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STUDENTS' MATHEMATICAL PROBLEM-SOLVING SKILLS ON CONGRUENCE MATERIAL IN RELATION TO INTRAPERSONAL INTELLIGENCE

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ABSTRACT

Intrapersonal intelligence can help students solve mathematical problems, and each student has different abilities depending on their level of intelligence. This study aimed to determine and explain students' mathematical problem-solving skills on congruence material in relation to intrapersonal intelligence. A qualitative approach with a case study design was used. The instruments included an intrapersonal intelligence questionnaire, a mathematical problem-solving skills test, and an interview guide. The results show that students' intrapersonal intelligence falls into three categories: high (21.43%), medium (60.71%), and low (17.86%). Students with high intrapersonal intelligence were able to fulfill all four indicators of mathematical problem-solving skills: understanding the problem, planning the solution, implementing the solution plan, and reviewing the solution. Students with medium intrapersonal intelligence were able to fulfill three indicators: understanding the problem, planning the solution, and implementing the solution plan. Students with low intrapersonal intelligence were able to fulfill two indicators: understanding the problem and planning the solution.

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INTRODUCTION

One of the process standards that students need to achieve when studying mathematics is problem-solving skills. This aligns with the provisions of the National Council of Teachers of Mathematics (NCTM, 2000) which outlines five primary standards of mathematical ability that students must develop: representation, reasoning, problem-solving, connection, and communication. It also aligns with one of the main objectives of studying mathematics, namely to prepare students to become problem-solvers, including the skills to comprehend issues, devise mathematical models, complete models, and interpret the solutions obtained (BSKAP Kemdikbudristek, 2022). Therefore, problem-solving abilities should not be separated from mathematics learning.

The urgency of developing problem-solving skills was also highlighted by Suprayitno (2019) who stated that many Indonesian students still struggle with mathematical problem-solving tasks, particularly those presented in the Programme for International Student Assessment (PISA). In 2022, the average score of Indonesian students was 366, compared to the OECD average of 472 (OECD, 2023). In 2018, the average score was 379, while the OECD average was 489 (OECD, 2019). These results show that Indonesian students' mathematics scores in 2022 declined compared to 2018. This indicates that Indonesian students' mathematical problem-solving abilities remain below international standards and have not yet achieved satisfactory levels.

Based on the experience of participating in the MBKM (*Merdeka Belajar Kampus Merdeka*) Internship at one of the public junior high schools in Pontianak from March to June 2023, it was found that students' mathematical problem-solving skills were not optimal. This was evident from students' difficulties in solving problem-solving questions on congruence material, such as determining the width of the bottom part of a cardboard not covered by a photo, as well as finding the ratio between the areas of the photo and the cardboard, given the size of the cardboard and the distances between the edges of the photo and the cardboard on the left, right, and top sides. The results showed that, out of 31 students, only 4 students (12.9%) were able to solve the problem correctly, while 27 students (87.1%) could not. Although students attempted to follow the problem-solving steps, they still experienced difficulties in arriving at the correct solutions.

Research by Fitria, Hidayani, Hendriana, and Amelia (2018); Pratiwi and Alyani (2022); and Tomo, Yusmin, and Riyanti (2016) also revealed that students' mathematical problem-solving skills are generally categorized as low based on their problem-solving test scores. Regarding problem-solving abilities, each student naturally has different capabilities

depending on their intelligence (Nurjanah, Hidayanto, & Rahardjo, 2019). According to Gardner (1999) intelligence can be divided into nine types known as multiple intelligences: intrapersonal, bodily-kinesthetic, interpersonal, linguistic, logical-mathematical, naturalistic, musical, spatial, and spiritual. Every student possesses diverse forms and levels of intelligence, with some types being more dominant than others.

In this study, the focus is on intrapersonal intelligence. The reason for studying intrapersonal intelligence is its crucial role in the learning process. Previous research has shown that intrapersonal intelligence positively impacts problem-solving skills (Zahra, Gresinta, & Pratiwi, 2021) and students' mathematics learning achievement (Mulbar, Arwadi, & Assagaf, 2019). Students with high intrapersonal intelligence tend to demonstrate greater self-confidence and effective time management when solving problems (Rochim, Hidayati, & Masruroh, 2023). In addition, they are better able to face challenges with a positive attitude, utilize their personal strengths, and develop effective learning strategies to enhance their mathematical abilities (Syafrida, Septinarami, & Alifviyani, 2023).

However, in reality, many students at school are still unable to face challenges with a positive attitude. This was observed in a Grade VII class, where no students were willing to solve problems at the front of the classroom. One student stated she lacked confidence, while another said he did not know how to solve the problem. This situation indicates students' low intrapersonal intelligence, making them unable to manage themselves effectively and resulting in passivity during learning.

Based on the explanation above, intrapersonal intelligence can help students in solving mathematical problems. Previous studies have shown a connection between intrapersonal intelligence and mathematical problem-solving skills. However, research specifically examining students' mathematical problem-solving skills based on their level of intrapersonal intelligence remains limited. Therefore, this study aims to explain the mathematical problem-solving skills of students with high, medium, and low intrapersonal intelligence.

METHOD

In this research, a qualitative approach was used, and the research type was a case study. A case study is research conducted by carefully investigating an activity, event, process, program, or group of individuals (Rusandi & Rusli, 2021). This study was carried out from May 15 to July 29, 2024. The research subjects were the students of Class VII C from one of the public junior high schools in Pontianak, totaling 28 students. The selection

of subjects was based on the fact that they had studied congruence material and through discussions with the mathematics teacher.

From the class, two students were selected for each category of intrapersonal intelligence. The selection was based on the students meeting the characteristics of each category, as well as considering time limitations and the availability of research personnel. Additionally, further criteria for selection included the students' ability to express their ideas clearly in both written and oral forms, as determined through discussions with the mathematics teacher. The objects of this research were students' mathematical problem-solving skills and their intrapersonal intelligence.

The data collection tools used in the research included a mathematical problem-solving skills test, an intrapersonal intelligence questionnaire, and an interview guide, all of which had been validated. An instrument is considered valid if it can accurately measure what it is intended to measure (Sugiyono, 2013). Each instrument was validated by two lecturers from FKIP UNTAN and a mathematics teacher from SMP Negeri 10 Pontianak. The data analysis technique referred to the model of Miles and Huberman (Sugiyono, 2013), which involves data reduction, data display, and drawing conclusions.

RESULT AND DISCUSSION

This section presents and discusses the findings of the study in relation to students' intrapersonal intelligence and their mathematical problem-solving skills. The results are organized into four sub-sections. First, an overview of the students' levels of intrapersonal intelligence is provided. Then, the mathematical problem-solving skills of students categorized as having high, medium, and low intrapersonal intelligence are analyzed and discussed in detail. The findings are interpreted in the context of relevant theories and previous research to provide a comprehensive understanding of the observed patterns

Students' Intrapersonal Intelligence

The data from the intrapersonal intelligence questionnaire are ordinal-scale data. Therefore, the data first needed to be converted into interval-scale data using the successive interval method to allow for further analysis. After conversion, the students' scores were grouped into three categories—high, medium, and low—based on criteria adapted from Lestari and Yudhanegara (2017) as shown in Table 1.

Table 1. Criteria for Grouping Intrapersonal Intelligence Scores

Criteria	Description
$x \geq 64{,}513$	High
$50{,}098 < x < 64{,}513$	Medium
$50{,}098 \geq x$	Low

The categorization results of students' intrapersonal intelligence questionnaire scores are presented in Table 2.

Table 2. Categorization Results of Students' Intrapersonal Intelligence Questionnaire Scores

Category	No of Students	Percentage
High	6	21,43%
Medium	17	60,71%
Low	5	17,86%

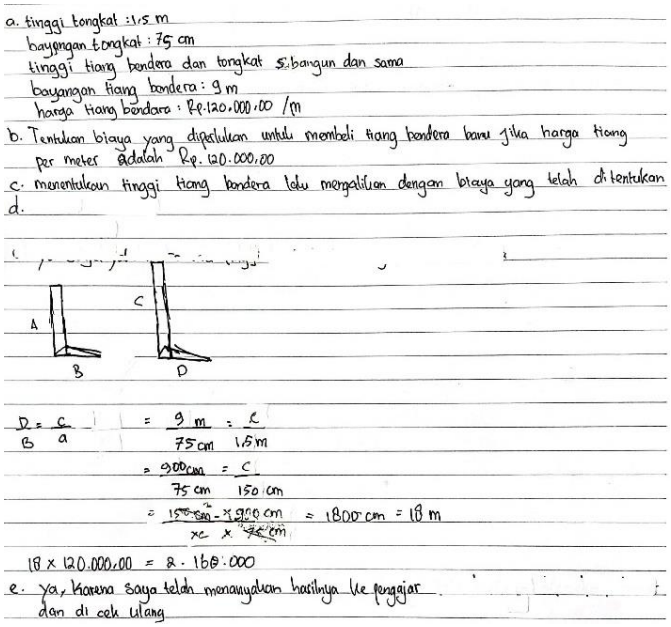
Table 2 shows that students' intrapersonal intelligence is predominantly in the medium category. This finding is consistent with the results of Rokhima and Fitriyani (2017), which showed that the intrapersonal intelligence of Grade VII students at SMP Muhammadiyah 1 Kalasan Sleman Yogyakarta was also dominated by the medium category, accounting for 56%.

Next, two students were selected from each intrapersonal intelligence category to be tested on their mathematical problem-solving skills and interviewed. Table 3 presents the list of students selected for the tests and interviews.

Table 3. List of Subjects Given Tests and Interviewed

No.	Student Name	Student Code	Intrapersonal Intelligence Category
1.	IPO	A-15	High
2.	THA	A-25	High
3.	AFM	A-5	Medium
4.	RFO	A-21	Medium
5.	FS	A-13	Low
6.	VAV	A-26	Low

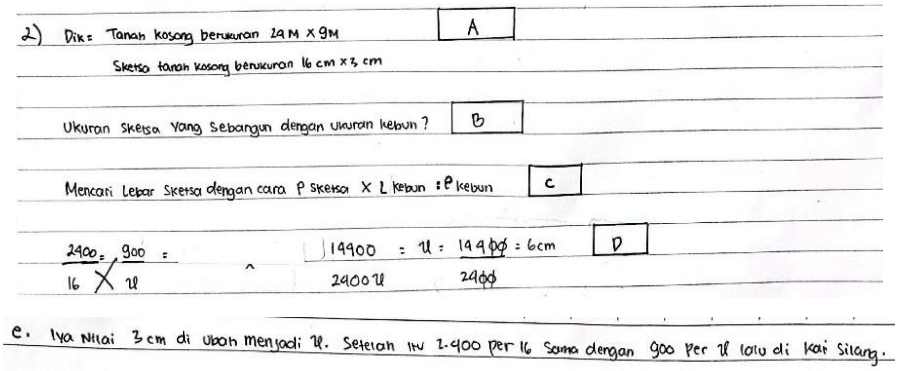
Mathematical Problem-Solving Skills of Students with High Intrapersonal Intelligence



Translation:

a. Height of stick: 1,5 m
Shadow of stick: 75 cm
The Height of the flagpole and the stick are proportional.
Shadow of flagpole: 9 m
Price of the flagpole : Rp 120.000,00/ m.
b. Determine the cost required to buy a new flagpole if the price per meter is Rp 120.000,00
c. determine the height of the flagpole, then multiply it by the given price
d. yes, because I have asked the teacher for the results and rechecked

Figure 1. Answer Number 1 Subject A-25



Translation:
a. Given: Empty land measuring 24 $m \times 9\ m$
Sketch of the empty land measures 16 $cm \times 3\ cm$
Question
What is the size of sketch that is proportional to the size of the garden?
Solution
To find the width of the sketch use the proportion: $p\ sketch \times l\ garden \div p\ garden$
e. Yes the value of 3 cm is changed to x. Then, set up the proportion 2,400 per 16 is the same as 900 per x Next, solve by cross-multiplying

Figure 2. Answer to Question Number 2 by Subject A-15

The interview results are presented in Table 4 below.

Table 4. Interview Results for Students with High Intrapersonal Intelligence

Indicators of Mathematical Problem-Solving Skills	Subject A-15	Subject A-25
Understanding the problem	Able to correctly identify the important information given and the questions being asked.	Able to correctly identify the important information given and the questions being asked..
Planning the solution	Can analyze strategies and formulas correctly using the various information provided in the questions.	Can analyze strategies and formulas correctly using the various information provided in the questions.
Implementing the solution plan	Able to complete the strategies and formulas that have been determined and can overcome calculation problems in question number 2. P: *Is the solution you worked on in accordance with the method you have chosen?* A-15: *Yes, it is, sis.* P: *Okay. Were there any obstacles when solving the problem?* A-15: *Yes, sis, for question number 2 during division because the values are in the thousands.*	Able to complete the predetermined strategies and formulas with no problems encountered during the calculation process.
Checking again	• Tries to verify the correctness of the solution by reviewing and recalculating the answer. • Feels satisfied with the solution because she has attempted to solve it.	• Tries to verify the correctness of the solution by checking for any deficiencies or errors and recalculating the answer. • Feels satisfied with the solution after completing it..

Understanding the Problem of Students with High Intrapersonal Intelligence

Analysis of Figures 1 and 2 shows that students with high intrapersonal intelligence accurately identify all key aspects of the problem, both known and asked. They are able to recognize and regulate their emotions when facing the problem, which supports effective problem solving. This is consistent with Nurhasanah and Safitri (2022), who found that students with self-control awareness manage problem-solving situations more effectively.

Planning the Solution of Students with High Intrapersonal Intelligence

Analysis of Figures 1 and 2 indicates that students with high intrapersonal intelligence can accurately identify the strategies and formulas needed to solve problems. Such students demonstrate the ability to plan solutions by considering the necessary steps and showing confidence in their approach without seeking external assistance. This is consistent with Zahra et al. (2021), who found that students with high intrapersonal intelligence tend to rely on their own judgment. These students are motivated to work according to their own plans.

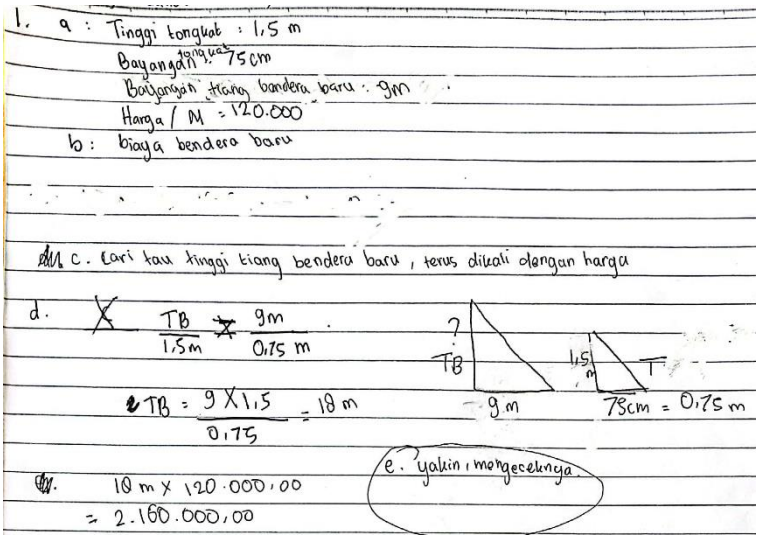
Implementing the Solution Plan of Students with High Intrapersonal Intelligence

Analysis of Figures 1 and 2 shows that students with high intrapersonal intelligence can correctly implement strategies and formulas to solve problems and find appropriate solutions. These students demonstrate confidence in executing their predetermined plans without hesitation. This finding is consistent with Rochim et al. (2023), who observed that students with intrapersonal intelligence respond to interview questions without hesitation or repetition. Although they may encounter calculation difficulties, they are able to overcome these obstacles (as shown in Table 4). This also supports the view of Arsita (in Mahmudah, Rukmigarsari, & Sunismi, 2023), who stated that students with intrapersonal intelligence tend to engage in self-reflection, correct their mistakes, and work to improve their weaknesses.

Checking Again by Students with High Intrapersonal Intelligence

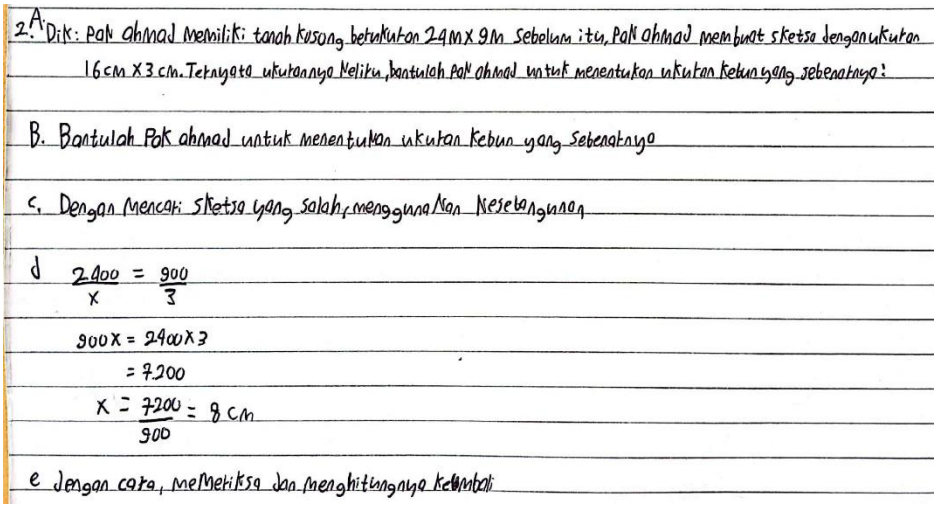
Analysis of Figures 1 and 2 indicates that students with high intrapersonal intelligence thoroughly review the problem-solving process and verify the accuracy of their solutions. Their methods include (1) rereading and recalculating the solution and (2) identifying and correcting deficiencies or errors. Students who engage in such verification express satisfaction with their problem-solving efforts, having made a deliberate attempt to achieve a correct solution. This finding is consistent with Haryaka (2017), who noted that achieving a mathematical answer requires both correct processes and sustained effort, leading to student satisfaction.

Mathematical Problem-Solving Skills of Students with Medium Intrapersonal Intelligence



Translation:
a. Height of stick : 1,5 m
Shadow of stick : 75 cm
Shadow of flagpole : 9 m
Price/ m: 120.000
b. cost of the new flagpole
c. first, determine the height of the new flagpole, then multiply it by the price peer meter
e. sure, check it

Figure 3. Answer Number 1 Subject A-5



Translation:
a. It is known: Mr. Ahmad has an empty land measuring 24 $m \times 9\ m$. Previously, Mr. Ahmad made a sketch measuring 16 $cm \times 3\ cm$. However, it turns out that the sketch size was incorrect.
b. Help Mr. Ahmad to determine the actual size of the garden.
c. To help Mr. Ahmad, find the correct size of the garden by using the concept of congruence
e. by rechecking and recalculating the measurements

Figure 4. Answer to Question Number 2 Subject A-21

The interview results are presented in Table 5. below.

Table 5. Interview Results for Students with Medium Intrapersonal Intelligence

Indicators of Mathematical Problem-Solving Skills	Subject A-5	Subject A-21
Understanding the problem	Able to correctly identify and mention the important known and questioned matters in the problem.	Able to identify important known and questioned elements in the problem appropriately.
Planning the solution	Can analyze strategies and formulas correctly, although the subject takes a long time to think due to forgetting the congruence formula. P: *When choosing a solution, do you search for it yourself or ask for help from friends?*	Can analyze strategies and formulas correctly based on the various information provided in the problem.

	A-5: *I search for it myself, sis; when determining the method, I think for a long time.* P: *Why is that?* A-5: *Because I keep forgetting the congruence formula, sis.*	
Implementing the solution plan	Able to complete the predetermined strategies and formulas with no issues during the calculation process.	Able to complete the predetermined strategies and formulas, though there were obstacles in converting units from meters to centimeters in question number 2, which were eventually overcome.
Checking again	Did not check the entire problem-solving process. In question number 1, the subject only checked the correctness of the known and asked points. In question number 2, the subject only recalculated the solution. P: *Was there any rechecking of the solution that was done?* A-5: *No, sis.* P: *Why is it written on the answer sheet that there was checking?* A-5: *There was checking, sis, but number 1 only checked part a with b. Number 2: I only checked the multiplication part.* P: *Why didn't you check everything?* A-5: *Because I was already confused, sis.*	Attempts to check the correctness of the solution by recalculating. However, the subject did not find any errors in the process. In question number 1, there was an error when implementing the solution plan, and in question number 2, there was a mistake in interpreting what was asked. P: *Was there a recheck of the solution?* A-21: *Yes, sis, I recalculated.*

Understanding the Problem of Medium Intrapersonal Intelligence

Analysis of Figures 3 and 4 shows that students with medium intrapersonal intelligence can accurately identify all important known and questioned elements of the problem. These students demonstrate the ability to recognize and understand their emotions when approaching the problem, which enables them to manage their emotions effectively. This finding is consistent with Nurhasanah and Safitri (2022), who stated that students with self-awareness and self-control are more successful in managing problem-solving situations.

Planning the Solution of Medium Intrapersonal Intelligence

Analysis of Figures 3 and 4 indicates that students with medium intrapersonal intelligence can correctly determine the strategies and formulas needed to solve problems. However, they may experience doubt regarding the solution steps, often due to forgetting the congruence formula (as shown in Table 5). This finding aligns with Polya's (1973) view that developing a resolution plan is challenging, but ultimate success in problem-solving depends on the quality of the plan.

Implementing the Solution Plan of Medium Intrapersonal Intelligence

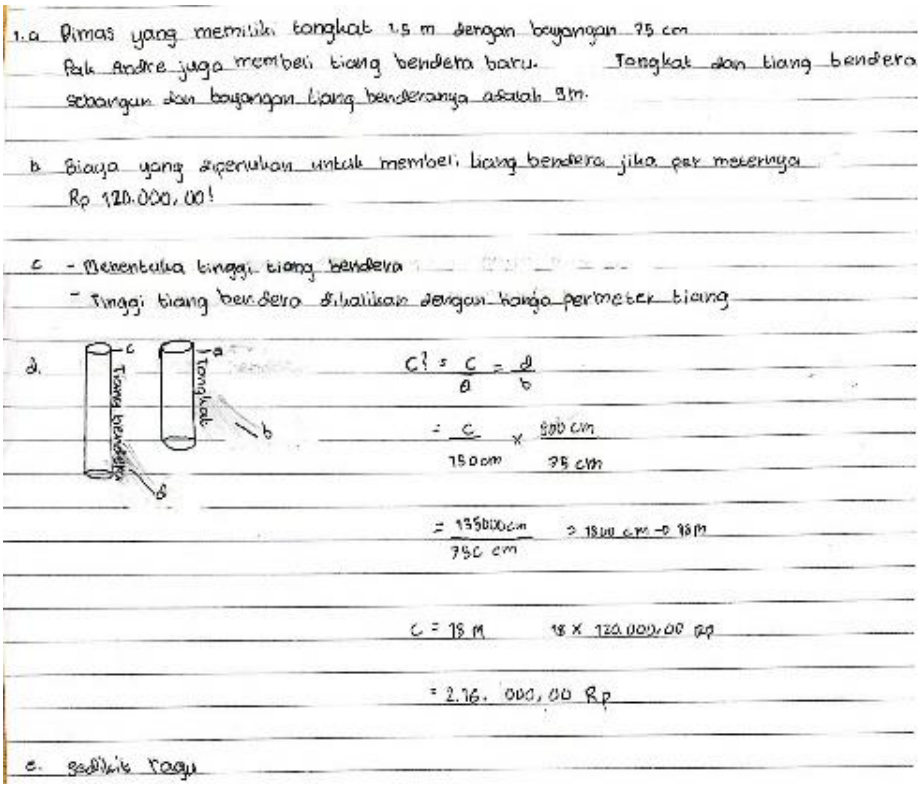
Analysis of Figures 3 and 4 shows that students with medium intrapersonal intelligence can correctly implement strategies and formulas to solve problems and reach accurate solutions. These students are able to articulate the difficulties they encounter, such as issues with unit conversion (e.g., meters to centimeters), which they ultimately overcome. This finding supports Arsita's view (in Mahmudah et al., 2023) that students with intrapersonal intelligence tend to engage in self-introspection to address their weaknesses

and actively work to improve.

Checking Again of Medium Intrapersonal Intelligence

Students with medium intrapersonal intelligence tend to be less proficient in fulfilling the "checking again" indicator. As shown in Table 5, this is due to factors such as (1) checking only parts of the solution process (e.g., verifying only the known and asked points or merely recalculating solutions) and (2) checking the solution but still overlooking errors. Students who struggle with this step demonstrate difficulty in reviewing the entire problem-solving process and verifying the final solution. This finding supports the observation of Septriansyah, et al. (2022), who noted that "checking again" is often the weakest step, as some students overlook question instructions and struggle to properly verify their work.

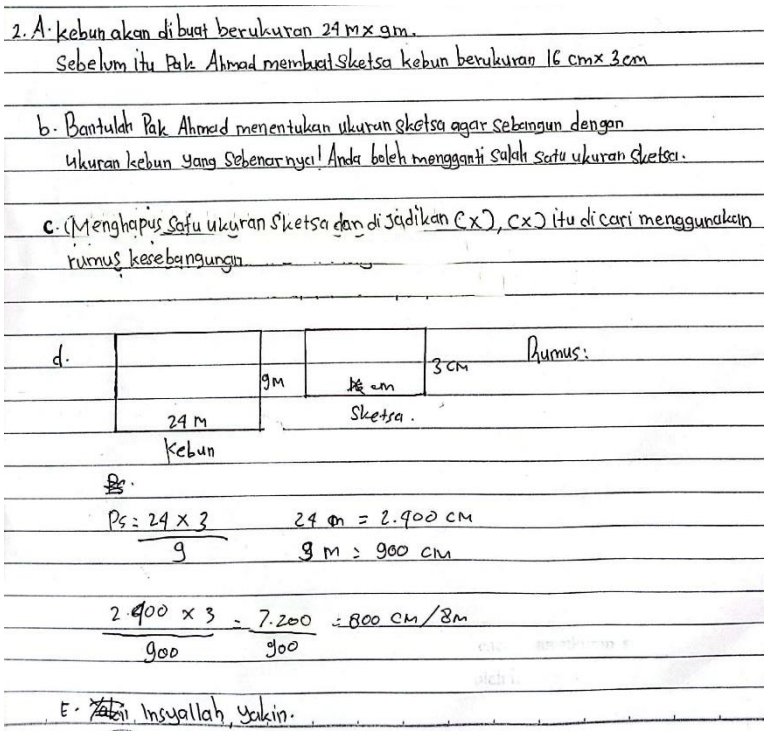
Mathematical Problem-Solving Skills of Students with Low Intrapersonal Intelligence



Translation:

a. Dimas has a 1,5 *m* stick with a shadow of 75 *cm*. Mr. Andre also bought a new flagpole. The stick and flagpole are similar and the shadow of the flagpole is 9 *m*.
b. The cost required to buy a flagpole per meter is Rp 120.000,00!
c. To determine the height of the flagpole, multiply the heigh of the flagpole by the price per meter of the pole
e. a little hesitant

Figure 5. Answer Number 1 Subject A-13



Translation:

a. The garden will measure measuring 24 $m \times 9\ m$. Before that, Mr. Ahmad sketched a garden measuring 16 $cm \times 3\ cm$.
b. Help Mr. Ahmad determine the size of the sketch so that it proportional to the actual size of the garden! You may change one of the sketch's diimensions
c. Remove one dimension of the sketch and label it (x), Find (x) using the similarity formula
e. God willing, sure

Figure 6. Answer for Question Number 2 Subject A-26

The interview results are shown in Table 6. below.

Table 6. Interview Results for Students with Low Intrapersonal Intelligence

Indicators of Mathematical Problem-Solving Skills	Subject A-13	Subject A-26
Understanding the problem	Able to mention important matters known and questioned in the questions appropriately.	Able to mention important matters known and questioned in the questions appropriately.
Planning the solution	Can analyze strategies and formulas correctly, although the subject thinks about it longer because she tries to recall the congruence formula. The subject also feels doubtful about the solution plan for question number 2. P: *When choosing that method, did you search for it yourself or ask for help from friends?* A-13: *I searched for it myself, but I was a bit hesitant.* P: *Why were you a bit hesitant?* A-13: *Because I had forgotten the congruence formula, sis.* P: *What about number 2?* A-13: *I searched for it myself, sis;but it took me a long time to find it.* P: *Why is that? This is similar to number 1.* A-13: *Number 2 is more difficult, sis; number 1 is shaped like a triangle, but this one is a rectangle. So I was a bit hesitant about my solution steps.*	Can analyze strategies and formulas correctly but feels doubtful about the solution plan that has been determined.
Implementing the solution plan	Able to complete predetermined strategies and formulas, but there are errors in the process. In question number 1, the subject was not careful in calculating the	In question number 1, the subject could not complete the strategy because she did not know how to determine the height of the pole and felt that the question was difficult. In

	multiplication, so the answer was off by one zero. In question number 2, the subject did not equate the units (m or cm) because she had already gotten the answer and thought there was no need to do it again. P: *For answer number 1, try recalculating the result of 18 multiplied by Rp 120,000.00.* A-13: *Okay, wait a minute. (recalculating). The result is Rp 2.160.000,00.* P: *Why is the result different from the answer sheet?* A-13: *I think the previous calculation was wrong; the zero is one less.* P: *For answer number 2, why are the units of m or cm not the same?* A-13: *Eeh, it should be the same, right, sis? Because I already got the answer, I didn't think it was necessary.*	question number 2, the subject could complete the strategies and formulas that had been determined, but there were errors in the process. The subject was not careful in calculating the division, causing the answer obtained to exceed by two zeros. P: *Why is the solution to number 1 not complete?* A-26: *It's difficult, sis.* P: *Where is it difficult?* A-26: *I'm confused about determining the height of the pole, sis.* P: *Then for question number 2, were there any obstacles when solving the problem?* A-26: *There were a few, sis, by the calculation part, I got confused with the cross multiplication. Then I forgot the part about changing $meters$ to $centimeters$.* P: *Where did you get 800 cm from? It should be 8 cm.* A-26: *Oh yeah, sis, I miscalculated.*
Checking again	• Not checking the correctness of the solution obtained because she feels dizzy when working on the problem. • Feels less confident about the solution obtained. P: *Is there any rechecking of the solution that was done?* A-13: *No, because it's already dizzy to recheck it.* P: *Okay. Are you satisfied with the solution that you did?* A-13: *Not bad, because I tried to do it.*	Not checking the correctness of the solution she gets. P: *Did you recheck the answers?* A-26: *No, sis.*

Understanding the Problem of Low Intrapersonal Intelligence

Analysis of Figures 5 and 6 shows that students with low intrapersonal intelligence can accurately record all the important known and asked elements of the problem. However, they tend to write the information directly from the question without rephrasing it in their own words. These students demonstrate the ability to recognize and understand their emotions when approaching the problem, which enables them to manage their emotions effectively. This finding aligns with Nurhasanah and Safitri (2022), who suggest that students with self-control awareness are more successful in managing situations during problem-solving.

Planning the Solution of Low Intrapersonal Intelligence

Analysis of Figures 5 and 6 indicates that students with low intrapersonal intelligence can correctly determine strategies and formulas to solve problems. However, they often doubt the solution steps due to the perceived difficulty of the questions (as shown in Table 6). This aligns with Polya's (1973) view that creating a resolution plan is challenging, but the success of problem-solving ultimately depends on the quality of the plan.

Implementing the Solution Plan of the Low Intrapersonal Intelligence

Based on Figure 5 and Figure 6, it can be seen that the students with low intrapersonal

intelligence are less able to fulfill the indicators of carrying out plans. The factors contributing to this include: (1) students making mistakes in the multiplication or division process due to carelessness, leading to incorrect solutions; and (2) students not equating the units (m or cm) first in their operations, thinking it's unnecessary. Students who cannot carry out the solution plan lack confidence in solving the problem because they forget to use the congruence formula and find the problem difficult (in Table 6). This aligns with the findings of Rokhima and Fitriyani (2017) who found that most students often struggle to remember mathematical formulas or facts.

Checking Again of Low Intrapersonal Intelligence

Analysis of Table 6 shows that students with low intrapersonal intelligence are unable to fulfill the "checking again" indicator. Factors preventing students from meeting this indicator include: (1) dizziness while working on problems, leading them to avoid rechecking their answers, and (2) inability to solve the problems. This finding aligns with Nurhasanah and Safitri (2022), who suggested that weak intrapersonal intelligence leads students to repeat mistakes and impedes problem-solving. Students unable to check their work express dissatisfaction with their problem-solving outcomes.

CONCLUSION

Based on the analysis of students' mathematical problem-solving skills in relation to intrapersonal intelligence, it can be concluded that students with high intrapersonal intelligence excel in all problem-solving indicators, including understanding the problem, planning the solution, implementing the plan, and checking their work. These students demonstrate confidence in their plans and satisfaction in solving problems. Students with medium intrapersonal intelligence are able to fulfill three of the indicators—understanding the problem, planning the solution, and implementing the plan—but struggle with checking their work. They exhibit emotional awareness and satisfaction, though they still have doubts about the solution steps. Students with low intrapersonal intelligence can only fulfill two indicators—understanding the problem and planning the solution—struggling with executing the plan and checking their work. These students recognize their feelings but lack confidence and show dissatisfaction in their problem-solving efforts. Overall, the findings underscore the significance of intrapersonal intelligence in mathematical problem-solving and highlight the need for additional problem-solving practice and support for students' emotional awareness in learning.

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