



Analysis of Students' Mathematical Literacy Ability in Solving Contextual Problems: A Study Based on the Programme for International Student Assessment (PISA)

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ABSTRACT

Mathematical literacy is an essential competency that enables students to understand, use, and interpret mathematics in real-life contexts. However, junior high school students' mathematical literacy remains suboptimal, particularly in solving contextual problems. This study aims to analyze the mathematical literacy profile of ninth-grade students at SMP Negeri 8 Kota Cirebon in solving contextual problems on systems of linear equations in two variables (SLETV), based on the Programme for International Student Assessment (PISA) framework. A descriptive qualitative approach was employed. Twenty students completed an eight-item mathematical literacy test and were classified into low, moderate, and high categories based on the sample mean and standard deviation. Written responses from nine representative students (three per category) were analyzed to examine the formulating, employing, and interpreting processes. The results showed that 20% of students were in the low category, 60% in the moderate category, and 20% in the high category. Differences across categories were primarily evident in formulating, particularly defining variables and constructing complete mathematical models, and interpreting, particularly drawing contextual conclusions. Meanwhile, employing was relatively well mastered. These findings highlight the importance of assessing students' mathematical thinking processes through contextual mathematical literacy problems.

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1. Introduction

Mathematics education at the junior high school level plays an important role in shaping students' critical and logical thinking as well as their problem-solving skills [1].



Mathematics can be understood as a field of study that examines abstract objects and concepts through a logically structured system based on certain axioms and definitions [2]. Mathematical knowledge is developed through deductive reasoning to produce consistent statements that can be formally proven [3]. The main focus of mathematics lies in the study of structures, patterns, and relationships between concepts, both for theoretical development and for application in understanding various phenomena [4]. Learning mathematics is a complex process because it involves active interaction between students and a contextual learning environment that is deliberately designed not only to achieve learning objectives but also to support students' cognitive development [5]. Literacy is defined as an individual's ability to access, understand, evaluate, and use information effectively in various life contexts [6]. Literacy is not only related to reading and writing skills but also includes critical thinking, reasoning, and decision-making based on the information obtained [7].

Mathematical literacy is one of the important mathematical abilities that allows individuals to use mathematics meaningfully in various life situations [8]. According to the Organization for Economic Co-operation and Development (OECD), mathematical literacy refers to a person's ability to formulate, use, and interpret mathematics in various situations, involving mastery of mathematical concepts, procedures, and facts [9]. Mathematical literacy can sharpen mathematical reasoning to solve problems encountered in everyday life [10]. Through mathematical literacy, students are not only required to master calculations and symbols, but are also able to reason, make decisions, and reflect on the results of problem-solving based on the context they face [11]. Thus, mathematical literacy becomes a bridge between abstract mathematical knowledge and its application in daily life [12]. Mathematical literacy does not merely mean that students must master concepts, but also that they are able to use and interpret mathematical procedures [13]. Mathematical literacy ability plays a role in facing the challenges of the 21st century, in which the younger generation is required to be adaptive, creative, and able to utilize mathematics meaningfully in various situations [14].

Mathematical literacy is developed in mathematics learning, particularly in facing increasingly complex real-life problems [15]. The OECD states that mathematical literacy consists of three main components, namely the ability to formulate, employ procedures, and interpret results back into the original context [16]. The ability to formulate mathematics relates to the process of identifying and representing contextual problems into an appropriate mathematical model [17]. Furthermore, the ability to employ mathematics refers to the use of procedures in solving problems that have previously been modeled [18]. Meanwhile, the ability to interpret mathematics emphasizes the process of reflecting on, evaluating, and relating the results of the mathematical solution back to the original problem context [19]. These three components of mathematical literacy confirm that learning mathematics does not merely show mastery of procedures, but also develops the ability to think in applying mathematics in daily life [20].

International data show that Indonesia's position is still lagging in the aspect of mathematical literacy. The results of the 2022 Programme for International Student Assessment (PISA) show that the average mathematics level of Indonesian students only reached level 2, with less than 20% of Indonesian students at the minimum mathematics proficiency level [21]. This condition shows that most students in Indonesia have not yet mastered higher-level mathematical skills, particularly in solving non-routine problems that require reasoning and the application of concepts in contextual situations. This condition also reflects that the mathematics instruction applied is still focused on memorizing procedures and routine practice problems, while the aspects of understanding and application in daily life have not been optimized [22].

In their research, Vebrian et al. [23] explained that students experience difficulties in connecting mathematical concepts with contextual problems, especially when the problems require higher-order reasoning skills. Laamena and Laurens [24] explained in their research that students' low mathematical literacy is related to the lack of implementation of real-problem-based learning strategies. In his research, Kohen [25] explained that the use of contextual problems can help students interpret problems and select solution strategies. Contextual problems can also help improve students' ability to communicate mathematical arguments more effectively [26]. However, most studies focus more on the effectiveness of a particular learning model, while in-depth analysis of the profile of mathematical literacy ability in solving contextual problems remains limited. This gap constitutes the urgency of this research.

Analyzing students' mathematical literacy through contextual problems is not, in itself, a new approach; previous studies have examined students' reasoning when solving contextual literacy problems [23] and how contextual problems support interpretation and the selection of solution strategies [25]. The specific contribution of this study is therefore narrower. First, it examines how the three PISA processes, namely formulating, employing, and interpreting, operate together within one content domain, systems of linear equations in two variables (SLETV), instead of reporting literacy as a single overall score. Second, it links a norm-referenced classification of students (low, moderate, and high relative to the sample) to an item-level analysis of their written work, so that differences between groups can be traced to specific processes. Third, it summarizes the evidence in a student-by-process matrix that shows where the chain from modeling to interpretation breaks down in each written answer. In this way, the study provides information on which literacy processes have developed and which remain weak when junior high school students solve contextual SLETV problems.

The purpose of this research is to analyze the profile of students' mathematical literacy ability in terms of formulating, employing, and interpreting when solving contextual problems on SLETV. Based on the PISA framework, this analysis is expected to benefit the field of education, particularly by presenting a picture of the profile of mathematical literacy ability at the junior high school level, enriching the literature on contextual-problem-based assessment, and serving as a basis for consideration for teachers and researchers in designing learning strategies so that learning and the development of students' abilities become more relevant to the demands of 21st-century mathematical literacy.

2. Methods

2.1 Research Design

This research employed a descriptive qualitative approach. The descriptive qualitative approach aims to describe and gain an in-depth understanding of the phenomenon under study based on the data obtained, without any treatment of or manipulation to the research subjects [27]. In the context of this research, this approach was used to describe the profile of students' mathematical literacy ability through the analysis of written answers in solving contextual problems, so that a complete picture of the mathematical literacy process demonstrated by students could be obtained [28]. This approach was chosen because the research aims to describe and gain an in-depth understanding of students' mathematical literacy ability in solving contextual problems based on the Programme for International Student Assessment (PISA) framework, particularly in terms of the mathematical literacy process demonstrated through students' written answers [29].

Research data were obtained through a mathematical literacy test. The test results were analyzed descriptively by calculating the percentage of student achievement in each

ability category (high, moderate, and low) to provide a general picture of the students' mathematical literacy profile. This percentage was used as the basis for grouping and supporting the qualitative description.

Qualitative analysis was conducted by examining in depth the written answers of students representing each ability category to identify solution patterns, characteristics of the mathematical literacy process, and difficulties experienced by students in formulating, employing, and interpreting contextual problems.

2.2 Participants

This research was conducted at SMP Negeri 8 Kota Cirebon in the odd semester of the 2025/2026 academic year. Participants in this study consisted of two groups. The first group was a try-out class of 15 students, used to evaluate the quality of the research instrument, including validity, reliability, discriminating power, and difficulty level of the items. The second group was the main research class, consisting of 20 ninth-grade students who were the main subjects of the mathematical literacy ability analysis. All 20 students were categorized quantitatively. For the qualitative analysis of written answers, nine of the 20 students (three from each category) were selected using purposive sampling, so that each ability category was represented by the same number of cases and the solution processes could be compared across categories. The selected students are coded S7, S11, and S12 (high category), S1, S2, and S3 (moderate category), and S4, S5, and S6 (low category).

2.3 Instruments

There were 8 test items developed by the researcher, referring to the mathematics assessment framework of the Programme for International Student Assessment (PISA) issued by the OECD [30]. The items were contextual problems on SLETV, for example the speeds of two printers (Items 2 and 6) and the unit prices of apples and oranges (Item 4). The items assessed three components of mathematical literacy ability, namely:

1. Formulating, the ability to translate a problem into a mathematical model.
2. Employing, the ability to utilize mathematical procedures.
3. Interpreting, the ability to interpret and relate the calculation results to the original problem context.

Items 1, 3, and 6 target formulating; Items 2, 4, and 7 target employing; and Items 5 and 8 target interpreting. Items 1, 3, and 6 ask students only to write the mathematical model, whereas the other items ask for a final answer. The complete set of items is provided in Appendix 1. Responses were scored with a three-aspect rubric (formulating the problem, application, and communication) with a maximum score of 10.

The instrument that had been developed was first tried out on 15 students to determine the quality of the items. Content validity was obtained through expert judgment from mathematics education lecturers. Furthermore, the empirical validity of each item was analyzed using product-moment correlation. Analysis of the discriminating power and difficulty level of the items was also conducted to ensure that each item could distinguish students' abilities and had an appropriate level of difficulty. The reliability of the instrument was then calculated using Cronbach's Alpha. Based on the results of this analysis, the eight items met the criteria of validity, discriminating power, and appropriate difficulty level, as well as reliability, and were thus used in the main research.

2.4 Data Analysis

This research used a descriptive qualitative approach, with data in the form of mathematical literacy test scores used as supporting data to describe the tendency of students' ability levels. The research data consisted of two types, namely mathematical

literacy test scores and qualitative data in the form of descriptions of patterns in students' written answers.

Data analysis was conducted in several stages. First, each student's score was calculated based on the established scoring guidelines. The scores were then used to classify students into mathematical literacy ability categories, namely high, moderate, and low, using a categorization formula based on the mean and standard deviation [31], as presented in Table 1.

Table 1. Mathematical Literacy Ability Categorization Formula

Category	Score Boundary
High	$X \geq \bar{X} + SD$
Moderate	$\bar{X} - SD < X < \bar{X} + SD$
Low	$X \leq \bar{X} - SD$

In Table 1, X is a student's total score, $\bar{X}$ is the mean of the total scores of the 20 students in the main class, and SD is their standard deviation. The empirical values in this study were $\bar{X} = 42.400$ and $SD = 9.719$, which give the boundaries of 32.681 and 52.119 reported in Table 2.

The mean $\pm$ SD (norm-referenced) rule was chosen for reasons specific to this study. First, the eight-item test covers one content domain (SLETV) and was not calibrated on the PISA proficiency scale, so there is no empirical basis for assigning students to PISA proficiency levels. Second, the purpose of the categorization was to select and contrast written answers from students at different positions in the class distribution, which requires relative groups. Third, a rule based on the sample distribution is transparent and can be replicated with the same data [31]. The consequence is that the categories describe students' relative standing within this sample of 20 students and not an absolute attainment of mathematical literacy: a student in the high category is high relative to this class, and the same score could fall into a different category in another class. In addition, because the cut-offs lie one standard deviation on either side of the mean, a roughly bell-shaped distribution places most students in the moderate category by construction. The terms high, moderate, and low are therefore used throughout this article only as relative labels.

Furthermore, the percentage of students in each category was calculated to provide a general picture of students' mathematical literacy ability profile. The next stage was qualitative analysis, namely examining students' written answers in each category to identify error tendencies, solution strategies, and the mathematical literacy processes that emerged, including the processes of formulating, employing, and interpreting.

This analysis was conducted to gain a deeper understanding of students' mathematical literacy ability in solving contextual problems, while also explaining the research findings in accordance with the research objectives.

3. Result and Discussion

3.1 Distribution of Mathematical Literacy Categories

The results of the analysis of students' mathematical literacy ability were obtained through a written test based on contextual problems developed with reference to the PISA framework. Students were categorized as high, moderate, or low relative to their class using the mean $\pm$ standard deviation approach as proposed by Lestari et al. [31]. The mean total score was 42.400 and the standard deviation was 9.719, which give the score boundaries presented in Table 2. These categories describe students' relative performance within this sample and are not established levels of mathematical literacy.

Table 2. Score Boundaries of Students' Mathematical Literacy Ability Categories

Category	Score Boundary
High	$X \geq 52.119$
Moderate	$32.681 < X < 52.119$
Low	$X \leq 32.681$

Table 3. SPSS Output of Student's Mathematical Literacy Ability Category Distribution

Category	Frequency	Percent	Valid Percent	Cumulative Percent
1 (Low)	4	20.0	20.0	20.0
2 (Moderate)	12	60.0	60.0	80.0
3 (High)	4	20.0	20.0	100.0
Total	20	100.0	100.0	

Table 3 shows that 4 students (20%) were in the low category, 12 students (60%) in the moderate category, and 4 students (20%) in the high category. This means that, relative to their classmates, four students obtained comparatively low total scores (32.681 or below), twelve obtained scores around the class mean, and four obtained comparatively high scores (52.119 or above). The finding that most students were in the moderate category should be read with caution, because a mean $\pm$ SD rule places most students in the middle group by construction (see Section 2.4). The qualitative analysis in Sections 3.2 to 3.4 examines what these relative differences look like in students' written work.

To obtain a deeper picture of students' mathematical literacy ability, a qualitative analysis was conducted on the written answers of nine students selected from the three categories: three students in the high category (S7, S11, S12), three students in the moderate category (S1, S2, S3), and three students in the low category (S4, S5, S6). Each answer was examined using the three PISA processes. Formulating was identified when students defined variables and translated the conditions of the problem into equations. Employing was identified when students carried out elimination, substitution, and arithmetic correctly. Interpreting was identified when students stated the result as an answer to the question in the original context, with units, or checked it against the problem. Only what is visible in the figures is used as evidence.

The following presents the results of the analysis of student answers with high, moderate, and low mathematical literacy ability categories.

3.2 Analysis of Student Answers in the High Category

Students in the high category showed the most complete chains of formulating, employing, and interpreting among the nine analyzed answers, although the evidence differs across the three samples.

Handwritten mathematical solution for a system of linear equations by Student S7. The student defines variables: V_a = A (lembar / jam) and V_b = B (lembar / jam). They then write the equations: $(V_a + V_b) \times 9 = 180 \rightarrow P_1$ and $V_a + V_b = 120 \rightarrow P_2$. The solution proceeds with elimination: $3V_a - 5V_b = 90$ and $1V_a + V_b = 120$, leading to $4V_b = 40$ and $V_b = 10$. Substitution is used to find $V_a = 110$. The final answer is $V_a = 110$ and $V_b = 10$.

Figure 1. Student S7's Answer

Handwritten mathematical solution for a word problem by Student S11. The problem involves calculating the total cost of 5 rotis and 3 teh. The student calculates: $5 \text{ roti} \times \text{Rp. } 4.000 = 20.000$ and $3 \text{ teh} \times \text{Rp. } 3.000 = 9.000$. The total cost is $20.000 + 9.000 = \text{Rp. } 29.000$. The final answer is $\text{Rp. } 29.000$.

Figure 2. Student S11's Answer to Item 5

4) 1 kg apel = x
1 kg jeruk = y
 $2x + y = 54.000$
 $4x + 2y = 68.000$
 $4x + 6y = 108.000$
 $(4x + 6y) - (4x + 2y) = 108.000 - 68.000$
 $4y = 40.000$
 $y = 10.000$
mencari nilai x: $2x + 3(10.000) = 54.000$
 $2x + 30.000 = 54.000$
 $2x = 24.000$
 $x = 12.000$
jadi, Pembeli harus membayar Rp. 110.000.

Figure 3. Student S12's Answer

Student S7 (Figure 1; Item 2) began by defining two variables, V_a and V_b , as the speeds of printers A and B in sheets per hour. S7 then translated two conditions into equations: $(V_a + V_b) \times 4 = 480$, simplified to $V_a + V_b = 120$, and $3V_a - 5V_b = 40$, with annotations showing that $3V_a$ and $5V_b$ are the numbers of sheets printed by printers A and B. This is an explicit translation from the situation to a model, including the meaning of each term (formulating). In the employing stage, S7 wrote $V_a = 120 - V_b$, substituted it into the second equation, obtained $-8V_b = -320$ and $V_b = 40$, and substituted back to obtain $V_a = 80$, with all operations correct. S7 closed with a statement that the speed of printer A is 80 sheets per hour and that of printer B is 40 sheets per hour (interpreting). The work does not show a check of the solution against the original conditions, so interpreting is evident as a conclusion in context but not as verification.

Figure 2 shows S11's answer to Item 5, which in the instrument blueprint targets interpreting and gives the unit prices of bread and tea. S11 organized the information by listing each product with its unit price and quantity (bread, $\text{Rp}4,000 \times 2 = 8,000$; tea, $\text{Rp}3,000 \times 3 = 9,000$), added the two amounts to obtain $\text{Rp}17,000$, and labeled the result *uang yang harus dibayar* (the money that must be paid). This shows correct computation (employing) and a result stated in the context of payment (interpreting). Because the item gives the prices and requires only arithmetic, it provides limited evidence of formulating a SLETV model. S11 is placed in the high category on the basis of the total score across the eight items, so Figure 2 is read here as evidence of employing and interpreting only.

Student S12 (Figure 3; Item 4) defined x as the price per kilogram of apples and y as the price per kilogram of oranges and wrote two equations, $2x + 3y = 54,000$ and $4x + 2y = 68,000$. S12 multiplied the first equation by 2 to obtain $4x + 6y = 108,000$, subtracted the second equation to obtain $4y = 40,000$ and $y = 10,000$, and substituted y into the first equation to obtain $x = 12,000$ (employing). S12 then returned to the question about buying 5 kg of apples and 5 kg of oranges, wrote $5x + 5y = 5(12,000) + 5(10,000) = 110,000$, and concluded *Pembeli harus membayar Rp 110.000* (the buyer must pay $\text{Rp}110,000$). This shows that S12 used the solution of the model to answer a new question in the original context (interpreting).

Taken together, the S7 and S12 answers show the full chain of defining variables, writing and solving a complete model, and answering in context, whereas the S11 answer, which comes from an item that targets interpreting, supports only employing and interpreting. In all three answers interpreting took the form of a statement of the result with units in context; none of the visible answers showed an explicit check of the result against the original conditions.

3.3 Analysis of Student Answers in the Moderate Category

Students in the moderate category were generally able to use the procedures for solving a system of linear equations in two variables (SLETV), but did not fully carry out the entire mathematical literacy process.

2.) ($B = 40$)
 Substitusikan ke persamaan pertama
 $(A + B) = 120$
 $A + 40 = 120$
 $A = 120 - 40 = 80$

Figure 4. Student S1's Answer

Jawaban :
 $m \times 4 = 4m$
 $t \times 2 = 2t$
 $4m + 2t = 124$
 $m + t = 40$
 $4m + 2t = 124$

Figure 5. Student S2's Answer

$4a + 6j = 108000$
 $(4a + 6j) - (4a + 2j) = 108000 - 68000$
 $4j = 40000 \rightarrow j = 10000$
 Substitusi:
 $2a + 3(10000) = 54000$
 $2a + 30000 = 54000$
 $2a = 24000$
 $a = 12000$

Figure 6. Student S3's Answer

The visible part of S1's answer (Figure 4; Item 2) shows $B = 40$, substitution into the first equation, $(A + B) = 120$, $A + 40 = 120$, and $A = 120 - 40 = 80$. These steps are correct and show that S1 solved the system by substitution (employing). However, the visible part does not show how the variables were defined or how the second equation was written, and it ends with $A = 80$ without a sentence that relates A and B to the context. Evidence for formulating and interpreting is therefore not visible in this answer, although the image may show only part of S1's work.

S2 (Figure 5; Item 1) wrote $m \times 4 = 4m$ and $t \times 2 = 2t$, and then the system $4m + 2t = 124$ and $m + t = 40$. Item 1 asks only for a mathematical model of the number of vehicles and wheels, and the system written by S2 is consistent with 4 wheels per car and 2 wheels per motorcycle and with the totals in the problem, so the formulating is largely correct. The remaining weakness is that m and t are not defined in words. Because Item 1 does not ask for a solution, employing and interpreting are not required by this item and cannot be judged from this answer.

S3 (Figure 6; Item 4) started from $4a + 6j = 108,000$, subtracted $4a + 2j = 68,000$ to obtain $4j = 40,000$ and $j = 10,000$, substituted into $2a + 3(10,000) = 54,000$, and obtained $a = 12,000$. The elimination and substitution are correct (employing), and the equations show that the conditions had been translated into a model (formulating, with a and j presumably standing for the prices of apples and oranges). However, the variables are not defined, and the visible work ends at $a = 12,000$ without units and without using the prices to answer the question about the new purchase, so interpreting is not evident.

In the moderate category, formulating was therefore mostly present as correct equations without defined variables (S2, S3), and employing was correct where it was visible (S1, S3). The two answers that required a final result (S1 and S3) did not end with a conclusion stated in the context of the problem. In these samples it is the missing variable definitions and conclusions, rather than the absence of equations, that distinguish the moderate category from the high category.

3.4 Analysis of Student Answers in the Low Category

In the low category, the written answers showed breakdowns at different stages of the mathematical literacy process for each student.

Handwritten work for Figure 7:

$$\begin{aligned} 2S + 3(12) &= 60 \\ 2S + 36 &= 60 \\ 2S &= 60 - 36 \\ 2S &= 24 \\ S &= 12 \end{aligned}$$

Figure 7. Student S4's Answer

Handwritten work for Figure 8:

$$\begin{aligned} X + Y &= 120 \\ 3 \times 5Y &= 40 \end{aligned}$$

Figure 8. Student S5's Answer

Handwritten work for Figure 9:

$$\begin{aligned} \text{total biaya } 5a + 5j \\ \text{total biaya} &= 5(12.000) + 5(10.000) \\ \text{total biaya} &= 60.000 + 50.000 \\ \text{total biaya} &= 120.000 \end{aligned}$$

Figure 9. Student S6's Answer

The work of S4 (Figure 7) corresponds to Item 7. S4 wrote an equation of the form $2S + 3(12) = 60$, which has the form of the first equation of the model ($2x + 3y = 60$) with $y = 12$ already inserted, and then $2S + 36 = 60$, $2S = 24$, and $S = 12$. The substitution and the arithmetic are correct, and the values agree with the solution of this item (12 shoulder bags and 12 backpacks). However, the visible part does not show how the equations were written or how $y = 12$ was obtained, no variables are defined, and no conclusion stating the number of each type of bag is written. Formulating is therefore only partly evident, employing is evident in the visible part, and interpreting is not evident.

S5 (Figure 8; Item 6) wrote $x + y = 120$, the first equation of the printer model, which indicates that S5 recognized the relationship between the total output and the two printer speeds. The second line, $3 \times 5y = 40$, should have been $3x = 5y + 40$: the first variable is missing and the comparison between the two printers is written as a multiplication. S5 therefore began to formulate the model correctly but broke down when translating the second condition into symbols. Item 6 asks only for the model, so employing and interpreting are not required by this item.

S6 (Figure 9; Item 4) wrote the total cost as $5a + 5j$, substituted $5(12,000) + 5(10,000)$, and then wrote $60,000 + 50,000 = 120,000$ instead of 110,000. The expression $5a + 5j$ is an appropriate model for the final question (5 kg of each fruit) and the substitution is correct, so S6's breakdown lies in the arithmetic of the employing stage. The visible work does not show how the prices of 12,000 and 10,000 were obtained, so the formulation and solution of the system itself cannot be assessed. The result is labeled *total biaya* (total cost) but is not followed by a sentence in context, and because the amount is incorrect, interpreting cannot be considered achieved.

The three low-category answers thus show different weaknesses rather than a uniform inability to formulate: an answer with correct substitution but undefined variables and no conclusion (S4), a partially symbolized model (S5), and a correct expression followed

by an addition error (S6). In the two answers that required a final result (S4 and S6), no conclusion was stated in the context of the problem.

3.5 Summary of the PISA Processes Across Categories

Table 4 summarizes the evidence for each process in the nine written answers. The symbol + means that the process was evident, $\pm$ that it was partly evident, and – that it was not evident in the part of the answer shown in the figures; n/a means that the item did not ask for that process (Items 1 and 6 ask only for a model). F, E, and I stand for formulating, employing, and interpreting.

Table 4. Evidence of the PISA Processes in the Nine Analyzed Written Answers

Student	Category	F	E	I
S7	High	+	+	+
S11	High	$\pm$	+	+
S12	High	+	+	+
S1	Moderate	–	+	–
S2	Moderate	$\pm$	n/a	n/a
S3	Moderate	$\pm$	+	–
S4	Low	$\pm$	+	–
S5	Low	$\pm$	n/a	n/a
S6	Low	$\pm$	$\pm$	–

Note: the S11 answer comes from Item 5, where unit prices are given, so $\pm$ for formulating reflects the organization of given information and not a SLETV model. For S1, – means not visible in the figure, which shows only part of the work. For S4, $\pm$ reflects an equation of the correct form whose derivation is not visible. For S6, $\pm$ for formulating refers only to the final expression $5a + 5j$.

Employing was evident or partly evident in every answer where it was required and visible (S7, S11, S12, S1, S3, S4, and S6). Formulating was fully evident in two answers (S7 and S12) and partly evident in six, and interpreting was evident in only three of the seven answers that required a final result, all of them in the high category. Formulating and, above all, interpreting therefore separate the high category from the other two categories in these samples, while employing does not.

3.6 Discussion

The categorization shows that, relative to one another, 60% of the 20 students scored within one standard deviation of the class mean, with 20% above and 20% below. Because the categories are norm-referenced, this result describes how scores are spread within this class. It does not show that students' mathematical literacy is at a moderate level in the sense of a PISA proficiency level, and it cannot be compared directly with the national PISA results cited in the Introduction [21]. What the categorization does provide is a principled way of choosing contrasting cases for the analysis of written work.

The more informative findings come from the written answers. In the PISA framework, formulating involves translating a real-world situation into mathematical form, employing involves carrying out mathematical procedures, and interpreting involves relating mathematical results back to the situation [16]. In the nine analyzed answers, employing was evident or partly evident wherever it was required and visible, formulating was fully evident in two, and interpreting in three of the seven answers that required a final result (Table 4). The processes that separated the high category from the others were therefore formulating and interpreting, and procedural skill was also present in most moderate-category answers. S3, for example, solved the system correctly but stopped at $a = 12,000$, and S1's visible work

ended at $A = 80$. Such answers are procedurally sound but not yet complete evidence of mathematical literacy. This agrees with reports that students find it difficult to connect mathematical concepts with contextual problems [23], and with the view that literacy requires students to reason and to reflect on the results of problem solving and not only to calculate [11].

The low-category answers show that weaknesses can occur at different points: S4 solved correctly but without defining variables or stating a conclusion, in S5 the second condition could not be symbolized, and in S6 a correct expression was followed by an arithmetic slip. A single label such as low therefore hides different needs, which supports scoring the three processes separately instead of relying on total scores alone. Several explanations for the observed patterns are plausible, but none was tested in this study. First, instruction that emphasizes memorizing procedures and routine exercises [22] gives students little practice in defining variables and writing conclusions, which routine problems rarely require. Second, the absence of a concluding sentence in most moderate and low answers may reflect a habit of treating a number as the end of a solution rather than an inability to interpret; interviews would be needed to tell these apart. Third, students with limited experience of real-problem-based learning [24] may find it hard to translate a contextual situation into equations, whereas regular work with contextual problems can help them interpret problems and select strategies [25].

This study contributes to the understanding of students' mathematical literacy in three ways. It shows, within the SLETV context, that correct procedures do not guarantee complete mathematical literacy, because formulating and interpreting can be missing even when employing is correct. It shows how written answers can be mapped to the three PISA processes (Table 4), which gives teachers a way to locate where a solution breaks down. It also shows that students in the same category can differ in where their solutions break down.

For mathematics teaching and learning, these findings suggest that teachers (a) ask students to define their variables and state what each equation represents before solving; (b) require a closing sentence that answers the question in context, with units, and encourage students to check the result against the original conditions; (c) use contextual tasks regularly, including tasks in which a second question reuses the model, as in the step that S12 carried out correctly; and (d) assess and give feedback on formulating, employing, and interpreting separately, for example with a rubric that has one row for each process. For assessment, the results support evaluating the solution process and not only the final answer.

3.7 Limitations of the Study

This study has several limitations that affect how the findings should be interpreted. First, it involved one class of 20 students in one school, so the findings describe this group and cannot be generalized to other schools or to ninth-grade students in general; readers should judge transferability by comparing their own context with the one described here. Second, the test contained eight items on one topic (SLETV), so the profile may differ in other content domains. Third, the categories are relative to the sample and based on mean $\pm$ SD cut-offs, so a different class or a criterion-referenced standard could place the same students in different categories. Fourth, the qualitative analysis is based on the written work of nine students, and in some figures only part of the work is visible. The interpretations concern what is evident on paper and were not checked against interviews or think-aloud data, so the reasons for omitted steps remain inferences. Future studies could use larger and more varied samples, add interviews, and compare relative categories with criterion-referenced levels.

4. Conclusion

Based on the research results, the mathematical literacy ability of ninth-grade students at SMP Negeri 8 Kota Cirebon is, relative to their classmates, generally in the moderate category (60%), with 20% of students in the low category and 20% in the high category. These categories are relative to this sample and do not represent established proficiency levels. Analysis of nine written answers showed that students in the high category carried out the three PISA processes more completely, while students in the moderate and low categories showed limitations, particularly in formulating problems (defining variables and writing complete models) and interpreting solution results (stating conclusions in context). Procedural skill (employing) was relatively better mastered.

These findings confirm the importance of relating mathematics to real-life contexts and strengthening mathematical literacy, so that students are not only procedurally skilled but are also able to understand and make sense of mathematics. For classroom practice, teachers can ask students to define variables, write the model explicitly, and close each solution with a conclusion in context, and can assess the three processes separately. The study is limited to one class of 20 students, eight SLETV items, and the written work of nine students, so the findings should not be generalized; larger samples and interviews are recommended for future research.

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