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Analysis of Junior High School Mathematics Literacy Skills in Problem-Based Learning (PBL) Using Stick Board Props

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Abstract

This study aims to analyze the mathematical literacy skills of students in PBL using the One Variable Linear Equation (OVLE) stick board props. This research adopts a qualitative descriptive approach. The research subjects were eighth-grade students at junior high schools in the Malang district. The instruments in this study were mathematical literacy test questions and interview guidelines. The research data were analyzed using three indicators of mathematical literacy, namely formulate, apply, and interpret. From a formal perspective, the subject successfully converted the problem into a mathematical model. In the employ aspect, the subject is able to apply the problem-solving strategy to obtain the final result. In the interpret aspect, the subject is able to draw appropriate conclusions. The results of the analysis of subjects who had learned by using PBL with stick board props showed that students with high literacy scores fulfilled three indicators of literacy skills, students with moderate literacy scores were able to fulfill two indicators of literacy skills, and students with low literacy scores were only able to fulfill one indicators of literacy skills. The conclusion shows that students with high, medium, and low literacy scores were able to fulfill the formulated indicator. This means that the use of PBL with stick boards can generate students' skills in formulating problems into mathematical models. This research implies that the PBL approach assisted by props such as Stick Board has great potential in improving mathematical literacy, but its effectiveness is highly dependent on the differentiation approach based on students' ability levels. Therefore, teachers are expected to implement adaptive and responsive learning to the needs of each student so that all aspects of mathematical literacy can be optimally developed.

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INTRODUCTION

Mathematics is a process of understanding concepts that begins with real-world problems, allowing students to relate them to everyday life and achieve effective problem-solving (Hidayat, 2019). The use of real problems at the beginning of learning aims to provide opportunities for students to find new ideas for solutions and relevant mathematical concepts (Morselli & Gorenc, 2022). Learners will understand the basics of mathematics more easily if they can relate it to real situations in learning (Ahmad & Nasution, 2019).

This ability is often referred to as mathematical literacy, which enables learners to understand and apply mathematics effectively in everyday life (Ananda & Wandini, 2022).

Mathematical literacy is crucial for developing life skills (Sumirattana et al., 2017). This is in line with Permendikbud Number 5 Article 9 of 2022, which emphasises the importance of literacy in education. In contrast to school mathematics, which prioritises material content, mathematical literacy is related to the use of mathematics in everyday life (Lange, 2003). Learners should be able to rediscover mathematical concepts through practice in mathematics lessons. In this case, teachers play a crucial role in creating lessons that support the development of learners' mathematical literacy (Aladağ et al., 2021).

Based on observations made by researchers at SMP An-Nur Bululawang Malang, it was found that 65% of 29 students (19 students) received low scores. This condition indicates that mathematics learning in schools has not been able to develop students' understanding deeply and contextually fully. In an effort to improve the quality of learning, analysing students' mathematical literacy skills is an important step. By conducting a comprehensive analysis, teachers can identify students' strengths and weaknesses in aspects of mathematical literacy. By conducting a comprehensive analysis, teachers and researchers can identify students' strengths and weaknesses in aspects of mathematical literacy. This information can be used to develop more targeted learning strategies, develop appropriate learning media, and apply differentiated approaches based on students' ability levels. Mathematical literacy is closely related to the cultivation of students' concepts through the application of relevant learning models and teaching aids. Therefore, determining the right learning model in the classroom and using teaching aids can make the learning process more effective (Rusiadi, 2020).

The application of PBL is highly relevant in efforts to improve mathematical literacy skills. Through PBL, students are trained to actively understand the given problem, identify important information, and design a solution strategy using their mathematical knowledge. This process directly involves all three aspects of mathematical literacy. The application of PBL to students is one of the efforts to overcome low mathematical literacy skills (Abdurrahman et al., 2023). The use of conventional methods without variation makes students uninterested in improving their mathematical literacy skills (Oktaviani et al., 2019). The PBL approach focuses on developing learners' skills by solving problems related to everyday life (Kumaş, 2023). The relationship between PBL and mathematical literacy lies in the phenomenon of presenting problems related to everyday life. This can trigger a sense of challenge in learners and encourage them to continue exploring their knowledge (Madyaratri et al., 2019). In addition, the use of teaching aids has a significant impact on mathematics learning (Fauziah & Amaliyah, 2021). It can help learners better understand abstract concepts. Teaching aids are useful in helping learners to solve problems appropriately (Fijačko et al., 2024). The use of teaching aids helps ensure the continuity of effective teaching and conveys concepts to learners more effectively (Rasul et al., 2011). In addition, the use of teaching aids emphasises emotional and persuasive aspects that impact on the improvement of mathematical literacy (Ayanwale et al., 2024). The use of props can help students visualize representations of abstract mathematical concepts (Jin & Shi, 2025; Mulianingtias & Pasaribu, 2024). Learners can also easily understand the relationship between elements in OVLE. The use of teaching aids by learners tends to enable better achievement of classical completion.

Several previous studies relevant to this research have shown an increase in mathematical literacy skills when using the PBL model. A study (Sriwahyuni et al., 2019) discussed the application of the problem-based learning model to improve the mathematical literacy skills of secondary school students. The results showed that the average of the pre-test and post-test results for the experimental class's mathematical literacy skills was greater

than that of the control class. This is evidenced by the difference in mathematical literacy achievement between the two classes. This is consistent with the research (Subaryo, 2022) that analyzes mathematical literacy skills through problem-based learning models in high school students. Problem-based learning models can be implemented to enhance and positively impact the development of students' mathematical literacy skills in secondary schools.

Most of these studies focus more on quantifying the improvement of learning outcomes through pre-tests and post-tests, and comparing scores between experimental and control classes. The main emphasis remains on the result (output), while the process by which students develop aspects of mathematical literacy in depth through the application of PBL is rarely studied thoroughly. In addition, there are limitations in the use of media or concrete aids in the application of PBL. In fact, the use of props such as a Stick Board can help students visualise abstract concepts and facilitate understanding in solving contextual problems. Studies that integrate PBL with concrete learning media, such as the Stick Board, in the context of improving students' mathematical literacy are still very limited, especially at the junior high school level. Therefore, this study has an urgency to fill the gap by examining the mathematical literacy skills of junior high school students qualitatively based on the aspects of formulate, employ, and interpret, as well as providing a more in-depth description of the differences in literacy achievement based on student ability levels (high, medium, low) in the context of PBL implementation. This study aims to analyze the mathematical literacy skills of students in PBL using OVLE stick board props. This research highlights the mathematical literacy skills of students who have received OVLE material in PBL using stick board props. This research is important for providing a qualitative, in-depth description of students' mathematical literacy skills based on the aspects of formulating, employing, and interpreting.

METHODS

This study employed a qualitative descriptive approach, as described by Ibarra-Arias & Marta Lazo (2025). The research subjects were eighth-grade students at junior high schools in the Malang district. Eighth grade consists of 29 female students. Eighth grade was chosen as the research target because the class had received PBL learning assisted by OVLE stick board props. The research subjects were selected based on their performance in the mathematical literacy test.

The data collection techniques used were observation, tests, and semi-structured interviews. Observations were made to ensure that PBL had been implemented properly. In addition, observations were made to observe the implementation of tests and interviews with research subjects. The test aims to determine the mathematical literacy of the research subjects on the OVLE material. The mathematics literacy test consisted of 2 OVLE questions in the form of descriptions. Validation is carried out to ensure that the test items have been validated so that they are effective in measuring the subject's mathematical literacy. A single expert lecturer in the field of mathematics education conducted validation. Validation items include: instructions for solving the problem, aspects of content, language, and the appropriateness of the time taken to solve the problem. The validation results showed a good category (the total score was 28). Twenty-seven students took the test. This was because two learners were absent from class. The test results are categorised according to the acquisition score, namely high, medium, and low. Table 1 shows the lattice of mathematical literacy test questions.

Table 1 Lattice of mathematical literacy test questions

Learning Outcomes	Learning Objectives	Question Number	Score
Determine variable values and solve contextual problems related to Linear Equations of One Variable (OVLE)	Determining the value of variables related to the Linear Equation of One Variable (OVLE)	1	12
	Solve contextual problems related to Linear Equation of One Variable (OVLE)	2	12

The interview with the subject was conducted to justify the subject's completion of the given test. The interviews used interview guidelines, but the questions could be adapted according to the situation at the time of data collection. The interview contained questions about how the subject formulated the mathematical situation, how the subject solved the problem, and how the subject concluded the final result. The subjects interviewed were randomly selected for every 1 learner in each category of mathematical literacy level.

The data analysis techniques in this study are the reduction of the data obtained, the presentation of the data in the form of narrative text and tables, and the verification of the data for drawing conclusions. The completion of the test by the research subjects was analyzed using indicators of mathematical literacy. Table 2 is an indicator of mathematical literacy.

Table 2 Indicators of mathematical literacy skills

Aspects	Indicator
Formulate	To identify the facts and to formulate the problem mathematically.
Employ	Apply strategies in the problem-solving phase. Perform calculations according to predetermined rules or formulas.
Interpret	Draw conclusions from a case based on some observed data.

(Source: OECD, 2016)

The research procedure is shown in Figure 1.

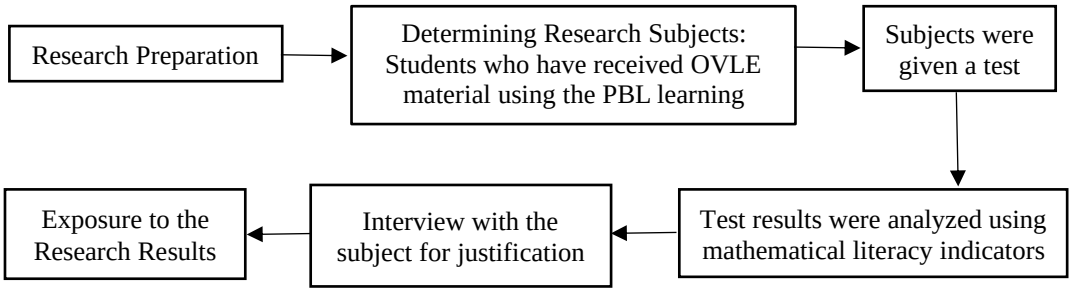

Figure 1 The research procedure

RESULTS AND DISCUSSION

The researcher made observations by observing the learning process using the PBL learning model with Stick Board props. Several learning stages were carried out, including: 1. Orientation of learners to the problem. At this stage, the researcher conveyed the learning objectives and gave an overview of the importance of learning OVLE. The researcher also explained the elements of the OVLE Stick Board props and how to use them—organising learners. At this stage, the researcher divided the students into six groups, each consisting of 4 to 5 students. Furthermore, researchers distributed worksheet 3. Guiding individual and group investigations. At this stage, researchers conditioned each group to discuss

during learning actively. Develop and present work. At this stage, each group solves the problems given 5. Analyze and evaluate the problem-solving process. At this stage, students and researchers together evaluate the activities that have been carried out. After learning, a test is administered to assess the students' learning achievements.
The following illustrates the results of students' test scores using OVLE mathematical literacy indicators, as reported by Fauzi et al. (2025). Table 3 presents the number of students categorized by OVLE mathematical literacy.

Table 3 Students test score results based on OVLE maths literacy ability category

Achievement Score of the Mathematical Literacy Indicator	Category of Mathematical Literacy Level	Number of Learners
$2 \leq NKLM \leq 10$	Low	5
$10 < NKLM \leq 18$	Medium	15
$18 < NKLM \leq 24$	High	7

Description:
NKLM : Math Literacy Completion Score

The researcher analyzed the work of three subjects: one with high literacy skills, one with medium literacy skills, and one with low literacy skills. The results of the subject's work are discussed below.

a. High mathematical literacy

The subject that represents the category of high mathematical literacy is H (High). An overview of the work of the subject H is given in Figure 2.

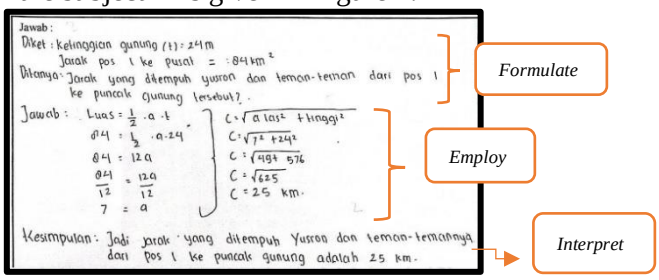

Figure 2 The results of the work of the subject H on question number 1

H subject wrote down the known information: the height of the mountain is 24 km and the distance from post 1 to the centre of the mountain is 84 km^2. Subject H wrote what was asked: the distance Yusron and his friends travelled from Post 1 to the top of the mountain. This means that H fulfills the formulate aspect. At the employ stage, H wrote:

$$\text{Area} = \frac{1}{2} \times a \times t \qquad C = \sqrt{base^2 + height^2}$$
$$84 = \frac{1}{2} \times a \times 24 \qquad C = \sqrt{7^2 + 24^2}$$
$$84 = 12a \qquad C = \sqrt{49 + 576}$$
$$\frac{84}{12} = \frac{12a}{12} \qquad C = \sqrt{625}$$
$$7 = a \qquad C = 25\ kilometres$$

At the interpret stage, subject H can conclude that the distance Yusron and his friends travelled from Post 1 to the top of the mountain was 25 km. Based on Figure 2. Subject H answered correctly. The following is an interview with subject H.

Formulate

Researcher	:	What information do you know from this question?
H	:	The height of the mountain is 24 km, and the distance from post 1 to the centre of the mountain is 84 km, Ma'am.
Researcher	:	From the information you know, what is the core problem?
H	:	The distance Yusron and his friends travelled from Post 1 to the top of the mountain, Ma'am.

Employ

Researcher	:	How did you solve the problem?
H	:	First, find the value of the base using the triangle area formula L− = $12 \times alas \times tinggi$. So $84 = \frac{1}{2} \times a \times 24$, then the result $84 = 12a$. So 84 divided by 12 equals 7, the result is 7. To find the distance from Post 1 to the summit, use the Pythagorean theorem formula to determine the hypotenuse. With formula $C = \sqrt{base^2 + height^2}$, then $C = \sqrt{7^2 + 24^2}$, the result $C = \sqrt{49 + 576} = \sqrt{625}$ is 25, and that's how it works, madam.
Peneliti	:	Why did you use these steps?
H	:	Yes, it's easy to determine the distance from post 1 to the summit, ma'am.
Peneliti	:	What is the end result of the problem?
H	:	25 km, madam.

Interpret

Peneliti	:	What can you deduce from this question?
H	:	So the distance Yusron and his friends travelled from Post 1 to the top of the mountain was 25 km.

According to the results of the work and interviews above, it can be seen that subject H on number 1 fulfills all three aspects of mathematical competence. In the formulating aspect, subject H is able to fulfill the indicators of identifying facts and formulating problems in mathematical form. In the application aspect, subject H is able to apply the solution strategy to the final stage according to the given formula, and subject H is also able to use mathematical symbols correctly. In the interpreting aspect, subject H is able to draw conclusions correctly. The results of subject H's work on number 2 are shown in Figure 3.

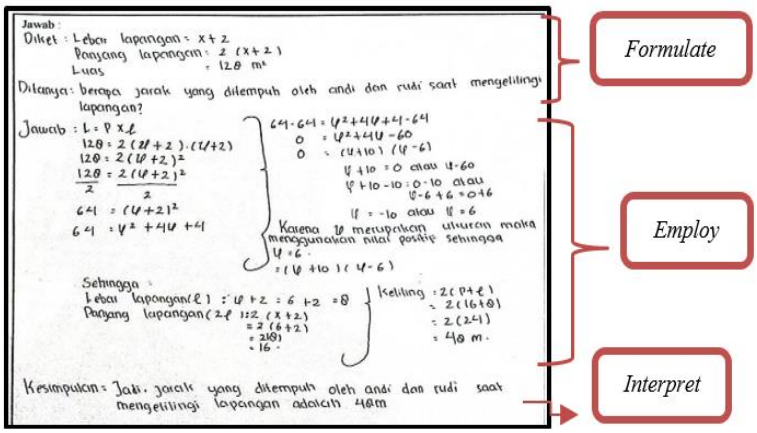

Figure 3 The results of the subject H's work on number 2

In question number 2, subject H wrote down the known information: The width of the field $x + 2$ is the same as the field area $128\ m^2$. The length of the field is $2(x + 2)$. At

the employ stage, H wrote:

$$
\begin{aligned}
L &= p\ x\ l \\
128 &= 2(x+2) \times (x+2) \\
128 &= 2(x+2)^2 \\
\frac{128}{2} &= \frac{2(x+2)^2}{2} \\
64 &= (x+2)^2 \\
64 &= x^2 + 4x + 4
\end{aligned}
\qquad
\begin{aligned}
64 - 64 &= x^2 + 4x + 4 - 64 \\
0 &= x^2 + 4x - 60 \\
0 &= (x+10)(x-6) \\
x + 10 &= 0 \text{ or } x - 6 = 0 \\
x + 10 - 10 &= 0 - 10 \text{ or } x - 6 + 6 = 0 + 6 \\
x &= -10 \text{ or } x = 6
\end{aligned}
$$

because x is a measure it uses positive values so x = 6, so,
field width $(l) \quad = x + 2 = 6 + 2 = 8$
field length $(2l) = 2(x+2) = 2(6+2) = 2(8) = 16$
around the field $= 2(p + l) = 2(16 + 8) = 2(24) = 48$

At the interpretation stage, H concluded that the distance travelled by Andi and Rudi when circling the field was 48 m. Based on Figure 2. Subject H answered correctly. The following is an interview conducted by the researcher with subject H.

Formulate

Researcher	:	What information do you know from the question?
H	:	The width of the field $x + 2$ is the same as the field area $128\ m^2$, Ma'am.
Researcher	:	Is there more?
H	:	Oh, yes, there is, ma'am. The length of the field is twice the width of the field, which means $2(x + 2)$.
Researcher	:	From the information you know, what is the core issue of the problem?
H	:	The distance travelled by Andi and Rudi as they circled the field, Ma'am.

Employ

Researcher	:	How did you solve the problem?
H	:	First, find the width of the field by typing it into the rectangular area formula, which is $L = lenght \times width$, so $128 = 2(x + 2) \times (x + 2)$. Then, the result $128 = 2(x + 2)^2$. Then, the two segments are divided by two: $64 = (x + 2)^2$, Ma'am.
Researcher	:	Then what is the next step?
H	:	Solving it using a quadratic equation, ma'am. So, the result $is\ 64 = x^{\wedge 2} + 4x + 4$. Then, 64 moves the left segment, so $0 = \ ^{x^{\wedge 2}} + 4x + 4 - 64$, which equals $x^{\wedge 2} + 4x - 60$. Then, it was factorized into $(x + 10)$ or $(x - 6)$, and from these two factors, the positive value is selected.
Researcher	:	Why did you choose positive values?
H	:	Since the size of the field width cannot be negative, Ms.
Researcher	:	Then are there more steps to solve it?
H	:	There is, ma'am. The positive value $x = 6$ is entered into the field width equation, which is (x+2), resulting in $6 + 2 = 8$. The length of the field is twice the width, so multiply 2 by 16. Now, use the new formula, where the perimeter of the field $is\ K = 2\ (length + width)$. Then, $2(16)(\ ) + 8 = 224 = 48$ meters.
Researcher	:	Why did you take these steps?
H	:	Well, because I thought it would be clear to determine the distance by going around the field, ma'am.
Researcher	:	What is the end result of the problem?
H	:	48 meters, Ma'am.

Interpret

Researcher : What can you infer from this question?
H : So the distance that Andi and Rudi cover when they run around the field is 48 metres, Ma'am.

Based on the results of the work and interviews above, it can be seen that the H subject on number 2 fulfils all three aspects of mathematical competence. In the formulating aspect, subject H is able to recognise facts and convert problems into mathematical form. In the application aspect, subject H can correctly solve the problem. In the interpreting aspect, subject H was able to conclude correctly. Learners with high literacy skills can formulate mathematical models, use appropriate solution strategies, and apply mathematical principles (Krisyani et al., 2024).

b. Moderate mathematical literacy

The subject representing the category of moderate mathematical literacy is M (Moderate). An overview of the work of subject M is given in Figure 4.

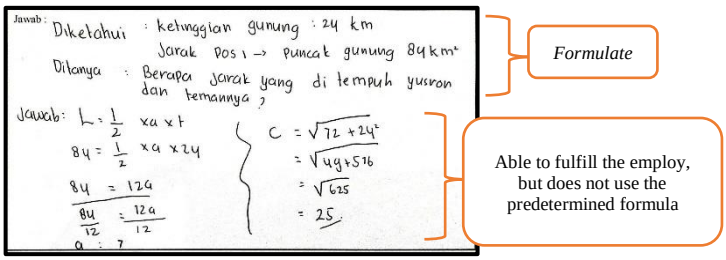

Figure 4 The results of subject M's work on question number 1

At the formulate stage, subject M wrote down what was asked: the height of the mountain is 24 km. Subject M could also write what was asked: How much distance did Yusron and his friend cover?. At the employ stage, M is able to make mathematical models from the facts identified:

$$L = \frac{1}{2} \times a \times t \qquad C = \sqrt{72 + 24^2}$$
$$84 = \frac{1}{2} \times a \times 24 \qquad = \sqrt{49 + 576}$$
$$84 = 12a \qquad = \sqrt{625}$$
$$\frac{84}{12} = \frac{12a}{12} \qquad = 25$$
$$a = 7$$

However, subject M did not perform the calculation according to the established formula. At the interpret stage, subject M was unable to draw conclusions from the problem. Subject M answered incorrectly. The following is an interview with subject M.

Formulate

Researcher : What information do you know from this question?
M : The height of the mountain is 24 km and the distance from post 1 to the centre of the mountain is 84 km, ma'am.
Researcher : From the information you know, what is the main problem?
M : What is the distance travelled by Yusron and his friends, Ma'am?

Employ

Researcher	:	What is your strategy for solving the problem?
M	:	Find the value of the base using the triangle area formula L—— = 12 × base × height. Then, 84 = 12 × a × 24. The result is 84 = 12a, so 84 divided by 12 equals 7. The result is 7. To find the distance from post 1 to the top, we need to find the hypotenuse, which means using the Pythagorean Theorem formula, but I have forgotten the formula, ma'am. So $C = \sqrt{7^2 + 24^2}$, the result $C = \sqrt{49 + 576} = \sqrt{625}$, equal to 25, and that is how it's done, ma'am.
Researcher	:	Why did you use these steps?
M	:	Because it's easier to work out the distance from post 1 to the summit, ma'am.
Peneliti	:	What is the final result of the problem?
M	:	25 km, ma'am.
Peneliti	:	What can you learn from this problem?
M	:	I forgot to write it down, ma'am.

The results of the work and interviews above show that subject M on number 1 fulfils both aspects of mathematical literacy. In the formulating aspect, subject M can identify facts and formulate problems into mathematical models. In the application aspect, subject M was able to apply the solution strategy, but not according to the given formula. Subject M could use mathematical symbols correctly. In the interpreting aspect, subject M was not able to draw conclusions. The results of subject M's work on number 2 are shown in Figure 5.

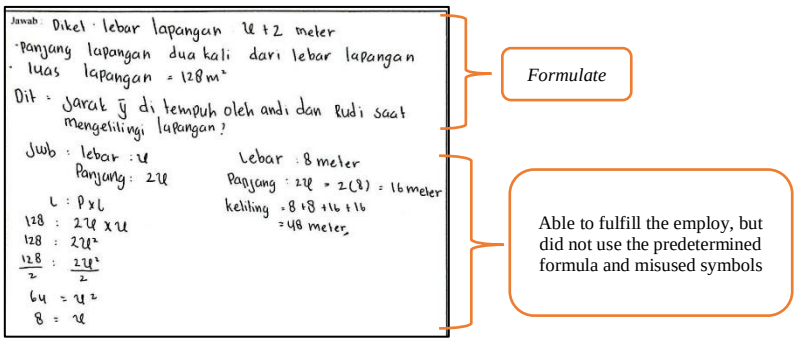

Figure 5 The results of subject M's work on number 2

At the formulate stage, subject M wrote down the known information: The width of the field $x + 2$ and the area of the field equals twice the width of the field. The size of the field is 128 $metres^2$. At the employ stage, subject M used a permutation of width equal to x (even though it was known that width was equal to $x + 2$), so the systematic solution was not correct. Subject M answered incorrectly. The following is an interview with subject M.

Formulate

Researcher	:	What kind of information do you know from the question?
M	:	The width of the field $x + 2$ and the area of the field equals twice the width of the field, Bu.
Researcher	:	Is there more?
M	:	There is, Ma'am. The size of the field is 128 $metres^2$.
Researcher	:	From the information you know, what is the core problem of the question?
M	:	The distance travelled by Andi and Rudi around the field, Ma'am.

Employ	:	How do you solve the problem?
Researcher		
M	:	Suppose the width $is\ x$ and the length $is\ 2x$, because it is twice the width of the field. Then he applied the rectangular area formula, namely $L = length \times width$. So, $128 = 2x \times x$. Then, the result is $128 = 2x^2$. Next, both segments are divided by two, so $64 =$ x^2. Then, $8 = x$. Ma'am.
Researcher	:	So what's the next step?
M	:	The width of the field is 8, Ma'am. Now, if the length is twice the width, then $2 \times 8 = 16$. That's it, Ma'am.
Researcher	:	Then there are more steps to complete it?
M	:	There is, Ma'am. Looking for the perimeter, but I forgot the formula, but remember the method by adding everything together: $8 + 8 + 16 + 16 = 48$
Researcher	:	Why did you use these steps?
M	:	Well, because it would be quick to determine the distance when going around the field, Ma'am.
Researcher	:	What is the final result that you obtained from the question?
M	:	48 meters, Ma'am.
Researcher	:	What can you conclude from the question?
M	:	Sorry, I forgot to write the conclusion again, Ma'am.

The results of the work and interviews above show that subject M for number 2 fulfils both aspects of mathematical literacy skills, namely formulating and employing. In the formulate aspect, subject M correctly identified the facts and converted the problem into mathematical form. In the employ aspect, subject M was able to apply the solution strategy to completion, but not in accordance with the established formula. Learners often fail to relate existing information to a mathematical concept, which prevents them from finding the correct solution strategy (Korkmaz & Alkan, 2023; Qoiriyah et al., 2021). Subject M also made mistakes in using mathematical symbols. In the interpret aspect, subject M was unable to draw conclusions based on the final results obtained.

c. Low mathematical literacy ability

The subject representing the low mathematical literacy category was L (Low). An overview of the work of subject L is as follows in Figure 6.

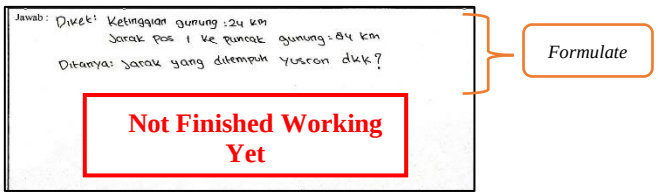

Figure 6 The results of subject L work on question number 1

At the formulation stage, subject L wrote what was asked and what was known correctly, but subject L has not completed his work. The following is an interview conducted with subject L.

Formulate

Researcher	:	What information do you know from the question?
L	:	The height of the mountain is 24 km, Ma'am.
Researcher	:	Is there anything else?

L	:	There is, Ma'am. The distance from post 1 to the centre of the mountain is 84 km.
Researcher	:	From the information you know, what is the main point of the problem?
L	:	What is the distance travelled by Yusron and his friends, Ma'am.
Researcher	:	What is your strategy to solve the problem?
L	:	I don't know how to solve it, Ma'am.
Researcher	:	Why don't you know how to solve it?
L	:	Because I'm confused about which formula to use, Ma'am.

The results of the work and interviews above show that subject L in number 1 only fulfills one aspect of mathematical literacy ability, namely, formulating. Subject L was only able to identify the facts in the problem. The results of subject L's work on question number 2 are shown in Figure 7.

Figure 7 The results of subject L work on question number 2

The results of the work of the subject L and the following researcher interview with subject L.

Formulate

Researcher	:	What information do you know from the question?
L	:	I don't know, Ma'am because I haven't done it yet
Researcher	:	Why haven't you done it?
L	:	Because I don't understand and the time is up, Ma'am

The results of the work and interviews above show that subject L at number 2 could not fulfil the aspects of mathematical literacy skills. Subject L could not solve the problem, because subject L did not understand the concept of the material and the problem that had been given previously. Furthermore, the subject L also had difficulty in interpreting the question order and applying the concepts that had been learned. Learners lack practice in understanding complex problems or mathematical language that is difficult to understand (Hasibuan, 2015).

The application of PBL is very relevant in an effort to improve mathematical literacy skills, which include three main aspects: Formulate, Employ, and Interpret. PBL is a learning process in which students are faced with a problem and are required to think critically in finding solutions so that students can develop their competence (Sriwati, 2021). Through PBL, students are trained to actively understand the given problem, identify important information, and design a solution strategy using their mathematical knowledge. This process directly involves the three aspects of mathematical literacy. The completion of the research subject is depicted as in Figure 8.

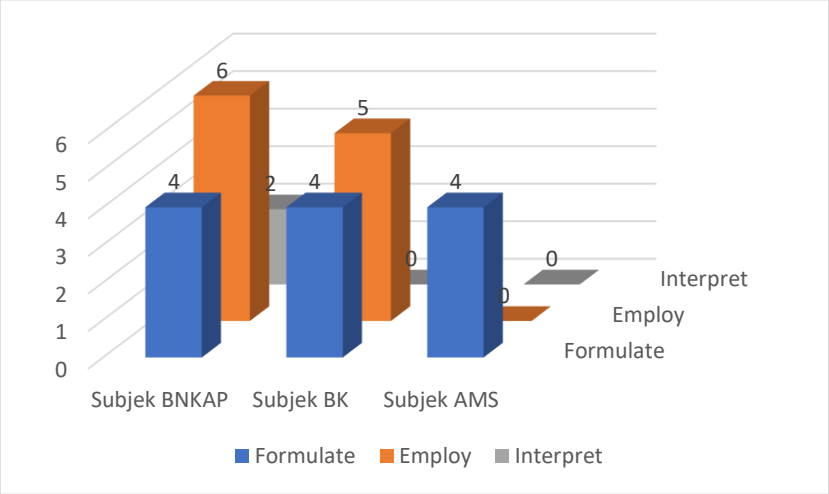

Figure 8 Overview of research subject completion according to indicators mathematical literacy skills

The results of this study show that the mathematical literacy skill that students most commonly master is the formulation aspect. The formulate aspect is the initial stage in solving problems (Muzdalipah et al., 2021). Learners with high, medium, and low levels of mathematical literacy are able to present problems in mathematical form. In line with the opinion (Lestari & Annizar, 2020; Majid et al., 2025), which states that students who can explain knowledge about the data needed related to the problem at hand show a good understanding of the problem. In the employ aspect, only low literacy learners were unable to formulate a solution plan. A solution strategy can be obtained if students can understand every information in the problem so that students can put it into mathematical form (Upu et al., 2022). In the interpretation aspect, learners with moderate and low literacy skills cannot draw conclusions. This is because students have not been able to analyze mathematical problems properly.

Students' mathematical literacy skills fall into three main categories: low, medium, and high. Each category requires a different approach to learning because it has different needs and challenges. Students with Low Mathematical Literacy require maximum use of concrete props (such as Stick Board) to help visual understanding and connect abstract concepts with real situations. Students with Moderate Mathematical Literacy need to be offered challenging and open-ended problems to encourage them to evaluate solutions from different perspectives. Whereas students with High Mathematical Literacy need to be given more complex challenges, such as projects or multi-step problems with a broad real-life context.

This study has several limitations that need to be considered, namely that the study was conducted in a single school with a limited number of subjects. Therefore, generalisation of the results to a wider population should be done with caution; Since this study used a qualitative approach, it emphasi"/ mp0sed more on the depth of analysis and did not focus on broader statistical measurements. As such, the results are more descriptive than generalised; The study only used one type of teaching aid. Other media could have yielded different or even more effective results for some students. Additionally, the application of the PBL model in this study was conducted within a limited timeframe (a few meetings). Long-term changes to students' mathematical literacy cannot be ascertained.

CONCLUSION

In completing the written test of mathematical literacy skills, subjects H, M, and L were able to fulfill the formulation aspect; the three subjects were able to identify facts and design problem formulations in mathematical form. In the employ aspect, subject M was able to apply the strategy until the final stage, although it did not fulfill the requirements of the predetermined formula. Subject M also made mistakes in the use of symbols. Meanwhile, subject L was unable to apply the solution strategy. In the interpretative aspect, subjects L and M were unable to draw a conclusion from a problem. It can be concluded that high category subjects were able to fulfill all three aspects of mathematical literacy skills, namely formulating, employing, and interpreting. Subjects from the low category only fulfilled the two aspects of mathematical literacy skills, namely, formulate and employ. While low category subjects only fulfilled one aspect of mathematical literacy skills, namely, formulating.

Based on the research results and limitations that have been identified, the researcher provides the following suggestions: This research can be continued using a mixed-method approach in order to obtain quantitative data that strengthens the qualitative findings; It is necessary to conduct research with a wider number and variety of subjects, in various schools or levels of education, so that the results are more general and representative; Future researchers can explore the use of other teaching aids or a combination of several media to see a comparison of their effectiveness in improving mathematical literacy; and it is also recommended to conduct long-term research to see the sustainable impact of PBL implementation on students' mathematical literacy development over time.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, NW & SH; methodology, NW & NF; formal analysis, NW; Validation, SH & NF; writing—preparation of the original draft, NW.

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