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Analysis of Students' Ability in Mastering the Process Components of Using Symbolic, Formal and Technical Language and Operation and Representation of PISA Mathematical Literacy at SMPN 4 Bengkulu City

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Abstract

This study aims to analyze students' abilities in mastering the process components of PISA mathematical literacy. This research is classified as descriptive research. The subjects of this study were students from classes IX-1 and IX-2 at SMP Negeri 4 Kota Bengkulu during the odd semester of the 2021/2022 academic year. The instruments and data collection techniques used in this research were test sheets and interviews. The results of the study show that 45.45% of students demonstrated the ability in the representation process, while 47.04% of students demonstrated the ability in the use of symbolic, formal, and technical language and operations process when solving PISA 2012 mathematical literacy problems.

Keywords: *Student Ability, PISA Mathematical Literacy Process Components*

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Introduction

Education is a process that plays an important role in shaping a person's mindset, behavior, and abilities towards better progress. Through education, it is hoped that every individual will be able to innovate and make improvements in various aspects of life, including improving the quality of self.(Stiadi et al., 2023). In the context of formal education, the achievement of educational goals is the main indicator of the success of education implementation. Dynamic national education goals are always adjusted to the development of the Indonesian nation and global challenges.

One of the fields of science that plays a major role in forming critical, logical, systematic and creative thinking patterns in students is mathematics. Stiadi et al. (2022) emphasizes that mathematics has a fundamental role in human life because almost all life activities are closely related to mathematical concepts. Therefore, learning mathematics is not only aimed at equipping students with knowledge of calculation, but also training the ability to reason critically, creatively, actively, and the ability to work together in solving problems.

Furthermore, mathematics education has a major contribution in building logical, systematic, efficient thinking skills, and accuracy in dealing with real problems. Students' success in understanding and applying mathematics is one indicator of achieving educational goals, especially in the field of numeracy (Stiadi et al., 2023). According to the mandate of Law Number 20 of 2003 concerning the National Education System, education aims to improve the life of the nation through the development of abilities, character formation, and dignified national civilization (Trianto, 2009).

However, the achievement of Indonesian students' mathematics achievement at the international level is still concerning. The results of the Program for International Student Assessment (PISA) survey show that Indonesian students' mathematical literacy skills are ranked low globally. In PISA 2006, Indonesia was ranked 50th out of 57 countries, in 2009 it was ranked 61st out of 65 countries, and in 2012 Indonesia was ranked 64th out of 65 participating countries (OECD, 2013). These results indicate that many Indonesian students still have difficulty in solving mathematical literacy-based problems, especially those related to real-life contexts and high-level reasoning.

One of the important components in PISA mathematical literacy is the process aspect, namely using symbolic, formal and technical language and operations and representation, which measures students' ability to use mathematical symbols, formal language, technical

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procedures, and model and represent mathematical problems into various visual or mathematical forms. Unfortunately, various studies show that the abilities of Indonesian students in both aspects are still relatively low.

Research conducted by Cahya et al. (2022) shows that most students have difficulty translating contextual problems into formal mathematical models, especially when it comes to using the right mathematical symbols or notations. A similar thing was also expressed by (Srimuliati, nd; Stiadi et al., 2023; Umaroh and Pujiastuti, 2020), who found that students' representational abilities, such as converting verbal information into diagrams, graphs, or equations, are still weak, especially in the context of PISA mathematical literacy questions.

In addition, studies byMauliandri and Kartini (2020) shows that students often make mistakes in formal mathematical operations, such as algebraic manipulation or the use of technical symbols, due to a lack of understanding of basic concepts and limited mathematical reasoning abilities. This condition causes low student ability in solving PISA problems that require symbolic understanding, visual representation, and the application of formal mathematical techniques appropriately.

The urgency of improving mathematical literacy has grown since the integration of PISA-based questions into the 2014 Junior High School National Examination (UN), as conveyed by the Deputy Minister of Education and Culture. However, the results of the 2014 UN showed that the success rate of students in PISA-based questions such as Pythagoras reached 77.48%, while in questions measuring data centralization it was only 48.78%, reflecting the imbalance in mastery of concepts and low representation skills and use of mathematical symbolic language.

Based on these conditions, it is very important to analyze students' abilities, especially in mastering the components of the PISA mathematical literacy process, namely using symbolic, formal and technical language and operations and representation. This study focused on grade IX students of SMP Negeri 4 Bengkulu City to obtain an empirical picture of the extent of students' mastery of these aspects, so that it can be a basis for improving mathematics learning strategies that are more contextual, adaptive, and based on global literacy.

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Research Method

Types of research

This study aims to describe students' abilities in mastering PISA Mathematical Literacy content. Therefore, the type of research used is descriptive research.

The research was conducted at SMP Negeri 4 Bengkulu City with the research subjects being grade IX students. The main data in this study were students' difficulties in solving PISA-based mathematical literacy questions.

Data collection was conducted through tests and interviews. The research instruments included multiple-choice and essay questions, while interview guidelines were used to dig deeper into information related to students' test results.

The data were analyzed using analytical descriptive analysis techniques. The assessment criteria are set as follows: students are declared to have the ability or mastery of PISA 2012 mathematical literacy content if they can solve the questions correctly according to the component categories.Using symbolic, formal and technical language and operationsAndRepresentationthe.

Table 1. List of Student Process Ability Assessments in Completing PISA 2012 Mathematical Literacy

Process Components	Student Category Has Ability
Representation	Students are able to create images to represent their explanations so that they are easier to understand.
Using symbolic, formal and technical language and operations	Symbolic process ability: Students are able to use symbols appropriately and correctly.
	Operation process ability: Students are able to calculate correctly and precisely

Source: OECD (2013), PISA 2012 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy, OECD Publishing. http://dx.doi.org/10.1787/9789264190511-en

Results and Discussion

The target of this study was students of class IX 1 and IX 2 of SMP Negeri 4 Kota Bengkulu in the 2014/2015 academic year. Class IX 1 has 32 students and IX 2 has 34 students. The reason these two classes were used as samples was because they had abilities that were considered superior by the teacher compared to other classes. However, for class IX 1, when

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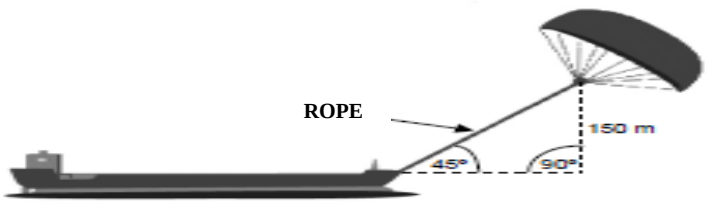
an interview was conducted with the teacher of class IX 1, there were 10 students who had below average mathematics abilities. So this class is quite representative for classes with students with low and medium abilities. SMP Negeri 4 Kota Bengkulu was chosen as the place of research because the school has good quality in Bengkulu city with A accreditation. Furthermore, both classes were given tests. The results obtained are as follows:

The first type of process component is representation. The ability of the representation process is related to the ability of students to create images to help their explanations so that they are easier to understand. In question number 2, there are still very few students who have the ability of the representation process, namely 3 students in class IX 1 and 10 students in class IX 2. This shows that the ability of students to create images to help their explanations so that they are easier to understand is still very lacking, and needs to be improved again. However, for question number 1, there are already quite a lot of students who have the ability of the representation process, namely 26 students in class IX 1 and 21 students in class IX 2. Here are some examples of answers from students who are able to master the components of the representation process:

Question 2: SAILING SHIP

What is the estimated length of rope for a kite sail, to pull the ship at a 45° angle and at a height of 150 m vertically, as shown in the figure below?



Notes :

Image cannot be scaled

A. 173 m
B. 212 m
C. 285 m
D. 300 m

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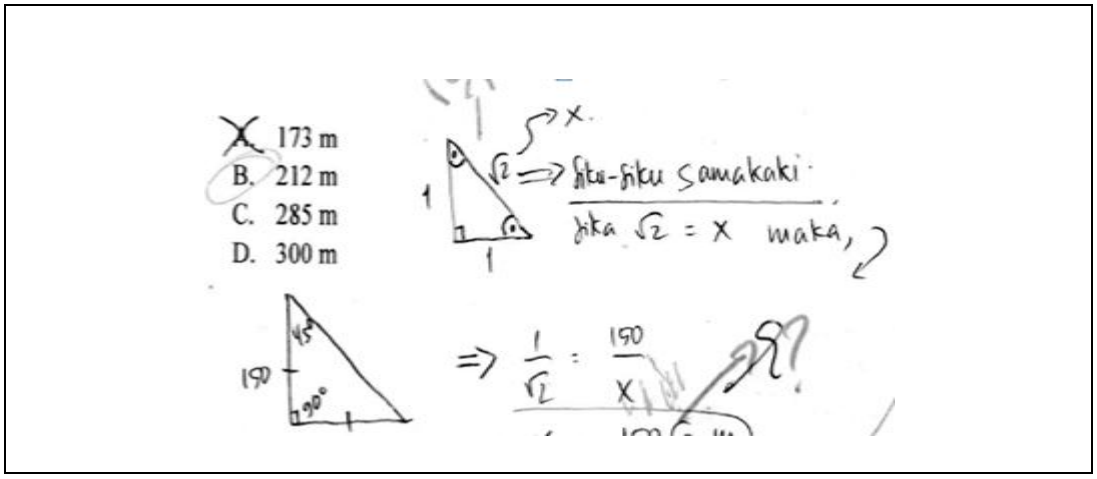

Figure 1. Example of Student Answers Who Have Representation Process Ability in Number 2

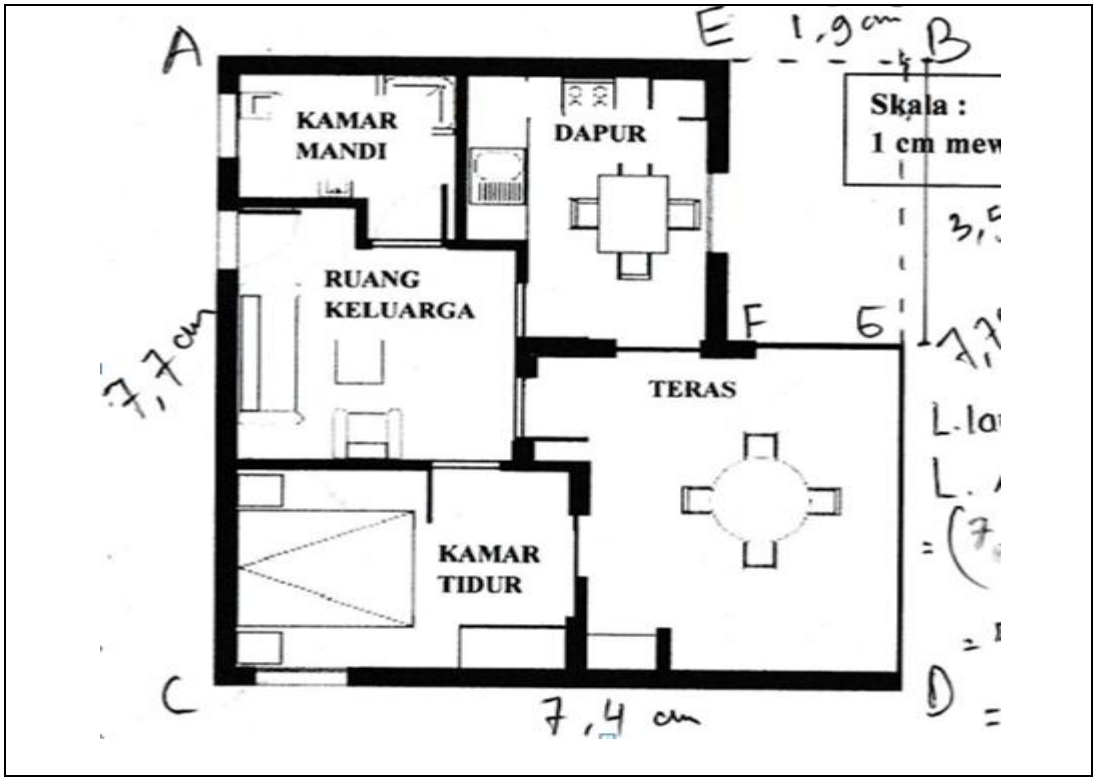

Figure 2. Example of Student Answers Who Have Representation Process Ability in Number 1

The second type of process component is using symbolic, formal and technical language and operation, this second process component is divided into 2, namely symbolic and operation process abilities. Symbolic process abilities are related to students' ability to use symbols correctly and properly. In question number 3, there are only 7 students in class IX 1 and 11 students in class IX 2 who are able to use symbols correctly and properly. Likewise in questions 2 and 4, in each question in sequence there are 3 and 8 students in class IX 1 and there are 11

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and 11 students in class IX 2 who are able to use symbols correctly and properly. This shows that there are still very few students who have the ability to use symbolic processes. However, for question number 5, almost all students are able to use symbols correctly and properly, namely in class IX 1 as many as 24 students and in class IX 2 as many as 31 students. This shows that in question number 5, students already have the ability to use symbolic processes. Likewise, in question number 1, there are 26 students in class IX 1 and 20 students in class IX 2 who can use symbols correctly and precisely. Judging from the student test, here are some examples of student answers who are able to/master the components of the symbolic process:

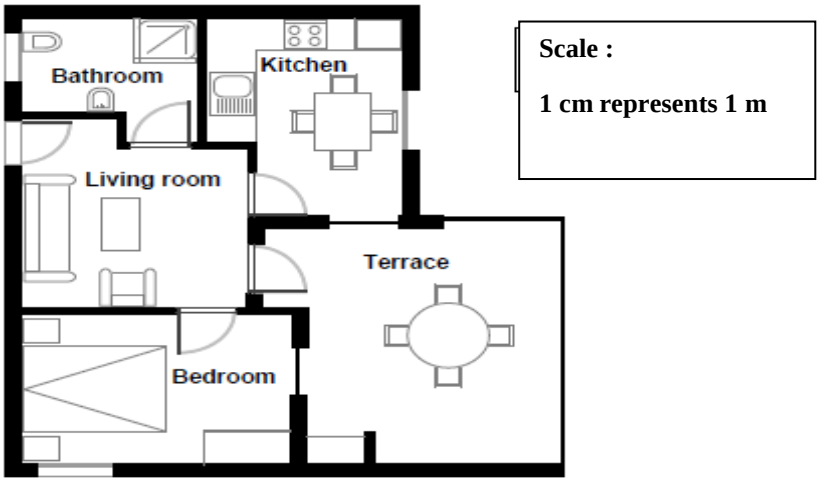
Question 1: APARTMENT PURCHASE

To estimate the total floor area of an apartment, you can measure the size of each room, calculate the area of each and add all the areas.

However, there is a more efficient method to estimate the total floor area where you only need to measure the length of 4 sides. Mark on the image above the length of the four sides needed to estimate the total floor area of the apartment. Calculate the total floor area of the apartment above! (Use a ruler to measure the length of the four sides)

……
……..

This is a sketch of the apartment George's parents want to buy from a real estate agent.



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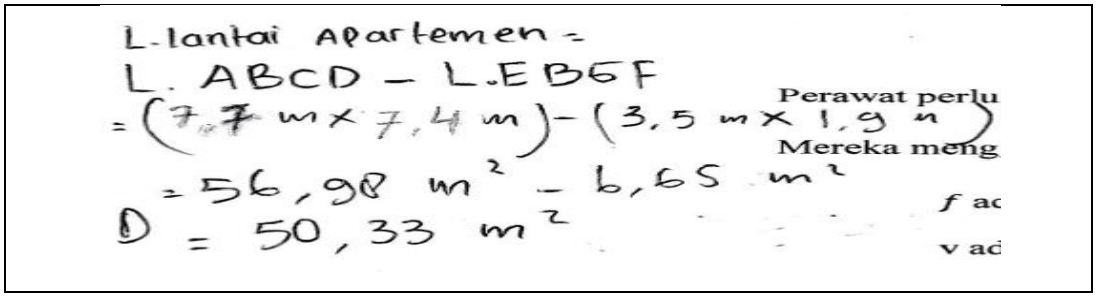

Figure 3. Example of Student Answers Who Have the Ability to Use Symbolic Processes on Question Number 1

Operation process ability is related to students' ability to calculate correctly and precisely. In question number 3, there are only 7 students in class IX 1 and 8 students in class IX 2 who are able to calculate correctly. Likewise in questions number 2 and 6, in each question in sequence there are 3 and 2 students in class IX 1 and there are 6 and 7 students in class IX 2 who are able to calculate correctly. This shows that there are still very few students who have operation process ability. However, for question number 1, almost all students are able to calculate correctly, namely in class IX 1 as many as 26 students and in class IX 2 as many as 31 students. This shows that in question number 1 students already have operation process ability. Judging from the student test, here are some examples of student answers that are able to/master the operation process components:

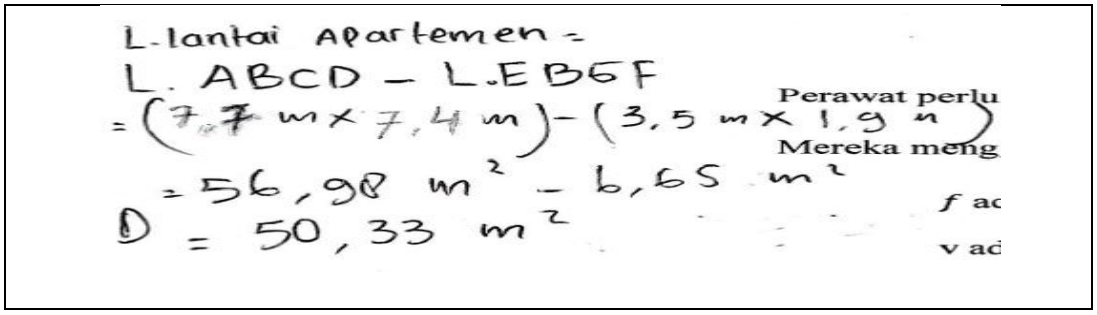

Figure 4. Example of Student Answers Who Have Operational Process Ability in Question Number 1

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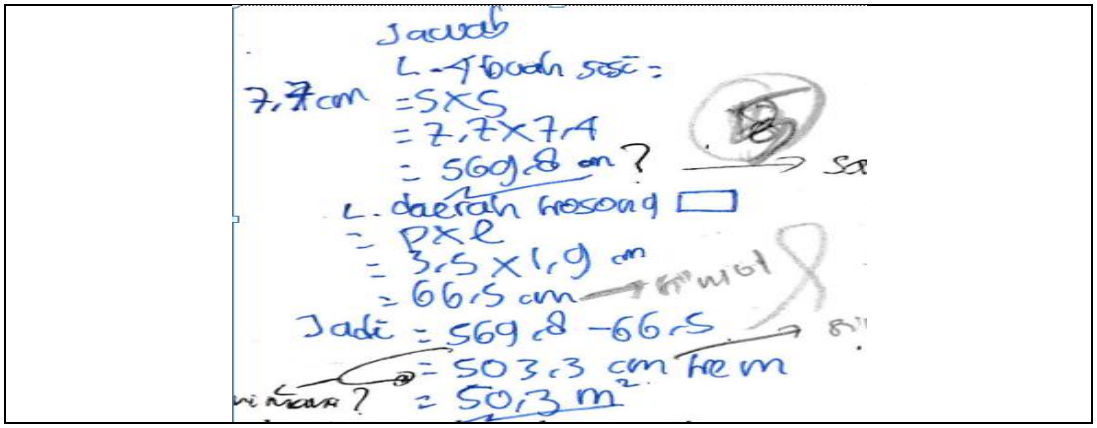

Figure 5. Example of Student Answers Who Made Operation Process Errors in Number 1

Based on previous results for representation process ability, only 45.45% of students have representation process ability. This shows that very few students can make good and correct drawings so that they can help explain their answers.

Meanwhile, for the ability to process using symbolic, formal and technical language and operation, only 40.74% of students have the ability to process using symbolic, formal and technical language and operation. This shows that very few students can calculate correctly and accurately and also write symbols correctly and precisely.

Based on the research results, it was found that students' abilities in the process representation aspect are still relatively low, which is only 45.45%. This percentage shows that less than half of the students are able to create appropriate images or visual representations to help explain and solve mathematical problems. This condition is in line with the findingsUmaroh and Pujiastuti (2020) which revealed that Indonesian students still have difficulty in changing verbal problems into mathematical representations such as pictures, diagrams, or graphs. Visual representation is an important part of solving PISA mathematical literacy problems, because it helps students model real situations into more structured mathematical forms. This low ability indicates that students' skills in connecting mathematical concepts with illustrations or visualizations still need to be improved.

Furthermore, students' abilities in the aspects of using symbolic, formal and technical language and operations also showed concerning results, namely only 40.74% of students were able to demonstrate skills in using mathematical symbols, formal language, and performing mathematical calculations and manipulations correctly. These results are consistent with researchFebryana et al. (2023) who found that many students made mistakes in the use of

symbols, writing mathematical notation, and in applying formal mathematical operations due to a lack of strong understanding of basic concepts.

These two results indicate that most students do not yet have adequate skills in the aspects of representation and use of symbolic language and formal mathematical operations, both of which are essential components in PISA mathematical literacy questions. This condition also explains the low achievement of Indonesian students in international assessments such as PISA, as reported by OECD (2013), where Indonesia consistently ranks low in mathematical literacy.

The results of this study reinforce the importance of mathematics learning that not only emphasizes procedural aspects, but also trains students in terms of visual representation, appropriate use of symbols, and formal reasoning. Thus, students' ability to solve context-based problems such as PISA mathematical literacy can be improved, in line with efforts to improve the quality of education in Indonesia.

Conclusion

Based on previous results for representation process ability, only 45.45% of students have representation process ability. This shows that very few students can make good and correct drawings so that they can help explain their answers. Meanwhile, for the ability to process using symbolic, formal and technical language and operation, only 40.74% of students have the ability to process using symbolic, formal and technical language and operation. This shows that very few students can calculate correctly and accurately and also write symbols correctly and precisely.

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