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PROFILE OF STUDENTS' PROBLEM-SOLVING ABILITY BASED ON MATHEMATICAL LITERACY IN PISA CONTEXT

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ABSTRACT

Mathematical literacy plays a crucial role in developing students' ability to solve contextual mathematical problems. This study aims to describe the profiles of students' problem-solving abilities based on their levels of mathematical literacy in solving PISA-based questions. A descriptive qualitative approach was employed involving 28 eighth-grade students from SMP Negeri 1 Kolaka selected through purposive sampling. The students were grouped into three categories-high, medium, and low-based on their mathematical literacy test scores. The subjects were selected based on teacher recommendations, namely students with good communication skills who represented each mathematical literacy group. Data were collected using problem-solving tests and interviews, and the instruments were validated by mathematics education experts and teachers. Data analysis followed the Miles and Huberman model, including data reduction, presentation, and conclusion drawing, with source triangulation to ensure validity and credibility. The results showed that students with high mathematical literacy demonstrated comprehensive understanding, effective planning, and accurate problem-solving processes, though minor computational errors were found. Students with medium mathematical literacy could understand problems and plan solutions but often made mistakes in calculations and rarely verified their results. Students with low mathematical literacy only reached the problem-understanding stage and struggled with technical computations, leading to incomplete solutions. Overall, the findings indicate a progressive relationship between mathematical literacy and the completeness of problem-solving stages. The study suggests that integrating PISA-oriented contextual problems into mathematics learning can be a consideration for teachers to train students' problem-solving and reasoning skills.

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1. INTRODUCTION

Education has a strategic role in shaping human resources that are intelligent, creative, and competitive. It is not only a means of knowledge transfer but also a process of developing students' potential comprehensively. According to Law No. 20 of 2003 concerning the National Education System, education is a conscious and planned effort to create a learning environment that enables students to develop their spiritual, intellectual, and social potential. The success of national development is closely related to the quality of education, which is determined by the learning process in schools.

Among all school subjects, mathematics holds a central position because it underlies logical reasoning, problem-solving, and decision-making skills. Mathematics is a fundamental science that is a compulsory subject in education and daily life and is used as a reference for developing students' potential (Azka & Budiman, 2023). Mathematics learning aims to develop the ability to think systematically and analytically, which are essential in facing real-world challenges. As stipulated in Article 37 of Law No. 20 of 2003 and further regulated in the Ministry of Education and Culture Regulation No. 59 of 2014, mathematics is a compulsory subject from elementary to secondary school with objectives that include understanding mathematical concepts, reasoning logically, solving problems, and applying mathematics in everyday life. These objectives emphasize that mathematics learning should not only focus on procedural mastery but also on meaningful application, which is reflected through students' mathematical literacy (Kurniawan & Khotimah, 2022). One of the learning objectives according to Permendikbud No. 59 is to apply mathematical knowledge in social life. To achieve this objective, students need mathematical skills, including mathematical literacy.

Mathematical literacy refers to the ability to reason mathematically and to formulate, employ, and interpret mathematics in various contexts (Khotimah, 2021). It involves the use of mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. Through mathematical literacy, students can recognize the relevance of mathematics in daily life and make informed decisions based on quantitative reasoning. In the classroom, mathematical literacy provides a bridge between abstract mathematical knowledge and its real-world applications. Therefore, it represents a critical competence for students in understanding and solving contextual problems.

In mathematics education, problem-solving is considered both a goal and an indicator of successful learning. According to Polya's framework (Purwaningsih & Ardani, 2019) problem-solving consists of four sequential stages: understanding the problem, devising a plan, executing the plan, and evaluating the solution. These stages encourage students to think logically and reflectively. As stated by Nurojab et al., (2019). students' problem-solving ability demonstrates their capacity to apply mathematical knowledge to unfamiliar situations. A strong correlation exists between mathematical literacy and problem-solving ability because both involve reasoning, interpretation, and the ability to relate mathematical ideas to contextual situations (Samosir, 2022). Thus, enhancing mathematical literacy can indirectly improve students' problem-solving competence.

The importance of mathematical literacy is also reflected in the Programme for International Student Assessment (PISA), a global evaluation conducted by the Organisation for Economic Co-operation and Development (OECD). PISA assesses how well 15-year-old students apply knowledge and skills in reading, mathematics, and science to real-life problems. The PISA mathematics framework emphasizes three processes-formulating, employing, and interpreting-which correspond closely with

Polya's problem-solving stages. However, PISA results over the past two decades consistently indicate that Indonesian students' mathematical literacy remains low. In 2012 Indonesia ranked 64th of 65 participating countries with a mean score of 375; in 2015 it ranked 63rd of 69 countries (score 386); and in 2018 it ranked 72nd of 78 countries (score 379), all below the OECD average of 500 (Kurniawan & Khotimah, 2022). The most recent PISA 2022 report shows a similar trend, confirming that students' mathematical literacy has not improved significantly. These findings highlight persistent difficulties among Indonesian students in applying mathematical knowledge to real contexts.

Several researchers have investigated either mathematical literacy or problem-solving ability among Indonesian students (Kurniawan & Djidu, 2021). However, most of these studies examined both constructs separately and rarely integrated them into a single analytical framework. Previous research generally focused on levels of mathematical literacy or patterns of problem-solving without exploring how literacy indicators manifest through students' problem-solving processes using PISA-type questions. Consequently, there remains a gap in understanding students' problem-solving profiles viewed through the lens of mathematical literacy, especially in secondary school settings. Filling this gap is essential for developing more diagnostic and literacy-oriented approaches in mathematics learning.

Preliminary interviews with a mathematics teacher at SMP Negeri 1 Kolaka revealed that students have never been introduced to PISA-based problems and that mathematical literacy has not been explicitly measured in classroom assessment. This finding indicates that teachers' evaluation practices are still dominated by procedural and computational tasks rather than contextual reasoning. The lack of exposure to literacy-based problems potentially limits students' ability to apply mathematical concepts to real-life situations. Therefore, it is important to conduct research that describes students' problem-solving ability profiles based on mathematical literacy using PISA-type tasks.

This study aims to describe the profile of students' problem-solving ability based on mathematical literacy in PISA questions. Specifically, it seeks to identify the stages of problem-solving that students demonstrate-understanding, planning, executing, and evaluating-and to relate these stages to the three PISA mathematical literacy processes. The results of this study are expected to provide insights into students' strengths and weaknesses in mathematical reasoning and to serve as a reference for teachers in improving learning strategies.

The findings of this study are expected to contribute both practically and theoretically. Practically, the results can help teachers design learning activities that integrate mathematical literacy and problem-solving, allowing students to practice reasoning and applying mathematical concepts in meaningful contexts. Theoretically, this study contributes to the development of literature on mathematical literacy by providing a descriptive model of students' problem-solving profiles in the context of PISA-type tasks. Moreover, understanding these profiles will assist educators and policymakers in evaluating the effectiveness of current mathematics education practices and in designing interventions that foster 21st-century skills such as critical thinking, creativity, and adaptability.

In conclusion, mathematics learning should be oriented toward fostering students' ability to apply knowledge meaningfully through literacy-based problem-solving. Strengthening mathematical literacy is essential to improve students' problem-solving capacity, which in turn supports their readiness to face complex challenges in everyday life. By examining the problem-solving profiles of students through the lens of mathematical literacy, this study seeks to provide empirical evidence that can inform efforts to enhance the quality of mathematics education in Indonesia.

2. METHOD

2.1. Research Design

This study employed a descriptive qualitative research design, which aims to describe and interpret students' problem-solving abilities based on their mathematical literacy in PISA-type questions. The descriptive qualitative approach was chosen because this study focuses on exploring students' reasoning processes and understanding in depth rather than measuring variables quantitatively. According to (Ramdhan, 2021), descriptive qualitative research seeks to explain social or cognitive phenomena based on participants' perspectives and experiences. In this context, the researcher acted as the main instrument who observed, collected, and interpreted the data directly during the research process.

2.2. Participants

The participants in this study were students of class VIII-A at SMP Negeri 1 Kolaka, selected through a purposive sampling technique. This sampling was based on preliminary mathematical literacy test results, which classified students into high, medium, and low ability levels. Class VIII-A was selected because it represents the average academic achievement of eighth-grade students at the school. From this class, three students were chosen-one from each mathematical literacy category-to serve as the main research subjects. The selection aimed to represent the diversity of students' mathematical literacy and problem-solving profiles.

2.3. Research Instruments

The instruments used in this study consisted of:

1. Mathematical Literacy Test,
2. Problem-Solving Ability Test, and
3. Semi-structured Interview Guidelines.

The mathematical literacy test consisted of several open-ended questions adapted from the Programme for International Student Assessment (PISA) framework. These questions were designed to measure students' abilities to identify, formulate, and apply mathematical reasoning in real-life contexts. The problem-solving test was developed based on Polya's four stages-understanding the problem, planning, implementing the plan, and reviewing the result-to assess students' problem-solving performance.

Both tests were validated by two experts in mathematics education and one mathematics teacher to ensure content relevance, clarity, and alignment with the research objectives. The semi-structured interview guide was designed to explore students' thought processes and reasoning during problem-solving. Interviews were conducted individually with each participant, allowing the researcher to obtain deeper insights into students' cognitive strategies and difficulties.

2.4. Research Procedure

The study was carried out in two main stages:

1. **Stage 1 – Mathematical Literacy Assessment:**
   All students in class VIII-A were given a mathematical literacy test. Based on their test results, students were categorized into three levels of proficiency: high, medium,

and low, as adapted from Juniansyah et al., (2023): The categorization is shown in Table 1.

Table 1. Mathematical Literacy Proficiency Level Categories

Value	Category
$66,6 \leq N \leq 100$	High
$33,3 \leq N < 66,6$	Medium
$0 \leq N < 33,3$	Low

From this classification, one student from each category was purposively selected to be the research subject.

2. **Stage 2 – Problem-Solving Test and Interviews:**
   The selected students were given a set of mathematical problem-solving tasks adapted to their literacy level. Each student's responses were analyzed, followed by a semi-structured interview session lasting approximately 20–30 minutes. The interviews aimed to validate and expand the data obtained from the written tests by probing students' reasoning, strategy selection, and interpretation of results.

2.5. Data Collection Techniques

Data were collected through tests and interviews. The mathematical literacy test provided the basis for categorizing students, while the problem-solving test and interviews produced qualitative data on students' cognitive processes. All interviews were recorded and transcribed verbatim. The researcher also took field notes during the sessions to capture students' non-verbal cues, such as expressions and hesitations, which supported the interpretation of their reasoning patterns.

2.6. Data Analysis

The data analysis followed Miles and Huberman's interactive model (as cited in Spradley & Huberman, 2024), which includes data reduction, data display, and conclusion drawing/verification.

- Data reduction involved organizing, coding, and selecting essential data from students' written responses and interview transcripts. Data that were irrelevant or redundant were excluded.
- Data display was carried out by presenting students' problem-solving results in narrative and tabular form to facilitate comparison between literacy levels.
- Conclusion drawing involved synthesizing findings to describe the characteristics of students' problem-solving abilities based on their mathematical literacy levels.

To ensure analytic rigor, the researcher continuously compared data from multiple sources and revised interpretations as necessary until data saturation was reached.

2.7. Data Validation

The credibility of the data was established using source triangulation. Triangulation was conducted by comparing information obtained from different sources-namely, students' written test responses and interview data-to verify the consistency of findings. This process ensured that the interpretation of students' problem-solving behaviors accurately reflected their actual reasoning patterns. Furthermore, the researcher engaged in peer debriefing with mathematics education experts to validate the accuracy of coding and interpretation.

3. RESULTS AND DISCUSSION

3.1. Results

This study analyzed the problem-solving abilities of students with high, medium, and low mathematical literacy in completing PISA questions, with the following results presented by the researchers.

Mathematics Literacy Test Data

The Mathematics Literacy Test data in this study are the mathematics literacy test scores obtained from students in class VIII-A of SMP Negeri 1 Kolaka, which were then grouped into high, medium, and low mathematical literacy abilities. Students with high mathematical literacy abilities are those with test scores of $66.6 \leq$ test score ≤ 100, students with moderate mathematical literacy abilities are those with test scores of $33.3 \leq$ test score < 66.6, and students with low mathematical literacy abilities are those with test scores of $0 \leq$ test score < 33.3. The results of the mathematical literacy test and the grouping based on mathematical literacy are presented in table 2.

Table 2. Mathematical Literacy Test Data and Student Grouping Based on Mathematical Literacy in PISA Questions

No	Category	Frequency
1	High	6
2	Medium	12
3	Low	10

Based on the table above, it can be seen that 6 students have high mathematical literacy skills, 12 students have moderate mathematical literacy skills, and 10 students have low mathematical literacy skills. Furthermore, based on the results of the mathematical literacy test, students were grouped into three levels, namely high, medium, and low. Subjects were selected based on the teacher's recommendation, namely students who had good communication skills representing each mathematical literacy group. The details of each selected subject are presented in table 3.

Table 3. Research Subject

Initial	Subject	Score	Group
A	S1	98	High
RI	S2	55,5	Medium
ATA	S3	22,2	Low

The researcher then administered problem-solving tests and conducted interviews with the three selected research subjects.

1) Problem-Solving Skills of Students with High Mathematical Literacy

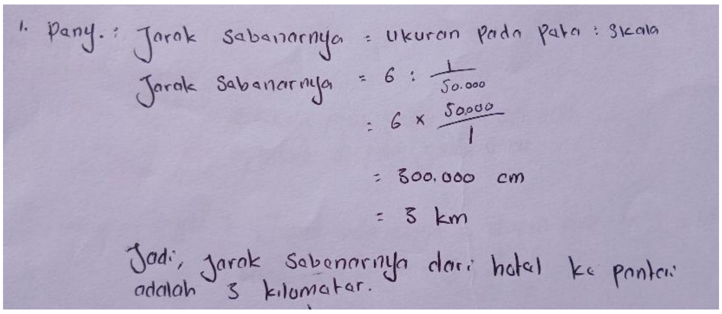


Figure 1. Problem Solving Ability Test Results

Based on Figure 1 for subject 1, the following analysis results were obtained.

In question number 1, S1 did not write down what they knew and were asked, but managed to plan the correct solution to solve the problem. This plan was based on the correct formula for finding the actual distance, and they were able to carry out the plan correctly and systematically and provide a conclusion. However, during the interview, S1 was able to explain the information about the scale on the map and the distance on the map completely. Subject S1 simply forgot to write down what was known and asked, so it does not mean that S1 did not understand or know the information. The following is an excerpt from the interview that shows this.

S1: In this question, the scale is 1:50,000 and the distance between the hotel and the beach is 6 cm. The question asks for the actual distance from the hotel to the beach in kilometers.

Thus, it can be said that S1 is able to understand the problem, which is to convert the distance on the map into actual distance, meaning that S1 has fulfilled the problem-solving ability indicator. S1's work on question number 2 is shown in Figure 2 below.

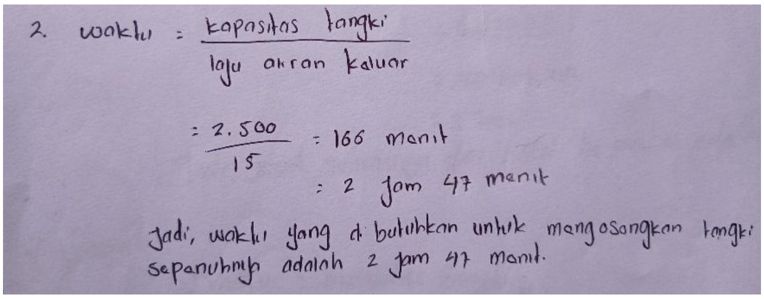


Figure 2. Problem Solving Ability Test Results

Based on Figure 2 for subject 1, the following analysis results were obtained.

In question number 2, S1 did not write down what was known and asked, but successfully planned the correct solution to solve the problem. They were able to carry out the plan correctly, but there were minor errors in the calculations and writing. The student calculated 2,500 : 15 and got the result 166 minutes. The correct calculation should be 2,500 : 15 = 166.667. The student tried to convert 166 minutes into hours and minutes. The correct conversion for 166 minutes is 2 hours and 46 minutes (120 minutes + 46 minutes). The student wrote 2 hours and 47 minutes, which indicates an error in rounding or calculation. In the conclusion and review stage, it shows that the student did not carefully review the results of his calculations. If the student had reviewed his work, he would have realized that 2 hours and 47 minutes is equal to 120 + 47 = 167 minutes, which does not match the result of 166 minutes. In this section, S1 explains during the interview with the following excerpt.

Researcher: How did you solve this problem? Can you describe the steps you took?
S1: The question states that the water tank has a capacity of 2,500 liters and water flows out of the tank at a rate of 15 liters per minute. Since the question asks for the time needed to empty the tank, I simply divided the tank capacity of 2,500 liters by the outflow rate of 15 liters per minute, which gives a result of 166 minutes.
Researcher: Why did you convert 166 minutes to 2 hours and 47 minutes? Please explain how you calculated it.
S1: Well, since 120 minutes is 2 hours, I simply subtracted 120 minutes from 166 minutes, but I wasn't paying attention, so I miscalculated. It should have been 46 minutes, but I got 47 minutes.

Based on the interview process, it can be concluded that S1 was able to understand the problem in the question but did not write down what was known and asked. S1 was able to determine the logical steps to solve the problem, which was to divide 2,500 by 15. Although the steps were correct, there were minor errors in the calculation and writing. The conversion error that occurred indicates that S1 was not thorough in checking the final result. S1's work on question number 3 is shown in Figure 3 below.

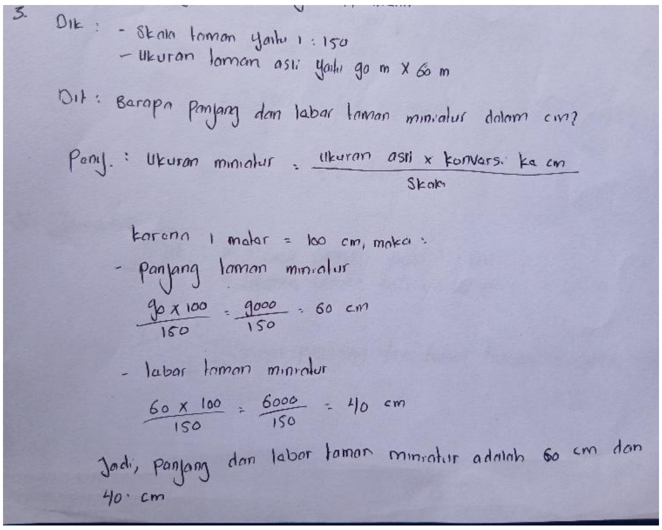


Figure 3. Problem Solving Ability Test Results

Based on Figure 3 for subject 1, the following analysis results were obtained.

In question number 3, S1 is able to identify what is known and what is being asked, able to plan the correct solution to solve the problem, able to implement the plan and calculation steps clearly and accurately, and able to provide the correct conclusion based on the calculations.

2) Problem-Solving Ability of Students with Medium Mathematical Literacy Skills

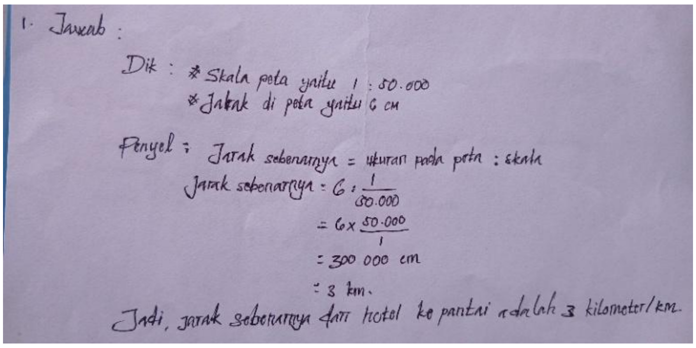


Figure 4. Problem Solving Ability Test Results

Based on Figure 4 for subject 2, the following analysis results were obtained.

In question number 1, S2 is able to identify what is known but does not write down what is asked, is able to plan the correct solution to solve the problem, is able to carry out the plan and the calculation steps clearly and accurately, and is able to provide the correct conclusion based on the calculation.

Based on the problem-solving ability indicator, S2 demonstrated fairly good problem-solving skills. However, there were some shortcomings in writing questions explicitly. S2's work on question number 2 is shown in Figure 5 below.

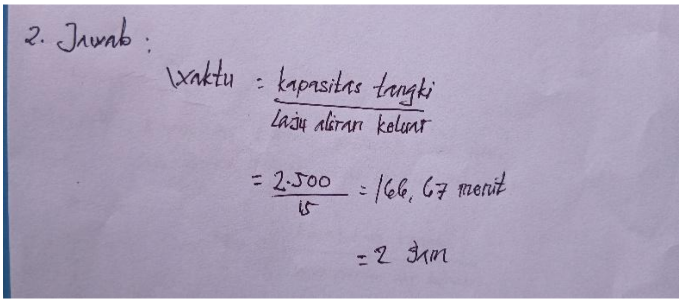


Figure 5. Problem Solving Ability Test Results

Based on Figure 4 for subject 2, the following analysis results were obtained.

In question number 2, S2 did not write down what was known and asked but managed to plan the correct solution to solve the problem. At the stage of implementing the plan, the student began to show weaknesses. Although the formula was correct, there were significant problems in the calculations. The result of dividing 2,500 by 15 is approximately 166.67 minutes. However, when converting it to hours, the student wrote 2 hours, which is incorrect. 166.67 minutes is actually equal to 2 hours and 47 minutes. This error indicates a lack of precision in calculations or unit conversion, and the student also did not provide a conclusion or any indication that they had double-checked their answer. In this section, S2 explained during the interview with the following excerpt.

Researcher: Earlier, you didn't write down what you knew and what you were asked. Did you understand the question from the beginning?

S2: Yes, the question was about a 2,500-liter water tank and water flowing out of the tank at a rate of 15 liters/minute, so to calculate the time needed to empty the tank completely, I divided 2,500 by 15, which resulted in 166.67 minutes.

Researcher: When calculating, did you find it difficult? What made you sure that 166.67 minutes is the same as 2 hours?

S2: Yes, it was difficult. I was confused, so I just estimated the answer to be 2 hours.

Based on the interview process, it can be concluded that S2 did not write down what was known and asked in the first indicator, but during the interview, S2 was able to identify important information from the question, namely the tank capacity of 2,500 liters and the water flow rate of 15 liters/minute. This shows that S2 was able to understand the problem well. In the second indicator, S2 successfully planned the correct solution, which was to divide the total volume of water by the flow rate to find the time required. In the third indicator, although the formula was correct, S2 was unable to perform the calculations accurately. S2 obtained the correct division result but made a mistake in converting the units, incorrectly concluding that 166.67 minutes was equal to 2 hours. On the fourth indicator, S2 showed no indication of checking their answer. S2's work on question number 3 is shown in Figure 6 below.

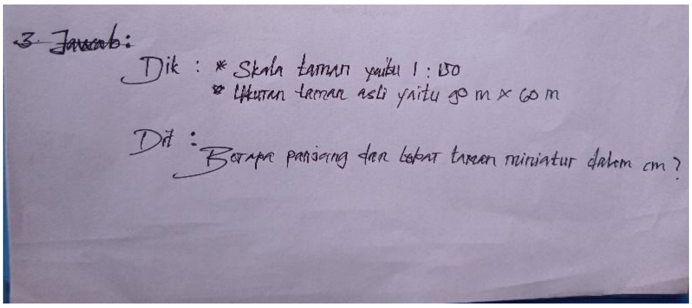


Figure 6. Problem Solving Ability Test Results

Based on Figure 6 for subject 2, the following analysis results were obtained.

In question number 3, S2 was only able to identify what was known and asked but did not plan a solution, did not implement the plan, and did not provide a conclusion.

Researcher: Why did you only write down what you knew and asked, and not proceed to the next step?

S2: I'm confused, sis.

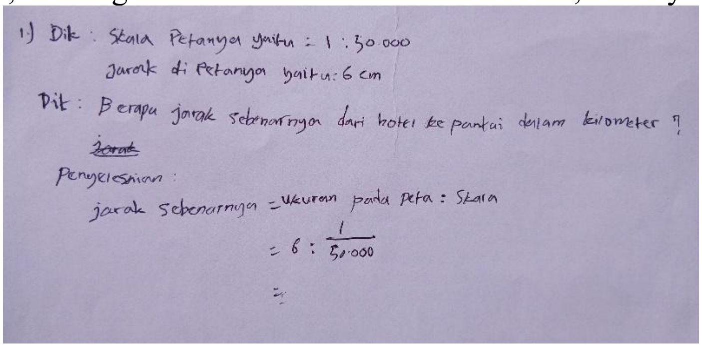
Based on the interview process, it can be concluded that S2 only fulfilled a small part of the problem-solving ability indicator, namely the first indicator of understanding the problem. S2 stopped at the initial stage and did not continue the process until completion, which shows that his ability still needs to be improved.

3) Problem-Solving Skills of Students with Low Mathematical Literacy

Based on Figure 7 for subject 3, the following analysis results were obtained.

In question number 1, S3 was able to identify what was known and what was being asked, was able to plan the correct solution to solve the problem, and demonstrated a good understanding of the basic concepts of map scale problem solving. He wrote down the correct formula for calculating the actual distance.

However, when implementing the plan, the student began to apply the formula that had been written, entering the known values into the formula, namely 6 : 1/50,000.



1) Dik : Skala Petanya yaitu : 1 : 50.000
Jarak di Petanya yaitu : 6 cm
Dit : Berapa jarak sebenarnya dari hotel ke pantai dalam kilometer ?
~~Jarak~~
Penyelesaian :
jarak sebenarnya = ukuran pada peta : Skala
= 6 : $\frac{1}{50.000}$
=

Figure 7. Problem Solving Ability Test Results

Up to this point, the steps taken by the student were correct, but the calculation was not completed and the result was not found. In this section, S3 explained during the interview with the following excerpt.

Researcher: Take a look at your answer. You have successfully written down the correct formula and entered the numbers. Can you tell me how you found that formula?

S3: From the question, the map scale is 1:50,000 and the distance on the map is 6 cm. The question asks for the actual distance from the hotel to the beach in kilometers, so I just entered the formula for finding the actual distance, which is the measurement on the map divided by the scale.

Researcher: After you entered the numbers 6 and 1/50,000 into the formula, what did you think the next step was?

S3: I was confused, the division was difficult.

Based on the interview process, it can be concluded that S3 showed good ability in identifying known information and questions from the problem in the first indicator. S3 successfully understood that the problem was related to map scale and asked about the actual distance. In the second indicator, S3 was able to plan the correct solution by writing the correct formula to calculate the actual distance. On the third indicator, S3 experienced difficulties even though they successfully entered the known values into the formula, namely 6 cm and a scale of 1:50,000. S3 did not continue the calculation process to completion, with the main difficulty being the division operation. This shows that their conceptual understanding was good, but S3 had difficulties with technical calculation skills. S3's work on question number 2 is shown in Figure 8 below.

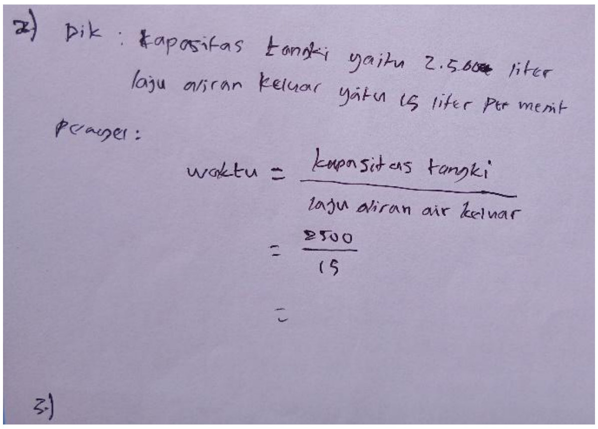


Figure 8. Problem Solving Ability Test Results

Based on Figure 8 for subject 3, the following analysis results were obtained.

In question number 2, S3 was able to identify what was known but did not write down what was asked. He was able to plan the correct solution to solve the problem, and the student demonstrated a proper conceptual understanding by writing down the correct formula to find the time required. In the implementation stage, the student began to apply the formula by entering the previously identified values, namely 2,500 / 15. This step was correct, but the student did not continue the calculation to obtain the final result. In this section, S3 explained during the interview with the following excerpt.

Researcher: How did you solve this problem? Can you describe the steps you took?

S3: From the problem, we know that the tank capacity is 2,500 liters and the water flow rate is 15 liters per minute, so I immediately divided 2,500 liters by 15.

Researcher: Next, why did you stop and not continue the calculation until it was finished?

S3: It's the same as number 1, the division was difficult because the numbers were too large.

Based on the interview process, it can be concluded that S3 on the first indicator shows the ability to understand problems well. S3 is able to identify the data known from the question, namely the tank capacity of 2,500 liters and the water flow rate of 15 liters/minute, but does not write down what is asked. On the second indicator, S3 demonstrated the ability to plan the correct solution by choosing the right formula to solve the problem, namely by dividing the tank capacity by the water flow rate. On the third indicator, S3 successfully began the calculation by writing the correct division, namely 2,500/15, but S3 was unable to complete the calculation. Based on the interview, the reason for not completing the calculation was because S3 considered the numbers to be too large and difficult to calculate, so S3 had difficulty with the division process, indicating that their ability still needs to be improved.

3.2. Discussion

This study aimed to describe the profiles of students' problem-solving abilities based on their levels of mathematical literacy in solving PISA-type problems. The discussion below interprets the findings in light of Polya, (1973) four stages of problem solving-understanding the problem, devising a plan, carrying out the plan, and reviewing the result-and the three processes of mathematical literacy outlined by OECD, (2023): formulating, employing, and interpreting. The findings reveal clear differences in how students with high, medium, and low mathematical literacy approach problem-solving tasks, both in their cognitive strategies and in their ability to translate conceptual understanding into accurate solutions.

3.2.1. Students with High Mathematical Literacy

Students with high mathematical literacy demonstrated comprehensive and structured problem-solving abilities. Subject S1 showed strong performance across all four of Polya's stages. The student was able to understand the problem context, identify relevant information, and apply mathematical concepts correctly. Even though S1 did not explicitly write the "known" and "asked" information on the answer sheet, the interviews revealed that the student could verbally articulate each element clearly. This indicates strong metacognitive awareness, a hallmark of proficient problem solvers (Bahar et al., 2020).

In terms of PISA's framework, S1 effectively performed the formulating process by translating the real-world situation into mathematical form and successfully executed the employing process through accurate computation. Minor errors, such as the rounding mistake in unit conversion, occurred during the interpreting process, where S1 failed to double-check the final result. Such oversight may reflect insufficient self-regulation during verification rather than conceptual misunderstanding. Similar patterns were observed by Wahyuni et al. (2025), who found that high-performing students often display strong reasoning but sometimes neglect verification due to overconfidence.

Overall, high-literacy students exhibit well-developed problem-solving behaviors characterized by clear logical reasoning, efficient planning, and high accuracy. Their mathematical literacy allows them to connect mathematical models with real contexts, which is essential for success in PISA-type problems. These findings reinforce the view that mathematical literacy and problem-solving ability are mutually reinforcing skills that develop through experience with contextualized mathematical tasks (Soares et al., 2023).

3.2.2. Students with Medium Mathematical Literacy

Students with medium mathematical literacy demonstrated partial mastery of problem-solving stages. Subject S2 consistently succeeded in understanding and planning the problem but encountered difficulties in execution and verification. For example, S2 correctly identified the given data and planned the solution using appropriate formulas but miscalculated time conversion from 166.67 minutes to hours. The interview revealed that the student relied on estimation rather than systematic calculation. This suggests that while conceptual understanding was sufficient, procedural accuracy and attention to detail were lacking.

From Polya's perspective, S2's difficulties mainly occurred in the carrying out the plan and reviewing stages. In PISA's terms, S2 succeeded in formulating but encountered obstacles in employing, particularly in algorithmic application and unit transformation. This pattern reflects a gap between conceptual reasoning and procedural fluency, a problem frequently found among students with intermediate achievement levels OECD, (2023). The inability to consistently verify answers also suggests limited metacognitive control.

S2's experience indicates that moderate-literacy students can engage meaningfully with mathematical contexts but need structured support to refine procedural accuracy. This aligns with Soares et al. (2023), who reported that medium-level students often struggle to transfer conceptual understanding into effective algorithmic strategies. Strengthening numeracy, estimation accuracy, and reflective habits may help such students bridge the gap between comprehension and execution. Furthermore, teachers should emphasize the importance of verification and reflection as integral parts of mathematical reasoning rather than as optional steps at the end of problem-solving.

3.2.3. Students with Low Mathematical Literacy

Students with low mathematical literacy, represented by S3, displayed awareness of the problem context but had limited capacity to translate this understanding into complete mathematical solutions. The student could identify known data and select relevant formulas, indicating partial conceptual grasp. However, S3 consistently failed to complete the computational process due to perceived difficulty in handling large numbers. This hesitation reflects not only a lack of computational skill but also low confidence and anxiety toward mathematical tasks—a common barrier for low-performing learners (Dewantara, 2019).

In Polya’s framework, S3 reached only the understanding and partial planning stages, without successfully implementing or reviewing the solution. From the PISA perspective, S3 could formulate a mathematical model but struggled to employ it effectively. This result is consistent with Wahyuni et al. (2025), who found that students in the low mathematical literacy category often demonstrate basic conceptual understanding but are unable to sustain logical reasoning throughout the problem-solving process. Their responses tend to stop prematurely, highlighting the need for scaffolding strategies that build persistence and confidence in mathematical reasoning.

S3’s case also underscores the importance of emphasizing process-oriented learning in mathematics. Students should be guided not only to understand what is being asked but also to practice executing procedures through repeated exposure to contextual problems. Encouraging collaborative problem-solving and using digital tools for visualization could also support these learners in bridging the gap between conceptual knowledge and computational practice.

3.2.4. Comparative Analysis and Theoretical Interpretation

Comparing the three groups reveals a progressive relationship between mathematical literacy level and the completeness of the problem-solving process. High-literacy students can move fluidly through all of Polya’s stages and PISA’s processes, while medium-literacy students tend to stagnate at the implementation stage, and low-literacy students often stop after understanding and partial planning. This hierarchical pattern reinforces the theoretical linkage between literacy and cognition: students with greater mathematical literacy exhibit stronger abstraction, reasoning, and metacognition.

Moreover, the differences among the three profiles suggest that mathematical literacy is not merely about computational skill but about the ability to contextualize, reason, and reflect. Students with high literacy demonstrate relational understanding-connecting mathematical symbols with real contexts-while those with lower literacy rely more on procedural recall. This finding supports the constructivist view that mathematical literacy develops through active engagement with contextual problems, where learners construct meaning through problem interpretation (Khotimah, 2021).

3.2.5. Practical and Pedagogical Implications

The findings have several pedagogical implications. First, teachers should integrate PISA-type contextual problems more frequently into classroom activities to foster students' ability to connect abstract concepts with real-life applications. Second, problem-solving instruction should explicitly model all stages of Polya's process, particularly emphasizing verification and reflection. Third, differentiated instruction is essential: high-literacy students may benefit from open-ended exploratory problems, while medium- and low-literacy students need guided practice with step-by-step scaffolding and feedback.

At the curriculum level, enhancing mathematical literacy should be an explicit goal of mathematics education, aligning with Indonesia's *Merdeka Belajar* policy that emphasizes contextual and meaningful learning. Continuous assessment using literacy-oriented tasks will help teachers identify students' strengths and weaknesses and design interventions that promote both procedural fluency and conceptual understanding

In summary, this discussion highlights that students' problem-solving profiles correspond closely with their mathematical literacy levels. High-literacy students exhibit complete and confident problem-solving behaviors; medium-literacy students demonstrate partial understanding with procedural weaknesses; and low-literacy students struggle with execution and reflection despite basic conceptual knowledge. These findings not only corroborate previous research (Bahar et al., 2020; Soares et al., 2023; Wahyuni et al., 2025) but also extend understanding by emphasizing the critical role of metacognitive control and verification in successful problem-solving. Strengthening mathematical literacy through contextualized and reflective learning experiences is therefore essential to improve Indonesian students' performance on international assessments like PISA.

4. CONCLUSION

This study aimed to describe the profiles of students' problem-solving abilities based on their levels of mathematical literacy in solving PISA-type problems. The findings reveal that students' levels of mathematical literacy have a significant influence on their ability to engage with and complete problem-solving processes. Overall, the results demonstrate a progressive pattern linking mathematical literacy to the completeness and accuracy of Polya's problem-solving stages. Students with higher literacy levels consistently display better understanding, logical reasoning, and verification skills compared to those with moderate or low literacy levels.

Students with high mathematical literacy demonstrate comprehensive mastery across all stages of problem solving. They are able to understand the context of the problem, plan and execute strategies effectively, and evaluate their results, even though minor errors in computation and checking sometimes occur. This suggests that their metacognitive awareness and conceptual understanding are well developed, allowing them to reason mathematically and validate their solutions effectively.

Meanwhile, students with medium mathematical literacy can generally understand and plan solutions but tend to face difficulties in implementing procedures and verifying outcomes. Errors often occur in the calculation or unit conversion stages, indicating partial comprehension and procedural weaknesses. Students in this group would benefit from explicit guidance in algorithmic reasoning and accuracy checking during mathematics instruction.

Students with low mathematical literacy can identify relevant information and formulate an initial plan but struggle with computational execution and often fail to complete the problem. Their limited calculation ability and low confidence in handling numbers hinder their progress. These results suggest that low-literacy students require scaffolding and gradual practice to build both their technical skills and confidence in problem solving.

Theoretically, this study strengthens the relationship between mathematical literacy and Polya's problem-solving framework, confirming that literacy is not limited to computational skills but involves the ability to reason, contextualize, and interpret. Students who possess strong mathematical literacy are more capable of integrating conceptual knowledge with real-world situations, consistent with the OECD, (2023) PISA framework emphasizing *formulating*, *employing*, and *interpreting* processes. This reinforces the view that improving mathematical literacy is essential for developing higher-order thinking and reasoning abilities among students.

Practically, the results imply that mathematics learning should emphasize contextual and reflective problem-solving activities. Teachers are encouraged to integrate PISA-oriented tasks into classroom practice, model each stage of problem solving explicitly, and foster habits of verification and reflection among students. For learners with moderate and low literacy, structured support such as guided exercises, collaborative problem-solving, and incremental feedback can help strengthen procedural fluency and accuracy.

Furthermore, students should be trained to document their thought processes systematically by writing down known data, questions, and solution steps to improve organization and clarity in reasoning. Encouraging regular checking of results will cultivate self-regulation and reduce careless errors.

For future research, it is recommended to expand the sample size and include diverse mathematical topics to explore how literacy-based approaches affect different types of reasoning skills. Further studies may also investigate the effectiveness of specific instructional models-such as problem-based learning or contextualized mathematics tasks-in improving students' mathematical literacy and problem-solving competence.

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