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Mathematical Literacy Review of PISA-Type Mathematics Tasks: A Focus on the Quantity Content

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Abstract: Mathematical literacy refers to students' ability to think logically in mathematical terms, as well as to formulate, employ, and interpret mathematics within real life contexts, as assessed by the Programme for International Student Assessment (PISA). This study aims to describe students' mathematical literacy skills in solving PISA-type mathematical problems with a specific focus on the quantity content. The research employed a qualitative approach using a descriptive method. The study was conducted in one ninth-grade class at junior high school 6 Jambi City, involving 37 students as research subjects. The research instruments consisted of PISA-based quantity content test items and in-depth interviews to explore students' thinking processes. This study refers to the indicators of mathematical literacy processes, including: (1) formulating situations mathematically; (2) employing mathematical concepts, facts, procedures, and reasoning; and (3) interpreting, applying, and evaluating mathematical outcomes. The findings indicate that students in the low category (54.05%) met only the "employ" indicator, those in the medium category (40.54%) met the "formulate" and "employ" indicators, while students in the high category (5.4%) fulfilled all indicators "formulate, employ and interpret. Further analysis reveals that students still struggle to formulate mathematical representations from given contexts and to reinterpret their solutions. These results highlight the need to integrate PISA-based contextual problems into mathematics instruction to enhance students' higher-order thinking and mathematical literacy, there by supporting effective decision-making in real-life situations.
Keywords: Junior high school, Mathematical literacy, PISA tasks, Quantity content

Introduction

In the 21st century, mathematical literacy has become one of the essential skills students must possess (Lusinda et al., 2025). Mathematical literacy refers to the ability to think logically in mathematical terms and to formulate, apply, and understand mathematics in solving problems related to everyday life (OECD, 2017; 2019; 2023). Through mathematical literacy, students are able to apply mathematical concepts to address real world problems, ultimately supporting decision-making across various aspects of life (Gustiningsi et al., 2023).

One of the international assessments that measures mathematical literacy is the Programme for International Student Assessment (PISA) (Setyaningsih & Munawaroh, 2022). PISA has recorded fluctuations in the achievement of Indonesian students over the past several years (Nusantara et al., 2021). Specifically, Indonesian students' mathematical literacy scores remain below the international average and have shown a declining trend. Indonesia's mathematical literacy score was recorded at 386 in 2015, decreased to 379 in 2018, and further declined to 366 in 2022 (OECD, 2016; 2019; 2023). This decline is attributed to the fact that students are rarely exposed to contextual, PISA-like problems, which limits the development of their higher-order thinking skills

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(Nusantara et al., 2021). This condition highlights the urgent need for more effective efforts to improve students' mathematical literacy.

Within the PISA framework, the mathematics domain is classified into four content areas: change and relationship, space and shape, quantity, and uncertainty and data (OECD, 2023). According to Mashuri et. al (2023), the quantity content plays a significant role in enhancing mathematical literacy, as mastery of numerical operations is fundamental to the mathematics learning process.

Several previous studies have examined mathematical literacy from various perspectives. For instance, Salsabilla & Hidayati (2021) investigated students' abilities in solving HOTS-type mathematics problems; Geraldine & Wijayanti (2022) examined students' performance on PISA tasks in the change and relationship content in relation to self-efficacy; and Setyaningsih & Munawaroh (2022) analyzed students' abilities in solving PISA-oriented tasks within the uncertainty and data content. However, no studies have specifically explored students' mathematical literacy skills in solving PISA-type mathematics problems focused on the quantity content.

Referring to the previous discussion, this study focuses on describing students' mathematical literacy skills in solving PISA-type mathematics problems within the quantity content. The analysis in this study centers on the mathematical literacy indicators, namely: formulating situations mathematically; employing mathematical concepts, facts, procedures, and reasoning; and interpreting, applying, and evaluating mathematical outcomes. The results of this analysis are expected to provide a more detailed understanding of students' mathematical literacy abilities, particularly in the quantity content, which can serve as a basis for improving and enhancing the quality of mathematics learning in schools.

Method

A research method refers to a series of systematic and scientific procedures undertaken to obtain data in order to achieve the intended goals and outcomes (Sugiyono, 2023). This study employed a qualitative approach with a descriptive research method. The purpose of this research is to describe students' mathematical literacy skills in solving PISA-type mathematics problems within the quantity content. The study was conducted on August 26, 2025. The research subjects consisted of one ninth-grade class at junior high school 6 Jambi City, comprising 37 students with diverse ability levelly high, medium, and low-based on their daily assessment scores and discussions with the mathematics teacher.

This study employed data collection instruments in the form of tests and interviews. The test items utilized were original PISA questions from 2012, encompassing four different PISA content domains, with item difficulty set at level 4. However, this study specifically focused on the quantity content domain. The selected items were first validated by two Mathematics Education lecturers, considering aspects of content, construction, and language, before being administered to students. After completing the test, one student from each ability category was selected as a representative to participate in an interview session. Semi-structured interviews were conducted to gain deeper insights into students' thinking processes and the challenges encountered during problem-solving.

Subsequently, the data were analyzed using the interactive model proposed by Sugiyono (2023) which comprises three main stages; (1) data reduction to filter essential information; (2) systematic data presentation to facilitate thorough examination; and (3)

drawing conclusions and conducting verification based on the predetermined indicators of mathematical literacy competence.

The research procedure was carried out by administering the test to all participants. The test was given to students with an allocated duration of 60 minutes. After the test was completed, the students' responses were assessed using a scoring rubric that had been developed beforehand and then analyzed in greater depth according to the mathematical literacy indicators. The descriptions of these mathematical literacy indicators are as follows:

Table 1. Indicators of Mathematical Literacy

No.	Mathematical Literacy Indicators	Descriptors
1.	Formulating situations mathematically	Identifying mathematical aspects within a problem and recognizing the key variables involved.
2.	Employing mathematical concepts, facts, procedures, and reasoning	Applying mathematical concepts, facts, procedures, and reasoning to determine appropriate mathematical solutions.
3.	Interpreting, applying, and evaluating mathematical outcomes	Reinterpreting the obtained solutions within the context of real-world situations.

Table 1 presents three indicators of students' mathematical literacy skills. The first indicator, formulating situations mathematically, emphasizes students' ability to identify relevant mathematical aspects and key variables within a given problem. The second indicator, employing mathematical concepts, facts, procedures, and reasoning, reflects students' capacity to apply appropriate mathematical knowledge, procedures, and logical reasoning to derive accurate solutions. Furthermore, the third indicator, interpreting, applying, and evaluating mathematical outcomes, focuses on students' ability to interpret the obtained results and relate them appropriately to real-world contexts.

Furthermore, based on the test result, students were classified into three ability categories: high, medium, and log. The guidelines foot categorizing students' abilities were adapted from Nurhayati et al. (2022), as presented in table 2.

Table 2. Ability Category Guidelines

Score Interval	Category
$\mathbf{x > 70}$	High Ability
$\mathbf{40 \leq x \leq 70}$	Medium Ability
$\mathbf{x < 40}$	Low Ability

Table 2 presents the score intervals used to categorize students' ability levels. Students who obtained scores above 70 were classified as having high mathematical literacy skills. Those who scored within the range of 40-70 were categorized as having medium literacy skills, while students who received scores below 40 were classified as having low mathematical literacy skills.

From each ability category, one student was selected to represent the group for the interview process. Semi-structured interviews were conducted to gain a deeper understanding of students' thinking processes and the challenges they encountered.

Result and Disscusion

The test results and interview data served as the basis for assessing students' mathematical literacy abilities. Based on the test outcomes, the distribution of students' scores can be seen in table 3 below.

Table 3. Categories of Students' Mathematical Literacy Ability

Interval	Category	Number of Students	Percentage
$x > 70$	High	2	5.4%
$40 \leq x \leq 70$	Medium	15	40.54%
$x < 40$	Low	20	54.05%

Based on table 3, it can be observed that students' mathematical literacy skills are predominantly categorized as low, with only a small proportion achieving high or medium levels. Students who obtained scores above 70 were classified as having high mathematical literacy, accounting for 2 students or 5.4%. In the score range of 40 to 70, a total of 15 students fell into the medium category with a percentage of 40.54%. Meanwhile, 20 students, or 54.05%, scored below 40, placing them in the low literacy category.

The analysis of the test result was conducted by examining each item and the students' corresponding responses. As an illustration, on PISA 2012 item from the quantity content domain is presented, along with sample student responses representing the high, medium, and low ability categories.

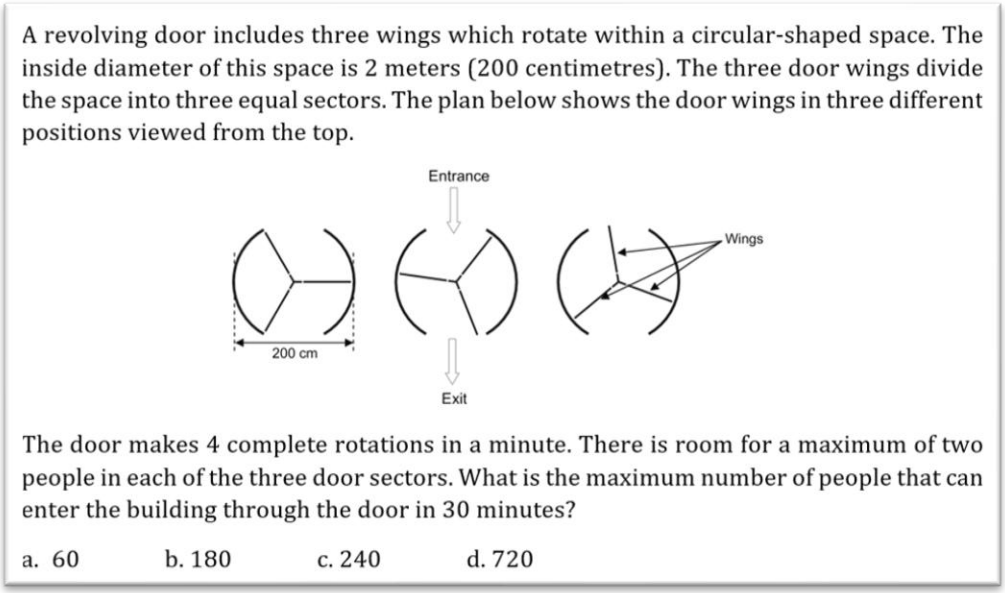

Figure 1. PISA 2012 Quantity Content Item on "Revolving Door"

Figure 1 presents the PISA 2012 item on the quantity content domain that was used in this study. The item illustrates a revolving door shaped like a circle, divided into three equally sized sectors. The door completes four full rotations per minute, and each sector can accommodate a maximum of two people. The main question requires students to calculate the maximum number of people who can enter the building within 30 minutes. Thus, students must employ their mathematical literacy skills to analyze the relationship between the number of door rotations, the capacity of each sector, and the duration of time specified in the problem.

In the quantity content item, the assessment focuses on the following mathematical literacy indicators: Formulating situations mathematically (LM 1), which is evaluated based on students' ability to identify the mathematical aspects of the problem, such as the revolving door completing four full rotations per minute, the presence of three sectors in the door with each sector accommodating a maximum of two people, and the requirement to determine the maximum number of people who can enter the building. Employing mathematical concepts, facts, procedures, and reasoning (LM 2) is assessed through students' ability to correctly perform multiplication using the information provided in the problem. Interpreting, applying, and evaluating mathematical outcomes (LM 3) is measured based on students' ability to reinterpret their final answer in relation to the context of the sectors in the revolving door.

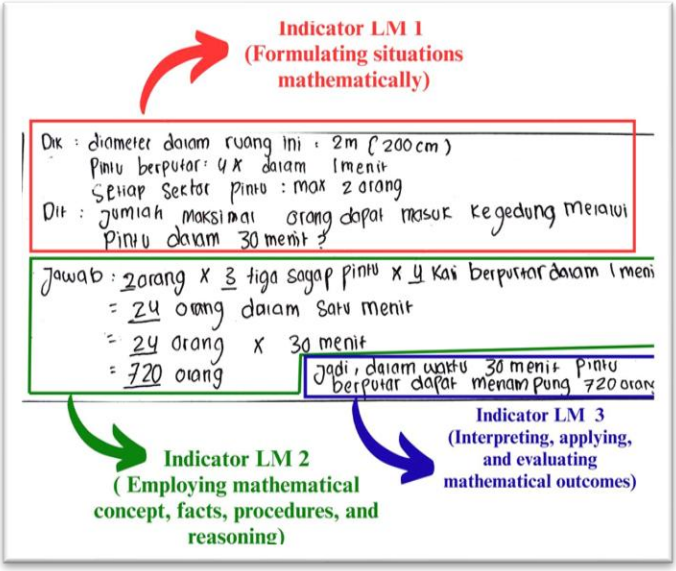

Figure 2. Student Response in the High-Ability Category

The student response shown in figure 2 represents a student in the high-ability category. This is indicated by the students' success in identifying the mathematical aspects of the problem, namely noting that the door rotates four times per minute, consists of three sectors, and that each sector can hold a maximum of two people. The student also correctly stated what the problem was asking, namely the maximum number of people who can enter the building through the revolving door within 30 minutes. Furthermore, the student was able to apply appropriate mathematical concepts to perform the calculations accurately. In addition, the student successfully reinterpreted the result in accordance with the context of the problem. Therefore, it can be concluded that the student met all three mathematical literacy indicators and is classified as having high ability. This finding aligns with Farida et al. (2021), who assert that students who successfully fulfill all three mathematical literacy processes are categorized as high-ability learners. The test results were further supported by the interview findings, as presented below:

P: In your opinion, were the steps you used to solve the problem, correct?
S: Yes, they were
P: Why are you confident that the steps you used were correct?
S: Because I understood the problem that was given
P: Are you sure that the answer you produced is correct?

S: Yes, I am sure, because I understand what is given and what is asked in the problem, and I used logical reasoning when solving it

Based on the interview results, the students demonstrated that they had fulfilled all indicators of mathematical literacy. The student was able to identify the known information and the question being asked in the problem (LM 1), apply logical reasoning and use mathematical concepts and procedures accurately (LM 2), and express confidence in their solution because they could interpret the result according with the context of the problem (LM 3).

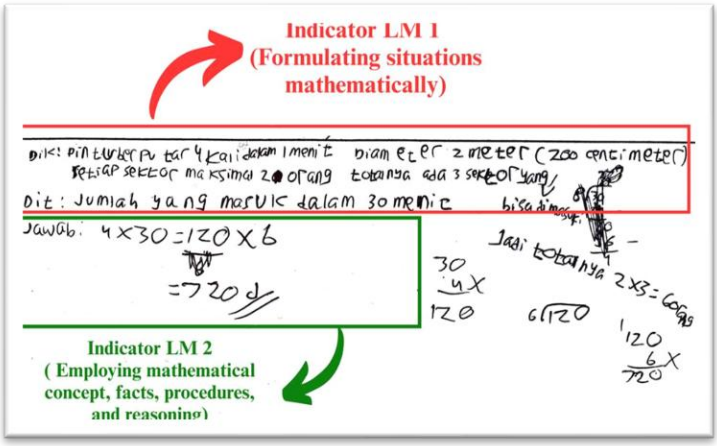

Figure 3. Response of a Student in the Medium-Ability Category

The student response presented in figure 3 represents a student in the medium-ability category. This classification is reflected in the student's ability to correctly identify and write down the information related to the given statements and questions. The student was also able to apply the appropriate mathematical concepts to carry out the calculations accurately. However, the student was unable to reinterpret the obtained result within the context of the problem, indicating that the interpretation aspect of mathematical literacy was not fully achieved. These test findings are further supported by the interview conducted as follows:

P: In your opinion, were the steps you used to solve the problem, correct?
S: Yes, they were
P: Why are you confident that the steps you used were correct?
S: Because it only needed to be multiplied, Kak. I just did 4 times 30, then multiplied it by 6
P: Are you sure your answer is correct?
S: Yes, because all the numbers are already provided, so I just needed to calculate them

Based on the interview results, the student demonstrated that he had fulfilled part of the mathematical literacy indicators. The student was able to identify the information provided and the question being asked in the problem (LM 1), as well as apply the appropriate mathematical concepts and procedures to complete the calculation (LM 2). However, the student was unable to reinterpret the obtained result within the context of the problem (LM 3), as he focused solely on the computational process without explaining the meaning of the result 720 people in the actual scenario.

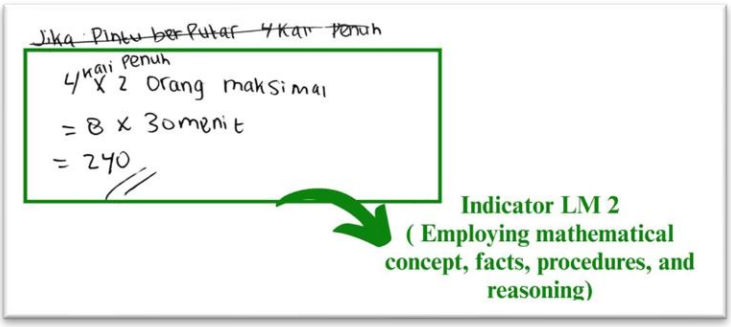

Figure 4. Response of a Student in the Low-Ability Category

The students' response presented in figure 4 represents a participant in the low-ability category. This classification is evident as the student was unable to fulfill the LM 1 indicator, particularly in correctly identifying the essential information needed to arrive at the final solution. This misunderstanding subsequently affected the LM 2 indicator, leading the student to perform incorrect computations and fail to obtain the correct final answer. Moreover, the student did not provide any conclusion based on the result obtained, indicating that the LM 3 indicator was also unmet, as the student was unable to reinterpret the solution within the context of the given problem. The findings from the written test are further supported by the results of the following interview:

P: Do you think you are confident with the method you used to solve the problem earlier?
S: Yes, I think so
P: Did you understand the problem that was given to you?
S: I understood it a little, Kak, but I was also confused
P: Why did you use the method you used earlier?
S: Because that was the only method I remembered, so I just multiplied it directly, Kak
P: Do you think your answer is correct?
S: I think it's already correct, because it was just a matter of doing the calculations

Based on the interview results, the student demonstrated that only one indicator of mathematical literacy was met, namely employing mathematical concepts, facts, procedures, and reasoning (LM 2), although errors were still present in the calculation process. The student was unable to identify and articulate the essential information required to solve the task (LM 1), nor could the student interpret the obtained result within the context of the problem (LM 3). The student tended to approach the task by relying on memory and basic computational procedures alone, without developing a comprehensive understanding of the given situation.

The findings of this study indicate that students' mathematical literacy skills are generally still categorized as low. This conclusion is supported by the test results, which show that many students were unable to meet all indicators of mathematical literacy proficiency. These results highlight the need for strengthening students' mathematical literacy, particularly in solving PISA-type tasks within the quantity content area, which requires the ability to interpret numerical relationships, apply mathematical principles, and reason within contextual situations.

Indicator 1. Formulating situations mathematically

Based on the research findings, students in the high and medium ability categories were able to fulfill the formulate indicator. This is evidenced by their ability to identify and write down the relevant information provided in the problem, as well as clearly stating the question being asked. In contrast, students in the low ability category were unable to meet this indicator. They did not record the essential information from the problem and were also unable to articulate what the task required, indicating a fundamental difficulty in recognizing and organizing the mathematical components necessary for further analysis.

In other words, the analysis of students' written responses and interview results indicates that most students were unable to fulfill the first indicator of mathematical literacy. This difficulty arises because they struggled to interpret the meaning of the problem and were not accustomed to identifying and recording essential information presented in the task. This finding aligns with Ridzkiyah & Effendi (2021), who reported that students generally lack the ability to communicate their mathematical reasoning effectively in written form

Indicator 2. Employing mathematical concepts, facts, procedures, and reasoning

Based on the findings, students in the high and medium-sized ability categories were able to fulfill the employment indicator. This is evidenced by their ability to apply appropriate mathematical concepts and carry out the required calculations correctly. Students in the low ability category also demonstrated partial achievement of this indicator; however, errors occurred in their computational process, resulting in incorrect final answers.

In other words, based on the analysis of students' answers and interview results, most students were generally able to meet the second indicator of mathematical literacy. However, students categorized as low achievers still exhibited frequents computational errors. These findings align with the studies (Fazzilah et al., 2020; Lestari & Effendi, 2022) which reported that students often make mistakes when solving problems due to inaccuracy and a tendency to work hastily.

Indicator 3. Interpreting, applying, and evaluating mathematical outcomes

Based on the findings, students in the high-ability category were able to meet the interpreting indicator. This is demonstrated by their ability to interpret the results of their problem-solving process by providing a clear and relevant conclusion. However, students in the medium and low-ability categories were unable to meet this indicator. They did not restate or provide a conclusion based on the results obtained, indicating an incomplete interpretation of the solution within the given context.

In other words, based on the analysis of students' written responses and interview results, most students were unable to meet the third indicator of mathematical literacy. This finding is consistent with Salsabilla & Hidayati (2021), who reported that students often did not provide a conclusion in their problem-solving process, indicating that they did not re-examine or validate the results obtained. Additionally, the tendency of students to omit conclusions is influenced by their desire to complete the task quickly, as noted by (Ridzkiyah & Effendi, 2021).

Based on the analysis of the three indicators, it can be concluded that students' mathematical literacy abilities in solving PISA-type mathematics problems remain below the expected standard or can be categorized as low. Most students were unable to meet the formulate and interpret indicators, primarily because classroom learning tends to emphasize routine exercises, which limits the development of students' comprehension

and reasoning skills. Considering the essential role of mathematical literacy, efforts to enhance these abilities are necessary. One strategic approach is to develop PISA-type problems within the quantity content domain using contexts that are closely related to students' daily experiences, such as local truism, culture settings, or other familiar environments. Furthermore, students should be trained to regularly engage with problems aligned with PISA standards (Nusantara et al., 2024).

Conclusion

The results of this study indicate that students' mathematical literacy skills in solving PISA-type mathematics problems with a focus on the quantity content domain remain at a low level. This is evident as most students were unable to meet the indicators of formulation and interpretation. This suggests that students still face difficulties in understanding the context of the problems, identifying relevant information, and reinterpreting the solutions within the real-life situations presented. Given the limited number of participants in this study, further research with a larger and more diverse sample is necessary to strengthen the generalizability of the findings. Future studies are also important to explore the underlying factors affecting students' low mathematical literacy performance, including the teaching practices implemented and the characteristics of tasks used in classroom learning. These difficulties are related to classroom instruction, which still tends to emphasize routine problem exercises, thereby affecting students' comprehension and reasoning abilities. Therefore, to support the enhancement of students' mathematical literacy, it is essential to develop and implement PISA quantity-content tasks that integrate contexts closer to students' experiences, such as tourism, cultural, or local contexts.

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Author Contribution

NH - Conceptualization, Writing - Original Draft, Editing and Visualization; DSN-Writing - Review & Editing, Formal analysis, Methodology and Supervision; TG- Validation and Supervision.

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