What Are Students' Difficulties in Implementing Mathematical Literacy Skills for Solving PISA-Like Problem?

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Mathematical literacy skills are individuals' ability to formulate, use, and interpret mathematics in various situations. However, no research exposes how difficult it is for students to implement mathematical literacy skills for PISA-like problem-solving. By knowing the difficulties, the teacher can take action for improvement. The research aims to reveal how difficult it is for students to implement mathematical literacy skills for solving PISA-like problems in the local context of Surakarta. Descriptive qualitative research employs 108 students from several junior high schools in Surakarta, Indonesia. Researchers use some methods to collect data among test, observation, and interview methods. The instruments are tests, observation sheets, and in-depth interview guidelines. The research employs validators in mathematics education research with a qualitative approach and experts in mathematical literacy. The data is analyzed through the stages of reduction, presentation, and conclusions. The study concluded that students have difficulty in mathematization. Further research could focus on defragmenting models to take mathematical literacy skills to a higher level.

Keywords: students' difficulties, mathematical literacy ability, PISA-like problem, local context of Surakarta

INTRODUCTION

The idea of mathematical literacy supported by the Program for International Student Assessment (PISA) has been widely accepted globally. Mathematical literacy skills are individuals' ability to formulate, use, and interpret mathematics into various situations, including mathematical reasoning and the use of mathematical concepts, processes, facts, and media to describe, explain, and predict an event (OECD, 2018). Hwang and Ham (2021) states that mathematical literacy explains the processes of content knowledge and contexts reflected in the assessment's mathematical problems. Mathematical literacy skills have an essential role in life, namely in making constructive and reflective decisions (Sfard, 2014).

However, the facts show that neither teachers nor students pay attention to mathematical literacy skills (Pradana, Sholikhah, Maharani, & Kholid, 2020). Teachers recognize whether a student's answer is correct or not without understanding the student's acquisition process (Kholid et al., 2019; Susandi & Widyawati, 2017). This fact indicates that the teacher has no reflection substance to improve the quality of problem-solving, especially concerning the mathematical abilities that students demand to have. This condition has been happening for a very long time resulting in Indonesia's international events lagging behind other ASEAN countries.

The achievements of Indonesian students in the PISA event are still straggling behind ASEAN countries. PISA results of Indonesia and nearby countries are presented in Table 1 (OECD, 2018).

TABLE 1
PISA 2018 REPORT FOR THE ASEAN COUNTRIES

No.	Countries	Rank	Math Score (Mean)
1.	Singapore	2	569
2.	Malaysia	47	440
3.	Brunei Darussalam	53	430
4.	Thailand	57	419
5.	Indonesia	72	379
6.	The Philipines	77	353
Internasional Mean			**489**

Table 1 shows the mathematical mean for Indonesia is still below the international mean of 379. The mean math score of Indonesian students in PISA in 2018 was ranked 72nd out of 78 countries that participated in PISA. Besides, it shows that of the several countries in Southeast Asia that follow PISA, Indonesia ranks bottom despite being above the Philippines. This data indicates that research related to mathematical literacy skills in solving PISA-like problems in Indonesia needs to be concerned to improve Indonesia's achievements in the events. This state shows that Indonesia demands to make an effort to improve its achievements in the PISA. The actions that are conducting research related to mathematical literacy skills both theoretically and practically.

Mathematical Literacy

The paradigm of learning in education in the 21st century emphasizes that students have more skills in thinking, including the ability to think critically, connect knowledge with real-world problems, master information, communicate technology, and collaborate. One of them is through efforts to improve the ability of mathematical literacy. Mathematical literacy skills are individuals' ability to formulate, use, and interpret mathematics into various situations, including mathematical reasoning and the use of mathematical concepts, processes, facts, and media to describe, explain, and predict an event (OECD, 2018). The achievement of a country's mathematical literacy skills can be observed through the acquisition of PISA (Programme for International Student Assessment) study results, one of the programs developed by the OECD (Organization for Economic Cooperation and Development). However, based on the results of the PISA 2018 study, Indonesia's math literacy score is still far below average. Efforts are needed to improve the ability of mathematical literacy. The existence of adequate mathematical literacy skills allows learners to use mathematics in real life, solve problems with practical methods, assess results, analyze situations, and describe conclusions(Genc & Erbas, 2019). In addition, the improvement of mathematical literacy skills has a direct impact on improving the quality of human resources (Masjaya & Wardono, 2018). In enhancing the ability of mathematical literacy, educators are encouraged to apply PISA-shaped questions. This aims to make each item of the problem meet the indicators of mathematical literacy, where students can reason mathematics in various contexts and solve math problems constructively (Riyatuljannah & Fatonah, 2021; Kholid, Pradana, Maharani, & Swastika, 2022).

How To Examine Students' Difficulties in Solving Pisa-Like Problems?

The math problems developed from PISA are contextual. Contextual problems require that students connect their mathematical knowledge into real-life problem solving (Novita et al., 2012). Students who are not used to solving math problems in the form of PISA will have difficulty solving them. Following the conclusion from Wijaya et al. (2014), students have difficulty solving context-based PISA math problems. In addition, research conducted by Haji et al. (2019) concluded that the difficulties experienced by students in solving math problems in the form of PISA include difficulty understanding problems, connecting real-life aspects into mathematical models, performing mathematical operations, and interpreting the results of solving to real-world problems. Therefore, it is necessary to strive so that educators and students always face contextual problems. Contextual problems lead to non-routine questions, meaning that the student's work is analyzed by observing the problem-solving process based on their problem-solving skills. It requires learners to solve problems in a structured and systematic manner, from understanding to concluding. However, today, many cases of students are not optimal in solving a mathematical problem in a structured and systematic way. One of them was obtained from Lukman & Zanthy (2019) and Kholid et al. (2020) that students made mistakes such as unsystematic settlement process, improper use of formulas, unit writing, inability to interpret questions, incorrect conclusions, and incomplete settlement. The condition can be used as a benchmark in improving learning.

The Use of Local Context in the PISA-Like Problems

Mathematical literacy skills can be improved by familiarizing learners with solving PISA-shaped problems, especially Pisa context components. The math problems applied can be linked to the local context around the students. Charmila et al. (2016) said that using local context-based math problems makes it easier for students to understand mathematical phenomena from the perspective of their own life experiences. This is in line with research conducted by Putra et al. (2016) that the use of local context makes it easier for students to put mathematics into context to help students apply literacy skills to answer questions, as well as challenge students' mathematical thinking patterns. Local context taken from the student environment can be used according to the needs without compromising the characteristics of that context (As & Rosalina, 2019). Researchers are competing to develop various problems with local contexts in Indonesia. In 2021, Amalia et al. (2021) successfully developed Pisa equivalent math problems with a valid, practical, and potential effect Pancasila context. (Putri & Zulkardi, 2020) has also produced math problems such as PISA with a valid and valuable Asian Games context. In 2020, Prastyo & Salma (2020) developed several PISA criteria questions using the context of East Kalimantan. Research by Efriani et al. (2019) successfully developed PISA-type math problems with the context of screen sports at the 2018 Asian Games that are valid, practical, and have a potential effect on mathematical literacy skills. In addition, in 2019, Usnul et al. (2019) produced a math problem equivalent to PISA with the context of Aceh traditional houses that has a potential effect. Therefore, it is crucial to develop local context-based math problems.

Why This Research?

Some research focusing on mathematical literacy in PISA problem solving has been conducted. The research is grouped into three main groups. First, research related to the development of instruments to explore the ability of mathematical literacy. Tools developed in the form of virtual mathematics kits (Pradana, Sa'dijah, Sulandra, Sudirman, & Sholikhah, 2020). It is a collection of products from various software such as GeoGebra, MatLab, and office mix. Machromah et al. (2021) develop a local context test instrument to measure students' mathematical literacy skills. Meanwhile, Rawani et al. (2019) developed a PISA-like test instrument with a sports context. The second category, research describing the ability of mathematical literacy in solving PISA problems. The study concluded that student's literacy skills are different from needing different treatment (Widjaja, 2011). This research shows students' mathematic literacy performance only reaches the third level. They were only representing the resource information (Sugiarto et al., 2021). Third, research focuses on the relationship of mathematical literacy skills to achievement. The study concluded that mathematical literacy focusing on citizenship also refers to the possibility of critically evaluating aspects of the surrounding culture (Jablonka, 2003). The test problems given are the PISA mathematical literacy that has a relatively close context with social arithmetic (Rohman, Susanto, Hobri, Saiful, & Sahnawi, 2019).

Based on the study's conclusions, there is a gap and advanced need in research mathematical literacy skills. It is identifying the challenge of students in implementing mathematical literacy skills for solving PISA-like problems with the local context. Thus, this study reveals how difficult it is for students to implement mathematical literacy skills in solving PISA-like with the local context. Students' difficulty in implementing mathematical literacy skills needs to be done so that teachers can defragment so that students' challenges in implementing mathematical literacy skills can be overcome.

METHODS

Research is descriptive qualitative research, which is research that explores the meaning in a number of individuals or groups deriving from social problems (Creswell, 2014). The social problems or data displayed are the difficulty of students in implementing mathematical literacy skills in solving the local context of Surakarta.

The study employed 108 students from different junior high school in Surakarta, Central Java. They were initially categorized into three groups of proficient, moderate, and low mathematical abilities based on middle semester test scores. This step is conducted to obtain as much variation of data regarding students' difficulties. The grouping rules and results are presented in Table 2.

TABLE 2
GROUPING RULES AND RESULTS

Groups	Rules	Results	The number of students
Proficient	$X > \bar{X} + \frac{1}{2} SD$	X >60,886	26
Moderate	$\bar{X} - \frac{1}{2} SD \leq X \leq \bar{X} + \frac{1}{2} SD$	36,892≤ X ≤60,886	52
Low	$X < \bar{X} - \frac{1}{2} SD$	X<36,892	30
Total			**108**

The criteria of the subjects employed are (1) students who can implement the think-aloud method, (2) students who have difficulty solving local context-based mathematical literacy tasks, and (3) students who volunteer to be the subject of research. Students who did not meet these criteria were not employed in the study. However, in this article, researchers report data from three subjects consisting of one subject from the proficient group (subject S-1), one subject from the moderate group (subject S-2), and one subject from the low group (subject S-3). The subject is selected because the data can represent the entire data of each group.

Research instruments consist of PISA-like tests of local Surakarta context, observation sheets, and interview guidelines. The instruments have been through the assessment and evaluation stage called content validity. It has been established by determining the domain of the instrument content through a review by a subject matter expert by alignment studies (Sireci & Faulkner-Bond, 2014; Thompson & Senk, 2017). The content validity stage conducted by employing three validators. They are experts in PISA problem development, mathematical literacy skills experts, and qualitative research experts in mathematics education research. Validators make improvements to redactional, and substances adapted to PISA standards. The value of local context can help students understand mathematical phenomena from the perspective of their own life experiences so mathematics much more exciting and beneficial for all students (Charmila et al., 2016; Murtiyasa et al., 2018). Because the research employs students from Surakarta, the local context used on the test is the local context of Surakarta. PISA-like problem with local context of Surakarta is presented in Figure 1.

FIGURE 1
THE PISA-LIKE PROBLEM WITH LOCAL CONTEXT OF SURAKARTA

A **B**

A kapal ice seller in Surakarta city offers two menu options, package A and B. Package A glass size is 7.5 cm in diameter and 8.5 cm high, while package B glass is 6.5 cm in diameter 11.5 cm tall. If the seller gives the same price for both options, then which package will you choose? Please give me your reasons!

The PISA-like problem with the local context of Surakarta was developed by covering mathematical literacy activities on each indicator. In addition, to facilitate the presentation of data, each indicator is given code (coding). There are seven basic mathematical abilities employed as indicators in mathematical literacy based on the PISA 2018 Framework (OECD, 2018). The seven basic mathematical abilities are shown in Table 2. However, the study does not discuss the seventh indicator related to media use because the PISA-like problem has presented illustrations of objects by including images in the test instrument.

TABLE 3
THE MATHEMATICAL LITERACY INDICATORS

Code	Indicator	Description	Activity in problem-solving
I1	Communication	Reading, translating, and making reasonable statements, questions, tasks, objects or images, to form a mental model of an existing situation.	The problem-solvers write down the information they obtained into the answer sheet.
I2	Mathematization	Identifies the variables and mathematical structures underlying them in real-life problems and makes assumptions.	Orally, the problem-solvers reveal the word or phrase's mathematical structure as a clue in the calculated operation.
I3	Representations	Create mathematical representations of real-life information.	The problem-solvers represent information from the question into a mathematical expression.
I4	Reasoning and opinions	Explaining, maintaining, or providing justification for identifying or composing representations of real-life situations	The problem-solvers present opinions on the selection of how to solve the problem and shown when explaining the final result that they choose.
I5	Ability to choose strategies to solve problems	Select or create plans or strategy mathematically rearrange contextual problems.	The problem-solvers determine the formula to be used in solving the problem.
I6	Ability to use symbolic, formal, and technical languages and operations	Using appropriate variables, symbols, diagrams, and standard models to represent real-life problems using figurative/formal language.	The problem-solvers perform unit calculations and conversions
I7	Ability to use mathematical tools	Using mathematical tools to recognize structures or to describe mathematical relationships.	The problem-solvers use a ruler to measure the difference in the size of the glass in the question.

To explore in-depth students' difficulties in implementing mathematical literacy and causative factors, researchers also employed the semi-constructed interview guidelines. The list of questions for the interview is presented in Table 4.

TABLE 4
LIST OF INTERVIEW QUESTIONS

Code	Indicator	Question
I1	Communication	Are you able to read the question until you understand the question's meaning?
		If so, make a statement regarding what the question commands according to your understanding!
I2	Mathematization	Are you able to identify the mathematical structure of the problem?
		If so, make assumptions about it!
I3	Representations	After understanding the question's commands, do you already have a mathematical idea that will bridge the problem-solving?
I4	Reasoning and opinions	Why did you choose that mathematical idea to solve the problem?
I5	Ability to choose strategies to solve problems	Once you have a mathematical concept, have you devised a plan or strategy to apply it?
		If so, explain the method or technique you've developed!
I6	Ability to use symbolic, formal, and technical languages and operations	Do you devote a formula to solve the problem?
		If so, explain the procedure you're using!
		Does the information on the question meet to use the formula you have selected?
I7	Ability to use mathematical tools	During the work, do you use mathematical tools relevant to the problem?

The test method was conducted to explore the difficulty of students in solving problems based on mathematical literacy tasks. Researchers administered tests to 108 students one by one. The subject implements the think-aloud method. At the same time, researchers worked on audiovisual recordings and made observations. The advantage of implementing audiovisual recordings is that researchers can playback problem-solving recordings if data needs to be re-excavated. Thus, the implementation of audiovisual recordings aims to enable researchers to obtain data as valid as possible.

Observations are made based on observation sheets so that researchers focus on mathematical literacy indicators that students are challenging to implement to answer the problems. Next, the researchers checked the subjects' answer sheets and did a think-aloud transcription. Besides, the researchers chose subjects with representative data from each group. These data can represent each group's entire data, and data can support the research objective. Obtained 12 subjects with representative data consisting of three proficient students, four moderate students, and five low students. The interview was conducted to delve deeper into how difficult students solve PISA-like problems based on mathematical literacy.

Data analysis through three stages, namely reduction, presentation, and conclusion drawing (Miles et al., 2014). In the first phase, the researchers sorted the data according to the purpose of the study. Data that does not fit the purpose of the study is not used. Next, the researchers presented data that hold the purpose of the study, namely data on students' mathematical literacy skills and constraints. In the final stages, the researchers concluded the students' difficulties in implementing mathematical literacy skills for solving PISA-like problems. The validity of the data in this study was conducted triangulation data methods and triangulation data sources (Creswell, 2014). Triangulation data methods are done by comparing data obtained from test methods, observations, and interviews. The triangulation data sources are conducted by presenting data of two subjects in each category of mathematical ability.

FINDINGS AND DISCUSSIONS

In this article, data from three subjects of research subjects consisting of two subjects from the proficient group (subject S-1 and S-2), two subject from the moderate group (subject S-3 and S-4), and two subject from the low group (subject S-5 and S-6). The subjects selected because the data can represent the entire data of each group.

Exposure to S-1 Data: Subjects From the Proficient Groups

Figure 2 shows the S-1 answer sheet in PISA-like problem-solving in the local context of Surakarta. S-1 reads and understands the contents of PISA problems in the Surakarta context, then sorts out the information. S-1 indicates I1 by the following interview transcript.

> *Researcher : Do you understand the question?*
>
> *S-1: Yes, I know the problem by reading it carefully. There are two different glasses, one measuring 7.5 cm in diameter and 8.5 cm high. The only diameter is 6.5 cm, and the height is 11.5 cm. The problem is I choose which glass if the price is the same.*

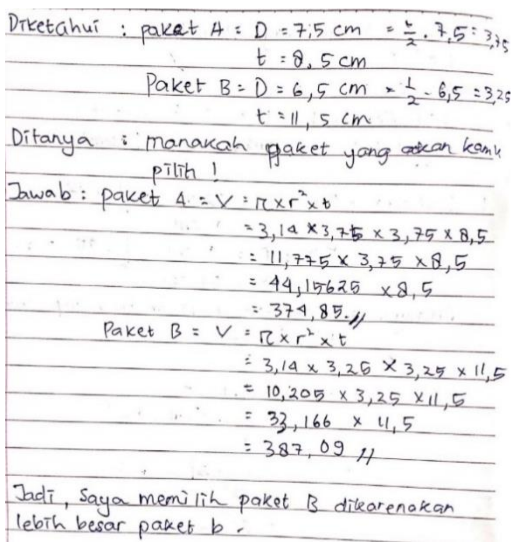
S-1 also writes information and commands from the question into its answer sheet (Figure 2). After reading and understanding the problem commands, S-1 began to write the formula that the glass volume is the volume of the tube (I3). Next, the subject performs the calculation. In this case, the S-1 has done the I5. In addition, formula writing, and calculated operations performed also prove that S-1 has done I6. After completing the calculation, S-1 obtained a volume value of glass A which is 374.85 cm3, while the volume of glass B is 387.09 cm3.

Furthermore, S-1 concludes the answer obtained that the S-1 chose glass B because the glass has a larger volume. This activity appears when the S-1 says, *"So, I chose package B because it is larger than package B glass"* when solving the problem. Such behavior indicates that the S-1 has performed I4. S-1 has not been able to dig deeper related to I2 following the existing problems. Here's a researcher interview with S-1 that supports the existence of I2.

> *Researcher: Are you able to identify the mathematical structure contained in the problem?*
>
> *S-1: Well, I have not been able to.*
>
> *Researcher: Why?*
>
> *S-1: Because I have no experience on that.*

Exposure to S-1 data as a student from the proficient groups shows that S-1 has difficulty implementing mathematical indicators. The reason is that teachers never train students to mathematize in problem-solving.

FIGURE 2
ANSWER SHEET OF S-1

Original Version (Answer sheet):	Translate Version:
 Diketahui : paket A : D = 7,5 cm = $\frac{1}{2}$. 7,5 = 3,75 t = 8,5 cm Paket B : D = 6,5 cm = $\frac{1}{2}$. 6,5 = 3,25 t = 11,5 cm Ditanya : manakah paket yang akan kamu pilih ! Jawab : paket A = V = $\pi \times r^2 \times t$ = 3,14 x 3,75 x 3,75 x 8,5 = 11,775 x 3,75 x 8,5 = 44,15625 x 8,5 = 374,85 // Paket B = V = $\pi \times r^2 \times t$ = 3,14 x 3,25 x 3,25 x 11,5 = 10,205 x 3,25 x 11,5 = 33,166 x 11,5 = 387,09 // Jadi, saya memilih paket B dikarenakan lebih besar paket b.	Suppose: Package A: D =7.5cm, r = 3.75cm, t = 8.5cm Package B: D =6.5cm, r = 3.25cm, t = 11.5cm Problem: Which package you will choose and why? Asnwer: Package A: V = $\pi r^2 t$ = 3.14X3.75X3.75X8.5 =11..775X3.75X8.5 =44.15625X8.5 =374.85 Package B: V = $\pi r^2 t$ = 3.14X3.25X3.25X11.5 =10.205X3.25X11.5 =33.166x11.5 =387.09 So, I prefer to buy package B because the glass is bigger.

Exposure to S-2 Data: Subjects From the Proficient Groups

S-2 reads and understands the contents of Pisa problems in the Surakarta context, then sorts out the information that can be used (I1). As for the interview excerpts that show that the S-2 did I1, as follows.

Researcher: Do you understand this problem?

S-2: Yes, very understanding.

Researcher: How do you know the problem?

S-2: I read the problem very carefully and repeatedly.

Researcher: Try to present your knowledge about this problem

S-2: There are drinks served on two different glasses. I was asked which glass to choose. It means that I need to determine the volume of each glass with the volume formula of a tube.

The interview excerpt also shows that the S-2 represents knowing that the concept that fits the problem is the volume formula of a tube (I3). After reading and understanding the problem commands, S-2 begins to write the formula and perform the calculation. In this case, S-2 has conducted indicators to develop strategies to solve mathematical problems and choosing methods to solve problems (I5). Simultaneously, formula writing, and calculated operations performed also prove that S-2 has done I6. After calculating the volume of both glasses, S-2 performs a volume comparison between the two glasses. S-2 concludes the answer obtained. The behavior indicates that S-2 has performed I4. Figure 3 shows the S-2 answer sheet in PISA-like problem-solving in the local context of Surakarta.

As for the think-aloud excerpts that show that the S-2 did I4, *"So, wait... The selected glass package is package B because... soon.... Because I get more drinks."* In problem-solving, S-2 not performed I2. The results are obtained from the following interview excerpts.

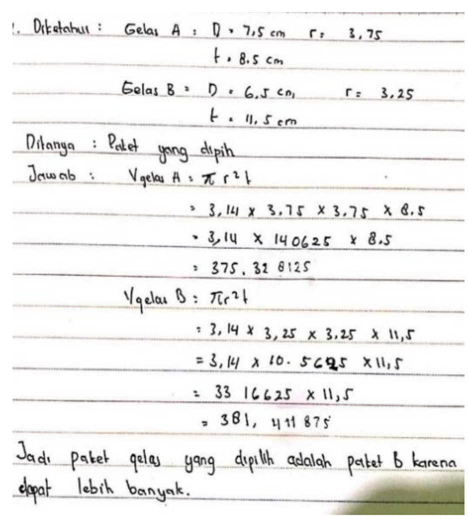
Researcher: Are you doing mathematization?

S-2: I have no experience in mathematization, Sir.

Researcher: Why don't you have experience?

S-2: It is probably because there has been no information or demands from the master, sir.

FIGURE 3
ANSWER SHEET OF S-2

Original Version (Answer sheet)	Translate Version
 1. Diketahui : Gelas A : D = 7,5 cm r = 3,75 t = 8,5 cm Gelas B : D = 6,5 cm r = 3,25 t = 11,5 cm Ditanya : Paket yang dipih Jawab : Vgelas A = $\pi r^2 t$ = 3,14 x 3,75 x 3,75 x 8,5 = 3,14 x 140625 x 8,5 = 375,32 8125 Vgelas B = $\pi r^2 t$ = 3,14 x 3,25 x 3,25 x 11,5 = 3,14 x 10.5625 x 11,5 = 33 16625 x 11,5 = 381, 411875 Jadi paket gelas yang dipilih adalah paket B karena dapat lebih banyak.	Suppose: Glass A: D =7.5cm, r = 3.75cm, t = 8.5cm Glass B: D =6.5cm, r = 3.25cm, t = 11.5cm Problem: Package you prefer to? Answer: Volume glass A= $\pi r^2 t$ = 3.14X3.75X3.75X8.5 =3.14X14.6025X8.5 =375.328125 Volume glass B= $\pi r^2 t$ = 3.14X3.25X3.25X11.5 =3.14X10.5625X11.5 =33.16625x11.5 =381.411875 I prefer to buy package B because I will get larger beverage.

The exposure of S-2 data in solving PISA-like problems with the local context of Surakarta shows that S-2 has difficulty in implementing mathematization. The causative factor is that there is no information and demands from teachers to employ mathematization in problem-solving.

Exposure to S-3 Data: Subjects From the Moderate Groups

When solving the problem, S-3 commences by reading and understanding the contents of the PISA problem in the Surakarta context, then classifying out the information. This activity is apparent at the time the S-3 says, *"Glass A diameter 7.5 cm. Height 8.5 cm. 7.5÷2 is 3.75. Which package you'll choose."* S-3 proves that the S-3 has done I1. In addition to the think-aloud, the S-3 also communicates information and grasps the question into its answer sheet.

First, S-3 defines the volume of glass A by using the volume formula of a tube (I3). S-3 realized that the volume of glass A is 375.328125 cm3. S-3 adds a base, and the phi value = 3.14 because 3.75 cannot be divided by 7. S-3 determines the volume of glass B, which is 381.411875 cm3. There is a reason why S-3 chose the value phi = 3.14. The reason seems to be when S-3 says, "I use phi = 3.14 because If I use phi = $\frac{22}{7}$ I will have trouble dividing 3.75 by 7". In this case, the S-3 has done the I5. S-3 writes the formula and completes the calculation (I6). Next, the S-3 executes its conclusions from the answers obtained. That the S-3 preferred glass B because it contains more volume. Such behavior indicates that S-3 has performed (I4). Based on this description, S-3 does not do I2. This fact is strengthened from the following interview excerpt.

Researcher: Did you conduct a mathematize?

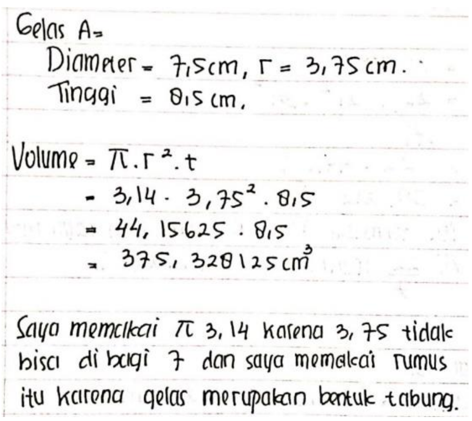
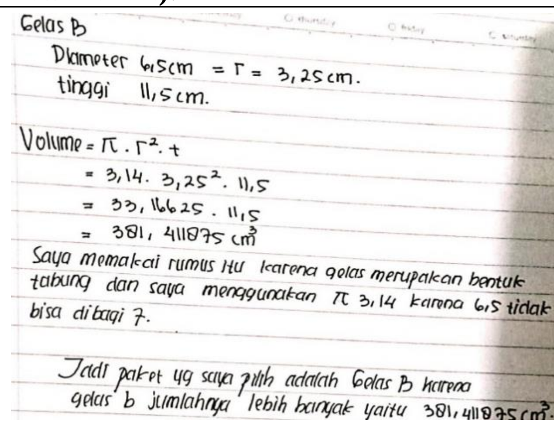
S-3: What is mathematization sir?

Researchers: Identify mathematical variables to be associated with problems in life.

S-3: I had a hard time doing it because we weren't trained to do it!

Figure 4 shows the S-3 answer sheet in PISA-like problem-solving in the local context of Surakarta.

FIGURE 4
ANSWER SHEET OF S-3

<table>
<tr><th colspan="2">Original version (Answer sheet):</th></tr>
<tr><td>
Gelas A=
Diameter = 7,5cm, r = 3,75 cm.
Tinggi = 8,5 cm,
Volume = π.r².t
= 3,14 · 3,75² . 8,5
= 44,15625 : 8,5
= 375, 328125 cm³
Saya memakai π 3,14 karena 3,75 tidak bisa di bagi 7 dan saya memakai rumus itu karena gelas merupakan bentuk tabung.</td><td>
Gelas B
Diameter 6,5cm = r = 3,25 cm.
tinggi 11,5 cm.
Volume = π . r² . t
= 3,14 . 3,25² . 11,5
= 33,16625 . 11,5
= 381, 411875 cm³
Saya memakai rumus itu karena gelas merupakan bentuk tabung dan saya menggunakan π 3,14 karena 6,5 tidak bisa dibagi 7.
Jadi paket yg saya pilih adalah Gelas B karena gelas b jumlahnya lebih banyak yaitu 381,411875 cm³.</td></tr>
<tr><th colspan="2">Translate version:</th></tr>
<tr><td>Glass A:
D =7.5cm, r = 3.75cm, t = 8.5cm
Volume = $\pi r^2 t$
= 3.14 x 3.75^2 X 8.5
= 44.15626 X 8.5
=375.328125 cm^3
I prefered to employ $\pi = 3.14$ because I face difficulties to devide 3.75 by 7. Besides, I employed the formula because the glass is a tube</td><td>Glass B:
D =6.5cm, r = 3.25cm, t = 11.5cm
Volume = $\pi r^2 t$
= 3.14 x 3.25^2 X 11.5
= 33.116625 X 11.5
=381.4111875 cm^3
I employed the formula because the glass is a tube. Besides I prefered to employ $= 3.14$ because I face difficulties to devide 6. 5 by 7.
So, I prefered to buy package B because the glass is bigger (381.4111875 cm^3)</td></tr>
</table>

Exposure to S-3 data as a student from the moderate groups shows that S-3 has difficulty implementing mathematical indicators. The reason is that teachers never train students to mathematize in problem-solving.

Exposure to S-4 Data: Subjects From the Moderate Groups

S-4 reads and understands the contents of Pisa problems in the Surakarta context, then sorts out the information that can be used (I1). As for the interview excerpts that show that the S-2 did I1, as follows.

Researcher: Do you understand the problem?

S-4: Yes, I know it by reading it carefully.

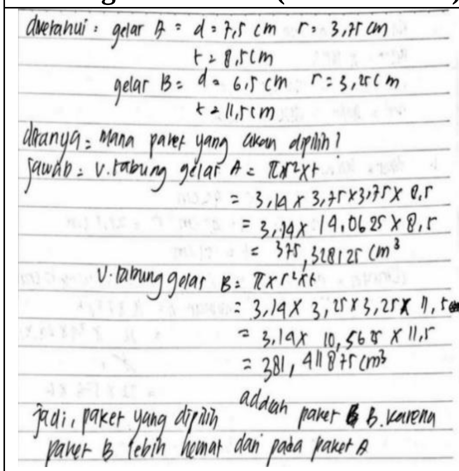
Researcher: Do you understand the problem?

S-4: There are two glass sizes. I had to choose a glass with a larger volume. Because the glass is tube-shaped, I use the formula of determining the volume of a tube, and then I compare the two.

The interview excerpt also shows that the S-4 represents by knowing that the concept that fits the problem is the volume formula of a tube (I3). After reading and understanding the problem commands, S-4 began writing the formula used and doing the calculation. In this case, the S-4 has conducted indicators to develop strategies to solve mathematical problems and indicators of choosing strategies to solve problems (I5). S-4 can determine the glass volume by writing the correct formula (I6), as presented in Figure 5.

Figure 5 shows the S-4 answer sheet in PISA-like problem-solving in the local context of Surakarta.

FIGURE 5
ANSWER SHEET OF S-4

<table>
<tr><th>Original Version (Answer sheet)</th><th>Translate Version:</th></tr>
<tr><td>
diketahui: gelas A = d = 7,5 cm r = 3,75 cm
t = 8,5 cm
gelas B = d = 6,5 cm r = 3,25 cm
t = 11,5 cm
ditanya: Mana paket yang akan dipilih?
Jawab: V. tabung gelas A = π×r²×t
= 3,14 × 3,75×3,75 × 8,5
= 3,14 × 14,0625 × 8,5
= 375,328125 cm³
V. tabung gelas B = π×r²×t
= 3,14 × 3,25×3,25 × 11,5
= 3,14 × 10,5625 × 11,5
= 381,411875 cm³
Jadi, paket yang dipilih adalah paket B b. karena
paket B lebih hemat dari pada paket A</td><td>Suppose: Glass A: D =7.5cm, r = 3.75cm, t = 8.5cm
Glass B: D =6.5cm, r = 3.25cm, t = 11.5cm
Problem: Package you prefer to?
Answer:
Volume tube/glass A= $\pi r^2 t$
= 3.14X3.75X3.75X8.5
=3.14X14.6025X8.5
=375.328125 cm^3
Volume tube/glass B= $\pi r^2 t$
= 3.14X3.25X3.25X11.5
=3.14X10.5625X11.5
=381.411875 cm^3
Because package B is more efficient than package A</td></tr>
</table>

The think-aloud transcription excerpt also shows that the S-4 had no difficulty in implementing I6. The transcription quote in question, *"The volume of a tube or glass A is equal to $\pi \times r^2 \times t$.... The volume of tube or glass B is equal to $\pi \times r^2 \times t$...."*. After calculating the volume of both glasses, S-2 performs a volume comparison between the two glasses. S-4 concludes the answer obtained. This behavior indicates that the S-4 has committed I4 without constraints. In problem-solving, S-4 has not performed I2. The results are obtained from the following interview excerpts.

Researcher: Are you doing mathematization?

S-4: I don't know what a mathematization pack is.

Researcher: It identifies mathematical variables associated with problems in life.

S-4: I apologize, sir. I Have no idea about that.

Researcher: Why?

S-4: I never did that, so I can't implement it.

Researcher: Can you explicitly state the causative factors?

S-4: I was never asked for it while studying math at school.

The exposure of S-4 data in solving PISA-like problems with the local context of Surakarta shows that S-4 has difficulty in implementing mathematization. The contributing factor is the absence of requests from teachers to employ mathematization in problem-solving. In other words, teachers do not apply mathematization in mathematics learning.

Exposure to S-5 Data: Subjects From the Low Groups

Figure 5 shows the S-4 answer sheet in PISA-like problem-solving in the local context of Surakarta. S-5 starts problem-solving by reading and understanding the contents of PISA problems in the Surakarta context, then sorting out the information. S-5 proves that the S-5 has done I1. In addition, the S-5 also writes information and commands from questions into its answer sheet. S-5 understands that the formula to be used is the volume formula of a tube (I3). The understanding of S-5 regarding the formula used is evident from the transcription of the following interview.

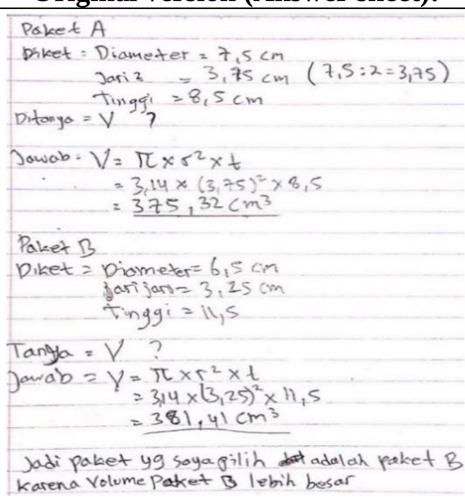
Researcher: Did you apply the formula to solve the error?

S-5: Yes, I use formulas $\pi r^2 t$.

Researcher: What is the formula?

S-5: I used the formula of determining the volume of the tube.

FIGURE 6
ANSWER SHEET OF S-5

Original version (Answer sheet):	**Translate version:**
 Paket A Diket : Diameter = 7,5 cm Jari 2 = 3,75 cm (7,5:2=3,75) Tinggi = 8,5 cm Ditanya = V ? Jawab : $V = \pi \times r^2 \times t$ $= 3,14 \times (3,75)^2 \times 8,5$ $= 375,32\ cm^3$ Paket B Diket = Diameter = 6,5 cm Jari jari = 3,25 cm Tinggi = 11,5 Tanya = V ? Jawab = $V = \pi \times r^2 \times t$ $= 3,14 \times (3,25)^2 \times 11,5$ $= 381,41\ cm^3$ Jadi paket yg saya pilih ~~dat~~ adalah paket B karena Volume Paket B lebih besar	Package A: Suppose: D =7.5cm, r = 3.75cm (7.5: 2 = 3.75), t = 8.5cm Problem: Volume Answer: V = $\pi r^2 t$ = 3.14 x $(3.75)^2$ X 8.5 =375.32 cm^3 Package B: Suppose: D =6.5cm, r = 3.25cm, t = 11.5cm Problem: Volume Answer: V = $\pi r^2 t$ = 3.14 x$(3.25)^2$ X 11.5 =381.41 cm^3 So, I preferred to buy package B because the glass is bigger

S-5 is reinforced when S-5 starts writing the procedure used and performing the calculation. In this case, the S-5 has done the I5. Formula writing and calculated operations performed also prove that S-5 has done I6. After completing the calculation, S-5 concludes the answer obtained. Such behavior indicates that the S-5 has committed I4. S-5 writes the conclusion of the solution it gets into the answer sheet. In the case of concluding, it also appears from the transcription, "Means the package I chose is package B because the volume of package B is greater." However, the S-5 has not been able to dig deeper into the indicators following the problems. In solving the PISA-like problem with the local context of Surakarta, S-5 did not conduct mathematization. It is because the S-5 does not understand what mathematization means and how to implement it. Supporting interview excerpts are as follows.

Researcher: Are you doing mathematization?

S-5: I don't understand mathematization

Researcher: Mathematization is Identifies the variables and mathematical structures underlying them in real-life problems

S-5: I don't understand the meaning of mathematization and how to do it

Exposure to S-6 Data: Subjects From the Low Groups

Figure 7 shows the S-6 answer sheet in PISA-like problem-solving in the local context of Surakarta. After reading and understanding the problem commands by reading the problem more than once (I1), S-6 begins to write down the formula used and perform the calculation (I5). The strategy is to determine the volume of glasses A and B, then compare the two. The transcript of the interview in favor is presented as follows.

Researcher: Do you understand the problem?

S-6: Yes, I know.

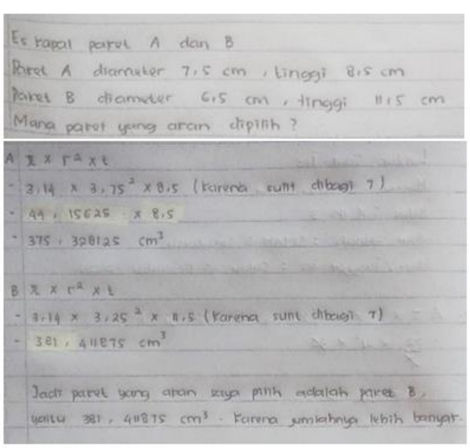
Researcher: How do you know the problem?

S-6: I read the problem about three times just understood.

Researcher: What do you know?

S-6: I know that the glass is tube-shaped. So I determined the volume of both glasses by employing the formula of determining the volume of the tube.

FIGURE 7
ANSWER SHEET OF S-6

Original Version (Answer sheet)	Translate Version:
 Es kapal paket A dan B Paket A diameter 7,5 cm, tinggi 8,5 cm Paket B diameter 6,5 cm, tinggi 11,5 cm Mana paket yang akan dipilih ? A $\pi \times r^2 \times t$ = 3,14 x 3,75^2 x 8,5 (karena sulit dibagi 7) = 44,15625 x 8,5 = 375,328125 cm^3 B $\pi \times r^2 \times t$ = 3,14 x 3,25^2 x 11,5 (karena sulit dibagi 7) = 381,41875 cm^3 Jadi paket yang akan saya pilih adalah paket B, yaitu 381,41875 cm^3. Karena jumlahnya lebih banyak.	Ice Kapal Package A and B Package A: D=7.5cm, t=8.5cm Package B: D=6.5cm, t=11.5cm Which package you prefer to buy? A = $\pi\ x\ r^2\ x\ t$ = 3.14x3.75^{2}x8.5 (it is hard devide by 7) =44.15625x8.5 =375.328125 B = $\pi\ x\ r^2\ x\ t$ = 3.14x3.25^{2}x11.5 (it is hard devide by 7) =381.44875 So, I prefer to buy package B with volume is 381.411875 because it is larger.

The quote shows that the S-6 understood that the drink was shaped like a tube (I3). On the answer sheet, it appears that the S-6 writes the formula for determining the volume of the tube without constraints (I6). In implementing I4, the S-6 had no difficulties, for example, in selecting phi values, calculating, and drawing conclusions. In addition to the answer sheet, the implementation of I4 is supported from the following think-aloud excerpt, *"I did not choose the value phi = 22/7 because I would have trouble dividing 3.75 by 7..... I didn't choose phi value = 22/7 because I would have trouble dividing 3.25 by 7.............. It appears that the volume of glass B is greater than the volume of glass A. So, I chose to buy package B because I got a bigger drink"*. In problem-solving, S-6 does not implement I2. It is discovered during an in-depth interview. The interview excerpts as follows.

Researcher: Did you do mathematization?

S-6*: Is mathematization the same as doing algebraic calculations, sir?*

Researcher: No. It is Identifies the variables and mathematical structures underlying them in real-life problems.

S-6*: Sorry, sir, I didn't make that identification.*

Researcher: Why?

S-6*: I don't know how to do the mathematization you're referring to.*

Researcher: Can you say another base?

S-6*: I've never heard what mathematization is, so I can't implement it when solving mathematical problems. In addition, the teacher did not introduce and encouraged me to do so.*

During problem-solving the PISA-like problem, S-6 had difficulty in implementing mathematization. The factor that causes this is that students do not know about mathematization.

The results showed that students did not experience any obstacles in implementing communication, representation, reasoning, selecting strategies, and using symbols. The difficulty experienced is in implementing mathematization. The interview said that they did not understand what mathematization is and how to do it. They have no experience in implementing because their teachers do not urge them to solve mathematical problems.

DISCUSSIONS

On communication indicators, learners can read, translate, and make statements, questions, objects, or images to form a model of the existing situation. The use of the local context of Surakarta is intended for researchers to know the extent of understanding the subject when faced with realistic mathematical problems. In addition, the use of mathematical models based on ethnomathematics and local culture can prove that there is a link between mathematics and daily life (Imswatama & Lukman, 2018). All subjects have made communication indicators. This statement is supported by writing information into the answer sheet and through the process of think-aloud and interviews. Students can conduct communication indicators through their understanding of problems related to their surroundings. The results of this study are relevant to the research of Widada et al. (2018), which concluded that the average understanding of learners who were given ethnomathematics oriented problems was higher than that of students who were given non-ethnomathematics problems. Therefore, contextual questioning that associates local context needs to be applied.

In the mathematization indicator, learners identify the underlying mathematical variables and structures and make assumptions to be employed. The mathematical process intended in the PISA 2003 Assessment Framework is that problems that exist from the real world are brought into the mathematical context to be solved. The results obtained are returned to the original context. The mathematical problems in this study use semantic structures, which prioritize linguistic elements in the form of words, phrases, and others as a pointer to certain calculation operations on the story. In this study, there is no subjects were able to perform mathematical indicators. This statement is supported by research conducted by Wardono & Mariani (2019). Mathematization is an essential indicator because it is a fundamental process in solving mathematical literacy problems. On the representation indicator, learners make representations of the real-world information they have obtained. NCTM developed representation standards for learning plans from preschool to grade XII. This standard allows learners to (a) create and use representations to organize, record, and convey their mathematical ideas, (b) select, implement, and use conversions between mathematical representations during problem-solving; and (c) use representations when modelling and interpreting physical, social, and mathematical events. Based on the interview data caused the teacher did not encourage students to do mathematization. They don't have any knowledge of what mathematization is and how it's advanced in mathematical problem-solving. Various efforts can be made to encourage students to implement mathematization, for example, through defragmenting methods. It is the changes in thinking structure caused by some interventions (Subanji, 2016; Wibawa et al., 2020). Subanji (2016) also asserts that the planned defragmentation can provide a cognitive conflict by comparing prior experience with the new problems or providing scaffolding in problem-solving. Both are based on the students' errors. The restructure of thinking behaviour is another term used to denote defragmentation. Indraswari (2012) encourages individuals to seek alternative thinking methods when the existing one does not work. It means we need some efforts to improve the errors by restructuring the thinking behaviour.

The results of the data analysis obtained that all subjects were able to perform representation indicators. All subjects can represent the information they get into a mathematical form of expression. They write general information, then continued using calculated formulas. The results are in line with research conducted by Santia, Purwanto, Sutawidjaja, Sudirman, & Subanji (2019) and Hijriani et al. (2018)on the ability of mathematical representation of learners when solving PISA problems using two representation indicators symbolic representation (equation or mathematical expression). Intended symbolic representations have operational forms, such as (a) creating mathematical equations or expressions from existing data or information and (b) using mathematical equations or expressions to solve a problem.

On reasoning and opinion indicators, learners explain, maintain, or justify identifying or composing representations of the real world. Herbert, Vale, Bragg, Loong, & Widjaja (2015) defines mathematical reasoning as reasoning that uses mathematical objects to reason or draw conclusions or make correct new statements based on several reports that have been proven or assumed before. Besides, problem-solvers are willing to correct their mistakes (Kholid et al., 2022). All subjects were able to perform reasoning and opinion indicators well. This statement is supported by reasoning that is implemented on how to solve mathematical problems and the opinions given both through the answer sheet and orally during the interview. These results conform to some standards of the NCTM 2000 process in mathematical reasoning, such as drawing logical conclusions; explain models, facts, relationships, or patterns; estimating solutions and strategies; develop valid opinions. Reasoning and opinion indicators can help learners reflect on the solutions they obtain, meaning that students can also interpret the solutions obtained from existing problems in addition to finding answers (Fatahillah et al., 2020; Tawfik & Kolodner, 2016).

On indicators choosing strategies to solve problems, learners choose or create a plan or strategy to rearrange contextual issues mathematically. This ability appears in all subjects. Therefore, students understand the math problems given then determine the approach to solve them. This result is relevant to the effects of research conducted by Rawani et al. (2019) that the ability to design problem-solving strategies arises in using various procedures when solving problems that lead to conclusions.

On language indicators and symbolic, formal, and technical operations, learners use appropriate variables, symbols, diagrams, and standard models to represent real-world problems using figurative/formal language. Overall, all subjects were able to perform this indicator. This effort is proved by the selection of formulas that correspond to the math problem. However, converting units to other units or writing down companies is still not optimal. According to research conducted by Tambychik & Meerah (2010), the lack of adequate language skills, information skills, and mastery of fact-of-fact skills will hinder the problem-solving process. These shortcomings lead to uncertainty, confusion, and inaccuracies in decision-making that ultimately lead to mistakes. Repeated PISA-type exercises will improve students' abilities.

CONCLUSION, IMPLICATION, AND LIMITATION

The study concluded that students from the proficient, moderate, and low groups had difficulty in implementing mathematization. The factor that causes this is that so far, teachers do not encourage students to do mathematization. They don't have any knowledge of what mathematization is and how it's advanced in mathematical problem-solving. The efforts that teachers can make so that students can do mathematization are through defragmenting methods. It is the changes in thinking structure caused by some interventions. Subanji (2016) also asserts that the planned defragmentation can provide a cognitive conflict by comparing prior experience with the new problems or providing scaffolding in problem-solving. Both are based on the students' errors. Further research can focus on defragmenting methods, which are efforts to start with students to implement socialization in problem-solving according to the difficulties face. Research is limited to the local context of Surakarta. Thus, the limitation is the possibility of different research results if the study uses other PISA-like problems.

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