to the size indicated on the arc.

Table 5.
Mathematical Communication Value Data for Students

No	No Back	Drawing	Written Text	Mathematical Expression	Value	Percentage	Category
1	7	2	2	2	6	50%	Low
2	9	4	4	4	12	100%	Tall
3	11	3	3	3	9	75%	Keep

From the results of the categorization, one student was taken in each category, namely high, medium, and low. The representative of the subjects to be analyzed with jersey numbers, namely 7, 9, and 11, shows the percentage of students. It can be seen that from the three indicators above, students who have high mathematical communication have a percentage of 100%, students who are in the medium category have a percentage of 75%, and students who are in the low category have a percentage of 50%.

B. Discussion

This study analyzes the written mathematical communication of junior high school students, especially in triangular congruence material, with a social-emotional approach using a problem-based learning model. One of the key findings of the study was the positive relationship between students' social-emotional levels and their mathematical communication skills. It was found that students with high social-emotional levels were able to express their mathematical ideas more clearly and completely through writing, as well as using mathematical symbols and images appropriately, which is in line with the research.

The results of the analysis showed that students with high social-emotional levels showed better mathematical communication compared to those with low social-emotional levels. (Rahmawati et al., 2023). Students with high social-emotional abilities can fluently express and interpret mathematical ideas, as well as use mathematical representations well. (Farhan et al., 2022). In contrast, students with low social-emotional levels have difficulty expressing their ideas, especially in the written aspect. (Nasution et al., 2023).

In the written test results, most students showed high mathematical communication skills, with 64.30% of students in the high category, 21.42% in the low category, and 14.28% in the medium category. This shows that although some students still

need improvement, a problem-based learning approach combined with attention to social-emotional aspects can have a positive impact on students' mathematical communication skills. (Yulianto & Mushafanah, 2023).

The problem-based learning model applied in this study plays an important role in improving students' social-emotional skills, which in turn improves their ability to communicate mathematically. In this model, students engage in activities that challenge them to solve problems in a group, which involves communication, collaboration, and emotional management. This helps students to not only develop their social skills but also improve their ability to communicate mathematical concepts in a more structured and transparent way. (Indriani et al., 2023).

From the results of the observations made, some students showed a significant improvement in mathematical communication skills after being given a social-emotional approach. Students with high social-emotional levels, as demonstrated by P9 students (with a percentage of 100%), are able to express and present mathematical ideas better through writing, drawing, and using mathematical symbols effectively. Meanwhile, students with low social-emotional scores, such as P7 (50%), still face difficulties in expressing ideas in writing even if they participate in discussions.

Although problem-based learning has a positive impact, some students still have difficulties, especially in expressing their math ideas through writing. This is related to a lack of understanding of concepts or difficulty in using appropriate mathematical symbols. Therefore, educators need to pay more attention to students who fall into the lower category by providing a more in-depth approach and more intensive support in math learning (Dewantara et al., 2023).

IV. CONCLUSION

This research shows that students' written mathematical communication can be improved through a social-emotional approach applied in a problem-based learning model. Students with a high level of social-emotional skills are able to express their mathematical ideas more clearly and precisely, both in the form of writing, pictures, and the use of mathematical symbols. On the other hand, students with low social-emotional levels show more limited mathematical communication skills, difficulty in expressing their ideas in writing, and experience obstacles in the correct use of mathematical symbols. Therefore, it is important to integrate social-emotional management in the math learning process so that students can optimally develop their mathematical communication skills.

In addition, the application of problem-based learning has been shown to be effective in improving students' social-emotional skills, which in turn helps them to be more open and confident in communicating mathematical ideas. Nonetheless, there are still challenges for students with low social-emotional levels, which require more attention in the learning process. Teachers need to provide more intensive support and create an

environment that encourages positive social interaction, so that every student, without exception, can develop their mathematical communication skills. This is important so that math learning can be more inclusive and provide equal opportunities for all students to optimize their potential.

The contribution of this research lies in offering a new perspective on the importance of linking cognitive and affective aspects in mathematics education, particularly in improving students' written mathematical communication. It enriches the field by showing how a social-emotional approach, when integrated into a problem-based learning model, can serve as an effective strategy to create a more inclusive, human-centered, and emotionally responsive mathematics learning environment.

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AUTHOR'S BIOGRAPHY

Evita Nasuwa Mufidah.

Evita Nasuwa Mufidah is a student of the Mathematics Education Study Program at the University of Muhammadiyah Malang (UMM).

Prof. Dr. Yus Mochamad Cholily.

Yus Mochamad Cholily is a professor at the University of Muhammadiyah Malang (UMM). Bachelor's degree in Mathematics at IKIP Negeri Malang. Community service activities have been carried out in a number of educational units in Indonesia and abroad. In addition, activities as Reviewers and Resource Persons have been carried out until now.

Dr. Alfiani Athma Putri Rosyadi, M. Pd.

Dr. Alfiani Athma Putri Rosyadi, M.Pd, is a lecturer at the University of Muhammadiyah Malang (UMM), Mathematics Education. Bachelor's degree in Mathematics at IKIP Negeri Malang. Community service activities have been carried out in a number of educational units in Indonesia.

Prof. Akhsanul In'am, Ph.D.

Prof. Akhsanul In'am, Ph.D., is a professor at the University of Muhammadiyah Malang (UMM). He holds a Ph.D in Mathematics Education from Sultan Idris Education University, Malaysia. Community service activities have been carried out in a number of educational units in Indonesia and abroad. In addition, activities as Reviewers and Resource Persons have been carried out until now.