



An Analysis of Mathematical Literacy Skills in Word Problem Solving among High-Achieving Students

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Abstract

Students' mathematical literacy in Indonesia remains low, according to the results of the international PISA study. This research aims to provide an in-depth description of students' mathematical literacy based on PISA levels and their relation to their mathematics achievement. The study employed a qualitative, phenomenological approach. The subjects were selected using purposive sampling, comprising two high-achieving eighth-grade students. Data collection techniques included literacy skill tests. Interview, field notes, and documentation. The research instruments used were mathematical literacy test sheets and interview guidelines. Data analysis was carried out through the stages of data collection, data reduction, data display, and conclusion drawing/verification. The results indicate that high-achieving students reached levels 5-6 in mathematical literacy. These students were able to identify information, formulate strategies, perform calculations, draw, and communicate conclusions accurately. This study provides practical implications for teachers as a reference for the learning process, particularly in designing PISA-based mathematical word problems to enhance students' mathematical literacy.

Kata kunci: PISA level, mathematical literacy, word problem solving

Abstrak

Literasi matematika siswa di Indonesia masih rendah, menurut hasil studi PISA internasional. Penelitian ini bertujuan untuk memberikan deskripsi mendalam tentang literasi matematika siswa berdasarkan level PISA dan kaitannya dengan prestasi matematika mereka. Studi ini menggunakan pendekatan kualitatif, fenomenologis. Subjek dipilih menggunakan purposive sampling, terdiri dari dua siswa kelas delapan berprestasi tinggi. Teknik pengumpulan data meliputi tes kemampuan literasi, wawancara, catatan lapangan, dan dokumentasi. Instrumen penelitian yang digunakan adalah lembar tes literasi matematika dan pedoman wawancara. Analisis data dilakukan melalui tahapan pengumpulan data, reduksi data, penyajian data, dan penarikan kesimpulan/verifikasi. Hasil menunjukkan bahwa siswa berprestasi tinggi mencapai level 5-6 dalam literasi matematika. Siswa-siswa ini mampu mengidentifikasi informasi, merumuskan strategi, melakukan perhitungan, menarik kesimpulan, dan mengomunikasikan kesimpulan secara akurat. Studi ini memberikan implikasi praktis bagi guru sebagai referensi untuk proses pembelajaran, khususnya dalam merancang soal cerita matematika berbasis PISA untuk meningkatkan literasi matematika siswa.

Kata kunci: level PISA, literasi matematis, pemecahan soal cerita

1. Introduction

Education is a conscious and planned effort to create a learning process that enables students to actively develop spiritual and religious strength, self-control, personality, intelligence, morals, and the skills needed by themselves, society, the nation, and the state. One subject that plays a strategic role is mathematics, as it helps students understand concepts, patterns, and structures within a system (Siagian, 2016). Mathematics should be taught from elementary school through university to equip students with skills in logical, analytical, systematic, critical, and creative thinking, as well as the ability to collaborate (Mahmudi et al., 2025). Therefore, mathematics learning in formal schools is not only aimed at mastering calculations but also at improving students' mathematical literacy (Gusteti & Neviyarni, 2022).

In mathematics learning, there is numeracy, also known as mathematical literacy. Numeracy plays a crucial role in schools, shaping how and where mathematics is taught and making it more relevant to students (Safitri et al., 2023). Mathematical literacy, on the other hand, is the understanding, use, evaluation, reflection, and engagement with texts to achieve personal goals, improve knowledge and skills, and contribute to society (OECD, 2023). Mathematical literacy is then defined as the ability to formulate, interpret, and apply mathematical concepts, facts, and procedures to explain and predict phenomena (Prasasti, 2022). Mathematical literacy is essentially the ability to understand, formulate, interpret, and apply mathematical concepts and procedures in real-life contexts to achieve individual goals and contribute to society. Mathematical literacy focuses on the ability to think mathematically and apply mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena (Malinda et al., 2019).

Mathematical literacy is a student's ability to formulate, apply, and interpret mathematics in various contexts, including the ability to reason mathematically (Farida et al., 2021). Mathematical literacy is not merely an understanding of basic concepts but also involves developing students' reasoning and analytical skills in everyday life. This includes applying mathematical skills to solve real-world problems, such as budgeting, analyzing survey data, and identifying patterns in different contexts. Thus, individuals can describe, explain, and predict phenomena and events around them, as presented in word problems.

A word problem is a question presented in the form of a short narrative (Dwidarti et al., 2019). In this format, information is presented in sentences that form a story, which must then be translated into mathematical sentences or equations. Mathematical word problems are presented in language media, with many symbols and notations, to convey the problem and its solution using mathematical thought patterns or concepts (Wibowo et al., 2020). When facing a word problem, students must first analyze and interpret the information to make choices and decisions (Muntaha et al., 2020). Students need to understand the problem well, plan a solution, implement the plan, and review the results.

Math word problems can improve math learning outcomes. Achievement is the result of an activity that has been done, created, or carried out, either individually or in a group, and is worthy of pride (Dono, 2021). Achievement in mathematics is the result obtained by students during their mathematics learning process. According to Humendru & Harefa (2023), achievement in mathematics refers to a student's ability to complete exams that meet the institution's criteria. Student achievement is considered good when it is driven by motivation from the school environment, friends, and parents (Khasanah, 2015). Mathematical learning achievement is considered perfect if it meets three domains: cognitive, affective, and psychomotor. However, in reality, students still struggle to find solutions when faced with word problems.

PISA word problems are divided into several levels, from level 1 to level 6. PISA questions are divided into six levels, each with its own criteria (Atiyah & Priatna, 2022). These criteria determine the questions used to assess students' mathematical literacy skills. Levels 1 and 2 are low, levels 3 and 4 are medium, and levels 5 and 6 are high. Students demonstrate inadequate abilities, resulting in difficulties solving or determining solutions to story problems, especially those of great difficulty. Students often experience difficulties solving contextual problems due to a lack of understanding of the problem content and confusion about which arithmetic operations to use (Ikroma, 2024). This is shown in previous research, where students were only able to answer mathematical literacy questions at difficulty levels 1 to 3, while those at levels 4 to 6 still received low scores (Siregar, 2023). This is based on the results of the 2022 PISA (Program for International Student Assessment); Indonesia's mathematical literacy declined compared to 2018. In 2022, Indonesia only scored 354 points (OECD, 2023). The score obtained was still far below the PISA average of 500. This shows that Indonesia's mathematical

literacy remains relatively low. Students can be categorized as having strong mathematical literacy if they can reason and communicate their mathematical knowledge and skills effectively (Adawiyah et al., 2023).

Students' mathematical literacy is considered low due to the difficulties they face in solving various problems. This low mathematical literacy stems from inadequate reading, writing, and numerical skills (Vitantri & Syafrudin, 2022). Low literacy skills are among the mathematical challenges students face when solving story problems encountered in everyday life. Some students still experience difficulties understanding and solving mathematical problems applicable to everyday life (Nurhayati et al., 2022).

2. Method

This study uses a descriptive qualitative research type with a phenomenological approach. As stated by Sugiyono (2019:18), qualitative research methods are research methods based on post-positivist philosophy, used to research in natural object conditions, where the researcher is the key instrument, data collection techniques are carried out through triangulation (combined), data analysis is inductive or qualitative, and research results emphasize meaning rather than generalization. The phenomenological approach is a research strategy in which researchers identify the nature of human experience of a particular phenomenon, thereby studying several subjects through direct involvement (Kusumastuti & Khoiron, 2019). The descriptive, qualitative approach with a phenomenological perspective was chosen because it enables researchers to explore students' lived experiences of solving PISA-based problems. This method emphasizes understanding students' thinking processes, not just the result, making it well-suited for describing mathematical literacy in depth.

This research was conducted at a public junior high school in Purworejo in August 2025. The purposive sampling technique was used. The subjects of this study were two high-achieving students in grade VIII. Categorization based on achievement was based on students' summative scores and interviews with subject teachers. Students with high achievement were selected based on their highest class scores. The instruments used in this study were a mathematical literacy ability test sheet with one word problem and an interview guide. This technique will help researchers find subjects who meet the research criteria to obtain satisfactory data. Data collection techniques used in this study were the

test method, interview method, field note method, and documentation method. Data analysis techniques used in this study were data collection, data reduction, data display, and conclusion drawing/verification.

3. Result and Discussion

The following is a problem created by researchers to assess students' mathematical literacy in math word problems:

“Rama and his friends are helping their teacher decorate the school wall for an Independence Day celebration. They use a long ladder to reach the top of the wall. The ladder is 10 meters long and is leaning against the school wall. To ensure safety and prevent the ladder from being too steep, Rama places the base of the ladder 6 meters from the base of the wall. How high can the top of the ladder reach from the top of the wall?”

This problem provides the results of a mathematical literacy test for high-achieving students.

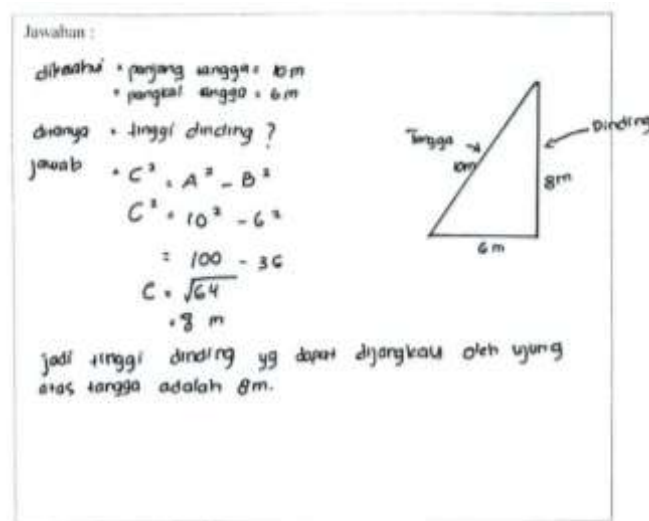


Figure 1. Results of the S1 mathematical literacy test

Figure 1 shows that subject S1 was able to determine the information obtained in the problem. Subject S1's work process is illustrated in the form of a picture of the information obtained using a mathematical model. Furthermore, in the answer given by subject S1, he quickly realized that certain issues needed to be addressed directly when finding information in the problem, and encountered a situation that required a direct solution: determining the wall's height.

The subject was able to identify the correct procedure for solving the problem after understanding the situation presented. In the process, the subject assumed that the information to be entered into the procedure was A as the hypotenuse or length of the ladder, B as the distance from the base of the ladder to the wall, and C as the height of the wall. So, to solve the situation, the subject wrote the procedure with $C = A^2 - B^2$. Furthermore, subject S1 demonstrated adequate ability in entering information into the solution procedure. Variable A was set to 10m for the ladder length, and variable B was set to 6m for the distance from the base of the ladder to the wall. The subject did not simply copy information; they also identified which data were relevant to enter into the procedure.

Next, in the story problem-solving stage, when entering the calculation step, the subject systematically wrote down the result $10^2 - 6^2 = 100 - 36 = 64$. The subject realized that the answer was incomplete, so he continued by finding $\sqrt{64}$ and obtained the result 8, with the unit meters. After completing the problem-solving, the subject gave a conclusion, writing that the height of the wall that can be reached by the top of the ladder is 8m. Although the conclusion was not explained in detail, the essence of the answer that must be conveyed has been written correctly. In this section, the subject completed the problem-solving strategy and communicated the problem-solving results clearly and precisely. This indicates that the subject was able to solve problems at the PISA 5-6 level.

The work process carried out by the subject is supported by interview results, which show that the subject can communicate the answers given.

- P : "Next, what strategy did you use when working on the problem?"
S : "It has to be understood carefully, especially since it's a story problem."
P : "Have you answered the question?"
S : "Yes."
P : "Explain how you concluded your answer!"
S : "If you want to understand this, you have to draw a picture first and understand it carefully. If possible, provide the knowledge that the slanted side is this much, the base is this much, and then calculate it using the correct formula. The result is 8m as the height of the wall that can be reached."

The subject employed a strategy of carefully understanding the problem, particularly because it was a word problem. To facilitate the solution, the subject first drew a picture to represent the problem, then identified key elements such as the

hypotenuse and base. Afterwards, the subject applied the correct formula to conclude that the wall's reachable height was 8 meters.

Jawaban :

$$\begin{aligned} \text{Diket} &= \text{Panjang tangga} = 10\text{m} \\ \text{Jarak dari tangga ke dinding} &= 6\text{m} \\ \text{Ditanya} &= \text{Tinggi dinding yang dapat dijangkau ujung tangga} \\ \text{Jawab} &= \text{T. Dinding} = b = \sqrt{c^2 - a^2} \\ &= \sqrt{10^2 - 6^2} \\ &= \sqrt{100 - 36} \\ &= \sqrt{64} = 8\text{m} \end{aligned}$$

Jadi tinggi dinding yang dapat dijangkau adalah 8m.

Figure 2. Results of the S2 mathematical literacy test

Figure 2 shows that subject S2 was able to pass PISA level 1 with relative ease, as the subject accurately determined the information in the question and provided illustrations after writing down the information. The information obtained by the subject was that the ladder was 10m long and that the base of the ladder to the wall was 6m. Furthermore, in the section on determining the situation described in the question, subject S2 was able to directly identify the situation to be resolved after finding the information in the question. The subject wrote down the situation that required direct resolution, namely, finding the height of the wall.

After finding a situation that requires a direct solution, the subject decides to use the Pythagorean formula. The subject assumes the wall height as b , the ladder length as c , and the ladder base length to the wall as a . From these assumptions, the subject formulates a procedure with the equation $b = \sqrt{c^2 - a^2}$ to obtain the answer to the story problem. At level 4, subject S2 correctly places the provided information into the solution procedure. In this procedure, the variable b represents the desired wall height, c is 10m for the ladder length, and a is 6m for the distance from the base of the ladder to the wall.

During the calculation stage, the subject first wrote $\sqrt{10^2 - 6^2}$. Then the subject got $\sqrt{100 - 36}$, after the calculation, the subject got $\sqrt{64}$ with the final result being 8. After completing the problem-solving, the subject gave a conclusion, writing that the

height of the wall that can be reached is 8m. Just as in the S1 subject, the conclusion was not too detailed, but the core of the answer that must be conveyed was stated correctly. This is also shown in the S2 subject interview,, where the subject communicated his answers coherently and easily. The results of the interview conducted with the subject are as follows.

- P : "Next, what strategy did you use when working on the problem?"
S : "If I didn't look at everything first, then I had to be precise about the length of the ladder. I had to be quick and not take too long."
P : "Explain how you concluded your answer!"
S : "We were given the challenge of finding the height of a wall that could be reached by a ladder. The problem had two given values: the length of the ladder (10 m) and the length of the base. Step by step, the first step was to draw the slanted side of the ladder, which is the base of the ladder. So, the base of the ladder is 6 m. We had to automatically find the wall's height, then use the formula b^2 , which equals 8 m. So, the wall is 8 m high."

The subjects used a strategy of first reading the problem, then carefully focusing on the important information and working quickly. To solve the problem, the subjects identified known data and then sketched to aid understanding. Next, the subjects followed systematic steps to apply the Pythagoras theorem.

Catatan deskriptif :
a) Subjek R12 langsung membaca soal
b) Subjek menuliskan nama pada lembar jawab.
c) Subjek memo detailkan informasi soal ke dalam bentuk gambar
d) Perhitungan awal dilakukan pada lembar kertas lain sebelum di kertas lembar jawab
e) Subjek menyelesaikan seluruh soal dalam waktu 30 menit.
f) Subjek tidak bingung selama pengerjaan.

Figure 3. Results of S1 field notes

Catatan deskriptif :
- Subjek menuliskan identitas diri pada lembar-jawab.
- Subjek langsung membuat model berupa gambar.
- Informasi dari soal ditulis sistematis sampai langkah-langkah.
- Subjek menuliskan jawaban langsung di lembar jawab.
- Subjek sempat berdiskusi dengan subjek lain.
- Subjek mendapati kesalahan pada jawaban
- Subjek memperbaiki jawaban dengan benar.
- Subjek menyelesaikan soal dalam waktu 30 menit.

Figure 4. Results of S2 field notes

The descriptive notes revealed differences in the problem-solving strategies used for mathematical literacy between undergraduate and postgraduate students. The undergraduate students began by writing down their identities, describing and rewriting the information from the problem, and then performing calculations on a separate sheet of paper before writing their final answer. In contrast, the postgraduate students performed calculations directly on the answer sheet, initially experiencing some confusion, but were able to refine their answers. These findings indicate that students with a better understanding developed systematic, efficient, and coherent problem-solving strategies.

Both subjects demonstrated good mathematical literacy skills in solving context-based problems using the Pythagorean theorem. Both were able to identify important information, determine the solution's objective, and obtain the correct result, namely an 8-meter wall. Ramadhani and Wijayanti (2024) stated that students with higher scores demonstrated the ability to formulate, apply, and interpret mathematics in real-world contexts.

The difference lies in the problem-solving strategies. Undergraduate students use systematic, structured steps: starting with creating illustrations and estimating variables, then performing sequential calculations. This demonstrates high-achieving abilities. Meanwhile, postgraduate students tend to use more direct strategies. Despite confusion, they are still able to solve the problems correctly. As noted by Putri and Ruli (2023), students with higher mathematics achievement demonstrate stronger mathematical literacy in communication, representation, and reasoning.

Subjects in the high-achieving category demonstrated strong problem-solving abilities in mathematical literacy. As Astuti (2017) noted, subjects with high academic ability demonstrated strong skills in mathematical representation. This was demonstrated by procedurally correct answers, the ability to accurately transform contextual problems into mathematical models, and the ability to present the relationship between real-world situations and mathematical concepts. Muslimah and Pujiastuti (2020) confirmed that the higher a student's group category, the greater their likelihood of answering questions correctly. Both subjects were also able to explain the process verbally, demonstrating a deep understanding.

Thus, it can be concluded that high-achieving subjects can solve problems at all PISA levels, from 1 to 6. As stated by Jannah et al. (2022), high-achieving subjects can solve mathematical literacy story problems at all levels. Astuti et al. (2024) "numeracy encompasses the ability to identify elements of contextual problems, represent them mathematically, and apply mathematical concepts and skills to generate and interpret solutions within real-life situations." This means that numeracy includes the ability to identify the contextual elements of a problem, represent them mathematically, and apply mathematical concepts and skills to generate and interpret solutions in real-life situations. Based on this, high-achieving students tend to be better able to reach that stage because they can more effectively connect the mathematical context with the problem context.

Mathematical literacy skills are determined not only by the accuracy of the final result but also by the thought processes and strategies used to solve problems. Subjects with a better understanding tend to develop more systematic, efficient, and coherent strategies, thereby supporting success in solving higher-level problems.

4. Conclusion

Subjects in the high-achieving category demonstrated comprehensive mathematical literacy skills. Both were able not only to complete problems to the final stage in accordance with the correct procedure but also to successfully transform contextual problems into relevant mathematical models, demonstrating strong representation skills. This ability was strengthened by the way they communicated their answers coherently, both in writing and verbally, which confirmed a deep understanding of the solution process. This finding indicates that high-achieving students exceeded all levels of PISA mathematical literacy while mastering aspects of information identification, strategy formulation, calculation implementation, and accurate communication of results.

This research should be followed up by examining mathematical literacy skills across other achievement levels (medium and low) to obtain a more comprehensive picture. Future research could develop learning models or teaching tools that can challenge high-achieving students and also test their effectiveness in improving mathematical literacy in the classroom. This research can serve as a reference for teachers during the learning process, particularly for developing story-based math problems aligned with PISA to improve mathematical literacy.

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