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Numeracy Literacy Skills of Vocational School Students at NU Sunan Ampel Poncolkusumo in Solving PISA and TIMSS Problems

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Abstract

Students must possess numeracy as a basic skill. Numeracy questions are developed from PISA and TIMSS questions. This study aims to describe students' level of numeracy literacy when solving questions adapted from PISA and TIMSS. This descriptive qualitative study was conducted on 25 students in the 11th grade of TKJ FO at SMK NU Sunan Ampel Poncokusumo. Three students were selected as research subjects based on high, moderate, and low numeracy literacy categories. Data were collected through tests and interviews. The students were given three PISA and three TIMSS test questions aligned with numeracy literacy indicators: applying, interpreting, and analyzing. The results showed that students in each ability category performed differently on the numeracy literacy indicators. Students in the low and medium categories only met the analyzing indicator when answering PISA questions. Meanwhile, students in the low category were able to meet the applying and interpreting indicators on TIMSS questions, but not the analyzing indicator. Students in the medium category could meet the interpreting and analyzing indicators on TIMSS questions but not the applying indicator. Conversely, students in the high category met all numeracy literacy indicators when completing PISA and TIMSS questions.

Keywords: Numeracy, Literacy, PISA, TIMSS

Abstrak

Siswa harus memiliki numerasi sebagai keterampilan dasar. Soal numerasi dikembangkan dari beberapa soal dalam PISA dan TIMSS. Penelitian ini bertujuan untuk menggambarkan tingkat literasi numerasi siswa dalam menyelesaikan soal yang diadaptasi dari PISA dan TIMSS. Penelitian kualitatif deskriptif ini dilakukan pada 25 siswa kelas XI TKJ FO di SMK NU Sunan Ampel Poncokusumo. Subjek penelitian dipilih 3 siswa berdasarkan kategori literasi numerasi tinggi, sedang, dan rendah. Pengumpulan data menggunakan tes dan wawancara. Terdapat 3 soal tes PISA dan 3 soal tes TIMSS yang sesuai dengan indikator literasi numerasi, yaitu menerapkan, menafsirkan, dan menganalisis. Hasil menunjukkan bahwa siswa dari setiap kategori kemampuan memiliki kinerja yang berbeda pada indikator literasi numerasi. Siswa dalam kategori rendah dan menengah hanya mampu memenuhi indikator menganalisis saat menyelesaikan soal PISA. Sementara itu, pada soal TIMSS, siswa kategori rendah mampu memenuhi indikator menerapkan dan menafsirkan, tetapi belum mencapai indikator menganalisis. Siswa kategori menengah mampu memenuhi kedua indikator menafsirkan dan menganalisis saat menyelesaikan soal TIMSS, tetapi tidak mampu memenuhi indikator menerapkan. Sebaliknya, siswa kategori tinggi mampu memenuhi semua indikator literasi numerasi saat mengerjakan soal PISA dan TIMSS.

Kata kunci: Literasi Numerasi, PISA, TIMSS

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Introduction

In the 21st century, improving the quality of education requires students to master several skills. Quality education plays an important role in a country's progress (Anggraini, 2021; Munasiah et al., 2020). Throughout the twelve-year educational process from elementary to high school, students study many subjects, including mathematics. However, many students perceive mathematics as a complex and confusing subject. Consequently, it is often neglected (Anggraini, 2021; Puka et al., 2021). et, mathematics is highly important because it is essential to all fields of knowledge (Setiawati et al., 2024). These perceptions lead to mathematics being less favored. Consequently, the learning objectives are not always achieved (Chisara et al., 2018).

Students' mathematical abilities must be continuously developed and improved. To achieve this, learning should focus not only on memorization and problem solving, but also on students' ability to understand and solve problems creatively and critically (Mustofa, 2020). In the 21st century, three main competencies have emerged: quality character, competence, and literacy (Ate & Lede, 2022). Basic forms of literacy that serve as a foundation for overcoming the challenges of this era include numeracy, digital literacy, language literacy, scientific literacy, financial literacy, and civic and cultural literacy (Ate & Lede, 2022; Diva et al., 2022). Among these types of literacy, numeracy has a strong connection to logical thinking and reasoning (Ate & Lede, 2022).

Numeracy literacy is central to learning mathematics (Rosidi et al., 2022). Therefore, the mathematics learning process is also expected to improve students' ability to solve contextual problems (Alfarisi et al., 2023). Literacy and numeracy are closely related: literacy is associated with language comprehension, and numeracy is associated with mathematical proficiency. Numeracy is defined as an individual's ability to apply mathematical concepts and basic calculation skills to solve everyday problems (Andrianti & Rahayu, 2022; Rosidi et al., 2022). This ability is often encountered in daily situations, such as conducting sales transactions or calculating distances or land areas (Baharuddin et al., 2021). In the context of numeracy, students must be able to think creatively and use mathematical ideas to solve problems (Alfarisi et al., 2023). However, conditions in the field show that these expectations have not been fully achieved.

According to PISA data, Indonesia ranks 74th out of 79 participating countries (OECD, 2019). his finding indicates that Indonesian students' numeracy literacy skills are relatively low. Their average scores are below the global averages of 371 for reading, 379 for mathematics, and 396 for science (Andrianti & Rahayu, 2022). These results place Indonesia among the countries with low student numeracy literacy levels (Kaka et al., 2021). One of the main causes of students' difficulties in solving mathematical problems is a lack of experience with questions in the PISA test format (Saputra et al., 2023). Additionally, students' lack of experience with questions in the PISA test format contributes to these low results (Ate & Lede, 2022). The results of the PISA and TIMSS assessments therefore indicate striking differences in numeracy literacy levels among students (Diva et al., 2022).

Based on interviews with teachers at SMK NU Sunan Ampel Poncokusumo in Malang Regency, it was found that students are rarely given math exercises containing real-world contexts that hone advanced thinking skills. Most of the exercises come from textbooks and conventional workbooks that are not fully aligned with the AKM question model. Consequently, students often have difficulty solving these problems.

Improving students' numeracy literacy requires strong mathematical thinking skills when dealing with diverse problems (Andrianti & Rahayu, 2022). The AKM measures two basic competencies: reading and numeracy literacy (Purwanto, 2021). Since 2021, numeracy literacy has been part of the AKM, replacing the National Examination (UN) (Mustofa, 2020). Additionally, numeracy literacy is important for preparing to face 21st-century challenges because it is related to daily life (Khamidah & Azizah, 2022). AKM uses numeracy literacy to identify and measure students' contextual problem-solving abilities (Diva et al., 2022). AKM questions are developed from problems in the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) tests (Rohmah et al., 2022).

Tests such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) can be used to assess students' numeracy literacy levels internationally (Ate & Lede, 2022). The OECD (Organisation for Economic Co-operation and Development) organizations TIMSS and PISA have developed six levels of numeracy literacy (Rosidi et al., 2022). PISA has six levels of numeracy literacy: Levels 1 and 2 include low-level questions; Levels 3 and 4, medium-level; and Levels 5 and 6, high-level (Rosidi et al., 2022). TIMSS consists of two domains: the content domain, which covers numbers, algebra, geometry, data, and probability, and

the cognitive domain, which covers knowledge, application, and reasoning in accordance with each country's curriculum (Alfarisi et al., 2023).

Various studies have examined students' numeracy literacy skills in solving math problems. Some of these studies focus on students' ability to solve Minimum Competency Assessment (AKM) questions (Andrianti & Rahayu, 2022), while others analyze students' numeracy literacy using TIMSS test items as a reference (Alfarisi et al., 2023). Additionally, some studies examine students' ability to solve Program for International Student Assessment (PISA)-based questions (Rosidi et al., 2022). This study aims to describe vocational high school students' numeracy literacy skills by having them complete questions based on the PISA and TIMSS models.

The results of this study suggest improving the quality of mathematics education in vocational schools by integrating contextual numeracy questions similar to those in the PISA and TIMSS models. Teachers must be empowered to develop and implement questions that emphasize applying, interpreting, and analyzing information so students become accustomed to questions based on real-world problem-solving. The curriculum must also be adjusted to encourage higher-order thinking skills. Additionally, these findings can inform school or education department policies for developing more relevant and practical numeracy literacy enhancement programs and serve as a reference for further research with a more diverse contextual approach.

Method

This study employs a descriptive qualitative approach. The research was conducted at SMK NU Sunan Ampel Poncokusumo during the odd semester of the 2023-2024 academic year. The data sources for this study were 25 students from 11th grade at SMK NU Sunan Ampel Poncokusumo. Six students were selected to represent each category of numeracy literacy ability: high, medium, and low.

Data were collected using written tests and interviews. There were six questions, consisting of three PISA questions and three TIMSS questions. Each question corresponded to a level and cognitive domain, aligning with the indicators of numeracy literacy ability. Numeracy literacy tests derived from PISA and TIMSS questions were used to assess students' abilities. Interviews were conducted to gather more comprehensive information about how the students answered the questions.

Based on these answers, scores were calculated and students were categorized. The categorization guidelines used are from (Nurutami, Riyadi, & Subanti, 2018) as shown in Table 1.

Table 1. Numeracy Literacy Ability Categories

Score (S)	Category
$S \geq 85$	High
$70 \leq S < 85$	Moderate
$S < 70$	Low

Based on the categorization results, two subjects were selected from each category, resulting in a total of six research subjects. The test data were analyzed based on indicators. There are three indicators of numeracy literacy ability, as shown in Table 2. (Ate & Lede, 2022).

Table 2. Numeracy Literacy Ability Indicators

No	Indicator	Description
1	Apply	Students can apply basic number concepts and mathematical notation to real-life problems.
2	Interpret	Students can interpret calculation results and use them for decision-making.

3	Analyze	Students can analyze quantitative information in the form of graphs, tables, charts, or diagrams.

The data analysis technique used in this study was the interactive analysis model developed by Miles and Huberman, which consists of three main stages: data reduction, data presentation, and conclusion drawing. In the data reduction stage, the researcher filtered the test and interview data from six subjects based on their numeracy literacy ability categories (high, medium, and low), then classified them according to three numeracy literacy indicators: applying, interpreting, and analyzing. Next, in the data presentation stage, the information was systematically organized in the form of qualitative narratives and supported by quotations from the subjects' answers and interview results. The data was also presented in tabular form to facilitate the identification of indicator achievements by each subject. The final stage is drawing conclusions and verification. The researcher concludes patterns of student achievement based on ability categories and fulfilled indicators, and performs triangulation between test data and interview results to ensure data validity.

Result and Discussion

The results of student categorization based on their written answers are presented in Table 3.

Table 3. Results of Student Numeracy, Literacy, and Ability Categorization

No	Numeracy Literacy Ability Category	Percentage
1	High	2%
2	Moderate	22%
3	Low	44%

Based on Table 3, most students have low numeracy and literacy abilities (44%). Only 22% of students have moderate numeracy literacy abilities. Only 2% of students are able to achieve the high category. Overall, this indicates that students' abilities to solve PISA and TIMSS questions are still suboptimal. Similarly, research findings (Khamidah & Azizah, 2022) indicate that only 12.9% of students fall into the high category.

Low Ability Category

Based on Table 3, 44% of students have low numeracy literacy skills, meaning many students' skills are suboptimal. This finding is similar to that of (Rahayu, Mulyono, & Cahyono, 2019) who also stated that students' numeracy literacy skills in Indonesia are still relatively low. The following is a presentation of the answers of students in the low category for each indicator.

Application Indicator

In the application indicator, students must be able to apply various basic mathematical numbers and symbols in solving everyday mathematical problems. The subject selected in the low category is EI. The following is a snippet of subject EI's answer in solving PISA question number 1, shown in Figure 1.

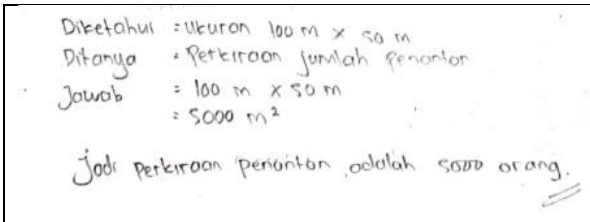
	Given: size 100m x 50m Question: estimated number of spectators Answer: 100m x 50m = 5000 m^2 so the estimated number of spectators is 5000 people

Figure 1. Subject EI's Answer to PISA Question No. 1

Based on Figure 1, subject EI wrote the answer by calculating the area of the field without considering how much space each person needs. Subject EI did not estimate the space required for each person, so the final answer written was still inaccurate.

Based on the interview, the EI subject stated that they did not calculate the space required for each person because they did not think of it. The EI subject only focused on finding the total area of the field. Based on the answer and interview results, the EI subject was unable to apply what they knew from the question to solve the problem correctly, thus failing to meet the application indicator.

In the TIMSS question, the EI subject was able to solve the problem correctly. The following is a snippet of the EI subject's answer in solving the TIMSS question, shown in Figure 2.

1 wadah = 2 kg 3 wadah = 4 kg $\frac{1 \text{ wadah}}{2 \text{ kg}} = \frac{3 \text{ wadah}}{4 \text{ kg}} = \frac{1 \text{ wadah} \ (3 \text{ wadah} \times 2 \text{kg})}{4 \text{ kg}}$ $= \frac{6 \text{ kg}}{4 \text{ kg}}$ $= 1{,}5 \text{ kg}$	1 container = 2kg 3 containers = 4kg $\frac{1 \ container}{2kg} = \frac{3 \ containers}{4 \ kg}$ $= \frac{1 \ container \ (3 \ containers \ \times 2kg)}{4kg}$ $= \frac{6kg}{4kg}$ $= 1{,}5 \ kg$

Figure 2. EI Subject's Answer to TIMSS Question No. 1

Based on Figure 2, the EI subject wrote the correct answer. The strategy used by the EI subject was to use the comparison method, so the EI subject found the final result to be 1.5 kg. The EI subject compared each container of peanuts with its weight, resulting in 1.5 kg.

Based on the interview, the EI subject stated that the steps used were based on what they understood from the question. Subject EI explained that they first calculated the total weight for the three containers, then divided it by the known weight. Subject EI was very confident in the answer they wrote. Based on the answer and interview results, subject EI was able to apply what they knew from the question to solve the problem correctly, thus meeting the indicator for application.

Interpreting Indicators

In interpreting indicators, students must be able to interpret calculation results and use them for decision making. The following is an excerpt from the EI subject's answer to PISA question number 2, shown in Figure 3.

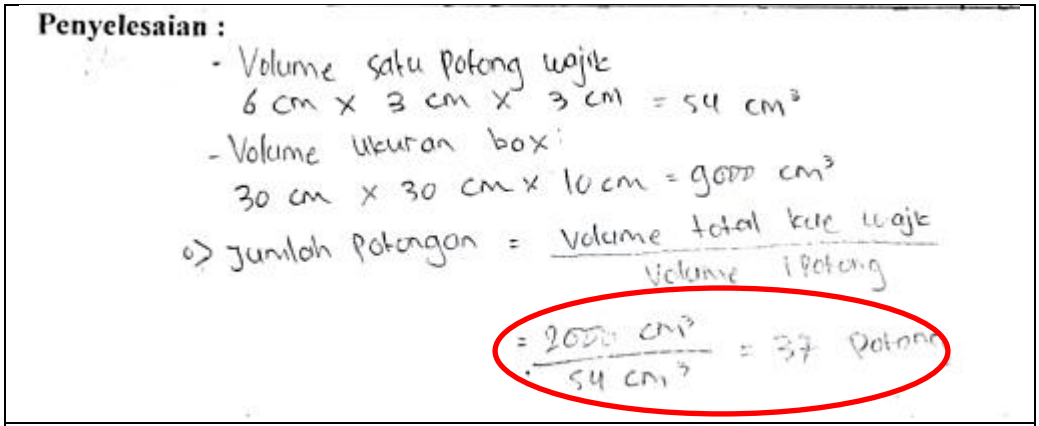
Penyelesaian : kue apem berdiameter 10 cm lebih murah karena, kue apem 10 cm → $\frac{2000}{10}$ = 200 rupiah/cm kue apem 12 cm → $\frac{2.500}{12}$ = 208 rupiah/cm
Solution: A 10 cm diameter apem cake is cheaper because, a 10 cm apem cake = $\frac{2000}{10} = 200$ rupiah/cm a 12 cm apem cake = $\frac{2500}{12} = 208$ rupiah/cm

Figure 3. EI Subject's Answer to PISA Question No. 2

Based on Figure 3, it is evident that the EI subject solved the problem by finding the price of each apem cake with a diameter of 10 cm and 12 cm. However, the strategy used by the EI subject was not appropriate, as they only divided the price by the diameter length without finding the area of each apem cake. Due to the incorrect strategy and calculations, this resulted in the final decision made by the EI subject being less accurate.

Based on the interview, the EI subject stated that they did not know they had to divide by the area of each apem cake. The EI subject also explained that they did not know the formula for the area of a circle, so they could not write the answer accurately. According to them, the answer they wrote was correct, even though it was still less accurate. Regarding the interpretation indicator, most students were unable to interpret the information obtained from the questions to find the correct solution (Kaka et al., 2021). Based on the answers and interviews, the EI subject was unable to interpret the calculation results and use them to make the correct decision, thus failing to meet the interpretation indicator.

In the TIMSS question, the EI subject was able to solve the given problem correctly. The following is a excerpt of the EI subject's answer in solving TIMSS question number 2, shown in Figure 4.



Solution:

Volume of one piece of wajik

$$6\ cm \times 3cm \times 3cm = 54cm^3$$

Volume of the box

$$30cm \times 30cm \times 10cm = 9000cm^3$$

$$\text{Number of pieces} = \frac{\text{total volume of wajik cake}}{\text{volume of 1 piece}}$$

$$= \frac{2000cm^3}{54cm^3} = 37 \text{ pieces}$$

Figure 4. Subject EI's Answer to TIMSS Question No. 2

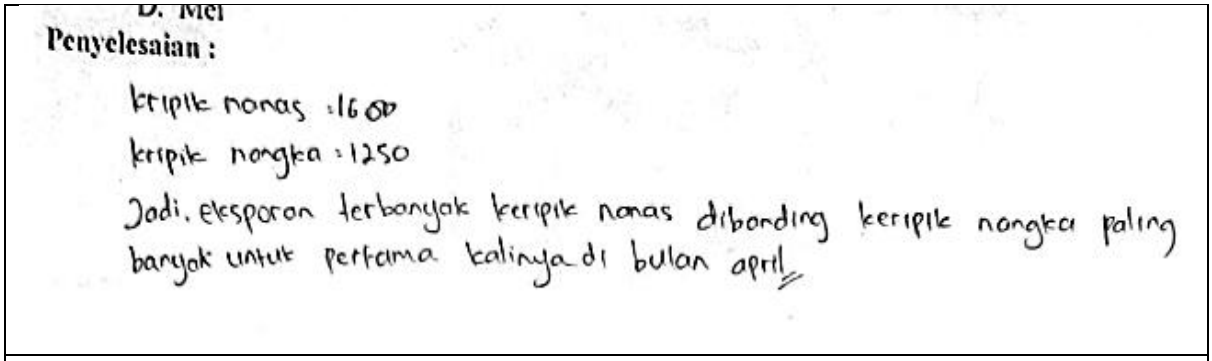
Based on Figure4, it can be seen that the subject EI was unable to write the correct answer to the problem given. The subject EI made a mistake in the calculation process, so the final result written was not accurate. The strategy used by the subject EI was correct, namely by first finding the volume of the diamond-shaped cake and then finding the volume of the box used. After finding all the volumes, to determine the number of wajik cakes that can be placed in the box, the EI subject divides the volume of the box by the volume of the wajik cake. However, the EI subject made a calculation error in the division process. The correct division should be 9000 ∶ 54, but the EI subject wrote 2000 ∶ 54. As a result, the final result obtained was incorrect.

Based on the interview, the EI subject stated that they were unaware of writing 2000 ∶ 54 instead of 9000 ∶ 54. After being asked again, the EI subject realized that there was an error in the calculation process. This was because the EI subject was not careful enough in performing the

calculation process. Subject EI also explained that they fully understood what the question meant and did not find it difficult to solve. Based on the answers and interview, subject EI was able to interpret the calculation results and use them for decision-making correctly, thus meeting the interpretation indicator.

Analytical Indicators

In analytical indicators, students must be able to analyze various information presented in the form of graphs, charts, diagrams, and tables. The following is an excerpt from the EI subject's answer to PISA question number 3, shown in Figure 5.



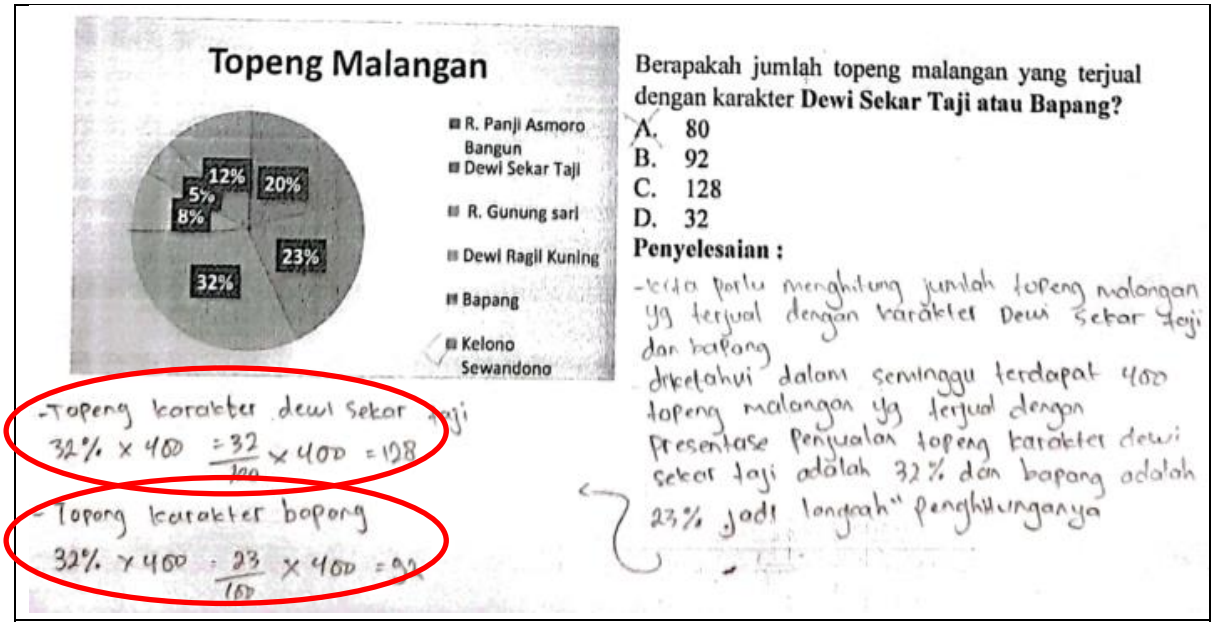
Solution:
pineapple chips = 1600
jackfruit chips = 1250
Therefore, pineapple chips were exported more than jackfruit chips for the first time in April.

Figure 5. EI Subject's Answer to PISA Question No. 3

Based on Figure 5, it is evident that the EI subject was able to solve the given problem correctly. The EI subject was able to read and understand the graph provided to solve the problem accurately. The EI subject first wrote down the number of pineapple chips and jackfruit chips as initial comparison data. Then, based on the information that had been understood and written down, the EI subject was able to write the correct answer, namely that in April, pineapple chips were exported more than jackfruit chips.

Based on the interview conducted, the EI subject stated that they could understand the graph provided, so they could write the answer correctly. The EI subject also stated that they did not find it difficult to understand the various information presented in the form of the graph. Based on the answers and interview results, the EI subject could analyze the information presented in the graph correctly, thus meeting the analysis indicator.

In the TIMSS question, subject EI has not been able to solve the given problem correctly. The following is an excerpt from subject EI's answer in solving TIMSS question number 3 shown in figure 6 below.



We need to calculate the number of Malangan masks sold featuring the characters Dewi Sekar Taji and Bapang.
It is known that in one week, 400 Malangan masks were sold, with the sales percentage for the Dewi Sekar Taji character mask being 32% and the Bapang character mask being 23%.
So, the calculation steps are:
Masks with the Dewi Sekar Taji character

$$32\% \times 400 = \frac{32}{100} \times 400 = 128$$

Masks with the Bapang character

$$23\% \times 400 = \frac{23}{100} \times 400 = 92$$

Figure 6. Subject EI's Answer to TIMSS Question No. 3

Based on figure 6, subject EI has not been able to solve the given problem correctly. Subject EI made a mistake in reading and understanding the diagram given to solve the problem. The subject wrote that the percentage of the Dewi Sekartaji mask sold was 32%, when in fact it should be 23%. Then subject EI also wrote that the percentage of the Bapang mask sold was 23%, when in fact the correct one was 5%. This error made subject EI less precise in calculating and writing the final answer.

Based on the interview, subject EI said that he realized that he had read the given diagram incorrectly. Subject EI was not careful in seeing the color of the information in the diagram and the percentage amount. When asked to rework according to the correct percentage, subject EI was also not able to write his answer correctly, because there were still some calculation errors. This means that the EI subject has not been able to understand the meaning of the question and because of his inaccuracy, it causes errors in writing the answer. As in the study (Ate & Lede, 2022) the majority of students have not been able to read and understand the date through the diagram correctly. Based on the results of the answers and interviews, the EI subject has not been able to analyze various information displayed in the form of diagrams correctly, so he has not been able to meet the analysis indicator.

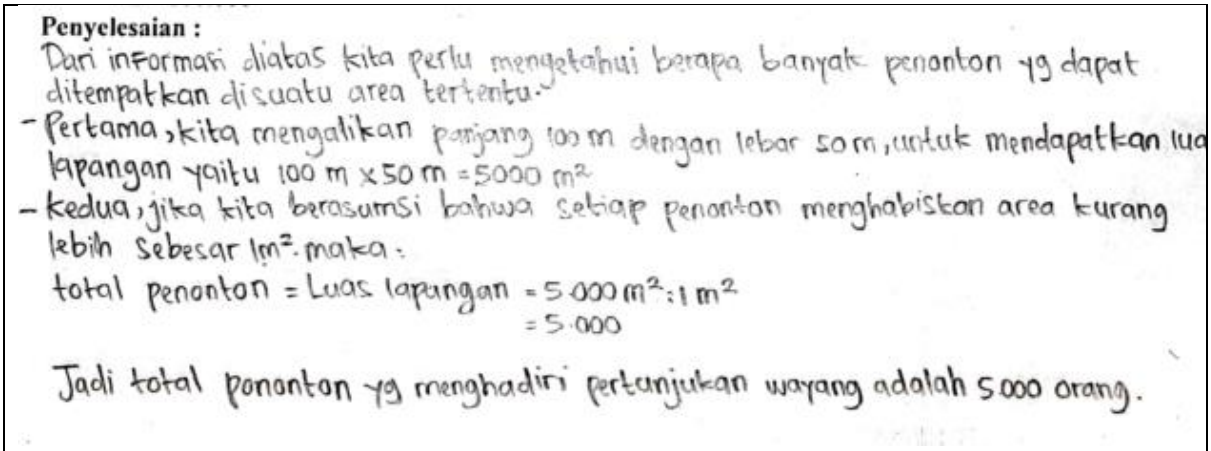
Moderate Ability Category

Based on Table 3, the percentage of students' numeracy literacy abilities in the moderate category is 22%, meaning that there are still students whose numeracy literacy abilities are not optimal.

The following is a presentation of the results of the answers of students in the moderate category for each indicator.

Applying Indicator

In the applying indicator, students must be able to apply various numbers and basic mathematical symbols in solving everyday mathematical problems. The subject selected in the moderate category is DA. The following is an excerpt from the results of the DA subject's answers in solving PISA question number 1 shown in Figure 7.



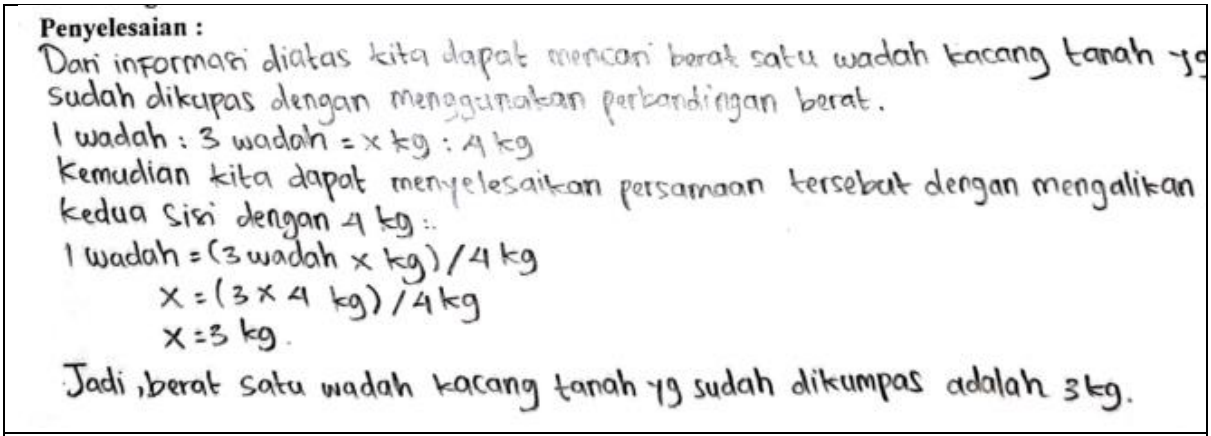
Solution:
From the information above, we need to know how many spectators can be accommodated in a certain area
First, we multiply the length of 100m by the width of 50m to obtain the area of the field, which is 100m x 50m = 5000m^2
Second, if we assume that each spectator occupies an area of approximately 1m, then:
Total spectators = area of the field = 5000m^2 : 1m^2 = 5000
Therefore, the total number of spectators attending the wayang performance is 5,000 people.

Figure 7. Subject DA's Answer to PISA Question No. 1

Based on Figure 7, Subject DA wrote several steps in determining the number of people who fit in the field. The first step written by Subject DA was to find the area of the field, which is $100 \times 50 = 5000$ m^2. Then Subject DA assumed that one person needs an area of 1m^2, so that the total number of spectators in the field is the same as the area of the field, which is 5000 m^2. In fact, an area of 1m^2 can actually accommodate more than one person.

Based on the interview, Subject DA said that it was assumed that 1 person needed an area of 1m^2. Subject DA also did not think that 1m^2 could be occupied by more than 1 person. Subject DA focused on finding the total area of the field. Based on the results of the answers and interviews, Subject DA has not been able to apply what is known from the questions to solve the problem correctly, so he has not been able to meet the indicator of applying.

In the TIMSS question, Subject DA has not been able to solve the given problem correctly. The following is an excerpt from Subject DA's answer results in solving the TIMSS question shown in Figure 8.


Penyelesaian :
Dari informasi diatas kita dapat mencari berat satu wadah kacang tanah yg sudah dikupas dengan menggunakan perbandingan berat.
1 wadah : 3 wadah = x kg : 4 kg
Kemudian kita dapat menyelesaikan persamaan tersebut dengan mengalikan kedua sisi dengan 4 kg :
1 wadah = (3 wadah x kg) / 4 kg
x = (3 x 4 kg) / 4 kg
x = 3 kg.
Jadi, berat satu wadah kacang tanah yg sudah dikumpas adalah 3 kg.

Solution:
From the information above, we can find the weight of one container of shelled peanuts using the weight ratio.

$$\frac{1\ container}{3\ containers} = \frac{x\ kg}{4\ kg}$$

Then we can solve the equation by multiplying both sides by 4 kg.

$$1\ container = \frac{3\ containers\ \times x\ kg}{4\ kg}$$

$$x = \frac{3 \times 4kg}{4kg}$$

$$x\ =\ 3\ kg$$

Therefore, the weight of one container of peeled peanuts is 3 kg.

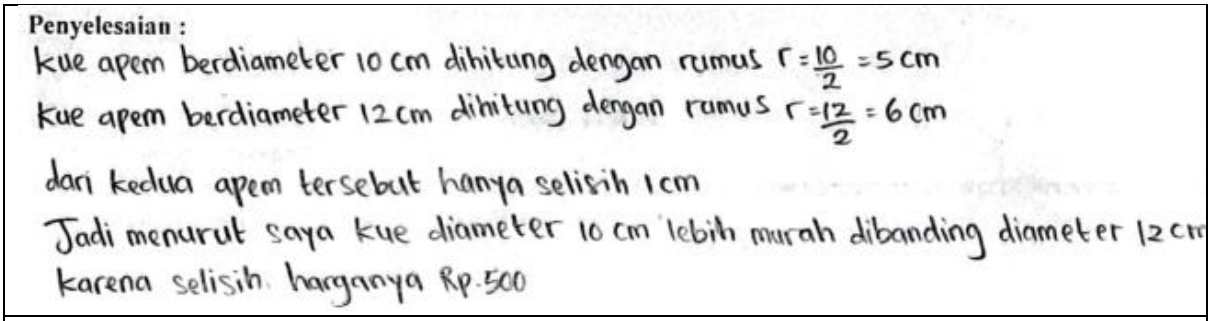
Figure 8. Subject DA's Answer to TIMSS Question No. 2

Based on Figure 8, subject DA has not been able to write the answer to the problem given correctly. The strategy used by subject DA is to write down the initial information first from what he understands from the question. Then make a comparison of value to determine $x\ kg$ of peanuts. However, the comparison written by subject DA is not quite right, so the final result written is not correct.

Based on the interview, subject DA said that the steps he took were based on what he understood in the question. Subject DA uses a comparison of value by utilizing information from the question to determine the final answer. Subject DA does not know that the comparison he wrote is wrong. Subject DA is very confident with the answer he wrote. Based on the results of the answers and interviews, subject DA has not been able to apply what is known from the question to solve the problem correctly, so subject DA has not been able to meet the indicator of applying.

Interpreting Indicator

In the interpreting indicator, students must be able to interpret the results of calculations and use them for decision making. The following is an excerpt from subject DA's answer in solving PISA question number 2 shown in Figure 9.



Solution:

A 10 cm diameter apem cake is calculated using the formula $r = \frac{10}{2} = 5\ cm$

A 12 cm diameter apem cake is calculated using the formula $r = \frac{12}{2} = 6\ cm$

The difference between the two apem cakes is only 1 cm.

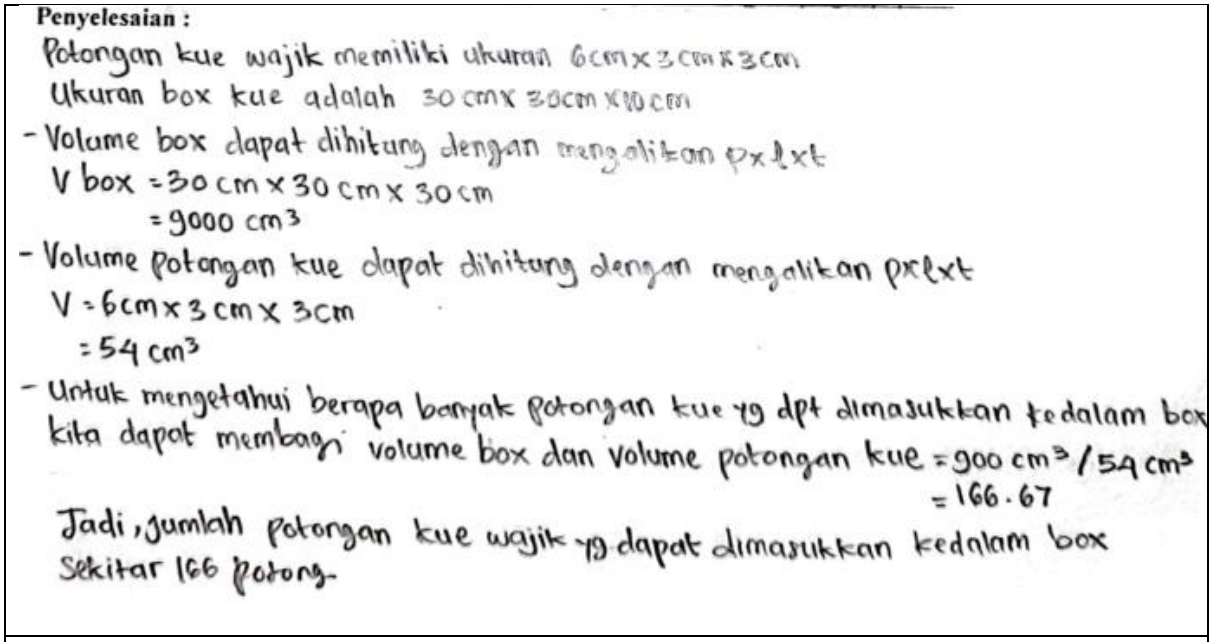
So, in my opinion, the 10 cm diameter cake is cheaper than the 12 cm diameter cake because the price difference is Rp. 500.

Figure 9. Subject DA's Answer to PISA Question No. 2

Based on Figure 9, subject DA has not been able to solve the given problem correctly. Subject DA took steps by estimating the price of each apem cake with a diameter of $10\ cm\ and\ 12\ cm$ based on the length of the radius which has a difference of 1 cm. The first step taken was to find each radius on the apem cake, then found that the difference in the length of the radius was 1 cm. Based on this, subject DA concluded that the apem cake with a diameter of 10 cm was cheaper because the price difference was $Rp.500$. Subject DA did not calculate the price of the apem cake per area of the apem cake.

Based on the interview, subject DA said that he did not know if he had to divide by the area of each apem cake. Subject DA also explained that he did not know the formula for the area of a circle, so subject DA could not write the answer correctly. Subject DA only looked at and compared the price with the known diameter of the apem cake without finding the area of each apem cake. As stated by (Purwanto, 2021) one of the difficulties faced by students in solving numeracy literacy questions is the difficulty in transferring the information in the question, so that students find it difficult to understand and determine the strategy used. Based on the results of the answers and interviews, subject DA has not been able to interpret the calculation results and use them for decision making correctly, so he has not been able to meet the interpretation indicator.

In the TIMSS question, subject DA can solve the given problem correctly. The following is an excerpt from subject DA's answer in solving TIMSS question number 2 shown in Figure 10.


Penyelesaian :
Potongan kue wajik memiliki ukuran 6cm x 3cm x 3cm
Ukuran box kue adalah 30 cm x 30cm x 10 cm
- Volume box dapat dihitung dengan mengalikan p x l x t
V box = 30 cm x 30 cm x 30 cm
= 9000 cm3
- Volume potongan kue dapat dihitung dengan mengalikan p x l x t
V = 6cm x 3 cm x 3cm
= 54 cm3
- Untuk mengetahui berapa banyak potongan kue yg dpt dimasukkan kedalam box kita dapat membagi volume box dan volume potongan kue = 900 cm3 / 54 cm3
= 166.67
Jadi, jumlah potongan kue wajik yg dapat dimasukkan kedalam box sekitar 166 potong.

Solution:
The size of each piece of wajik cake is $6cm \times 3cm \times 3cm$
The size of the cake box is $30cm \times 30cm \times 10cm$
The volume of the box can be calculated by multiplying $p \times l \times t$
V box $= 30cm \times 30cm \times 30cm$
$= 9000cm^3$
The volume of each piece of cake can be calculated by multiplying

$$V = 6cm \times 3cm \times 3cm$$
$$= 54cm^3$$

To find out how many pieces of cake can be put into the box, we can divide the volume of the box by the volume of each piece of cake

$$= \frac{900cm^3}{54cm^3} = 166{,}67$$

Therefore, approximately 166 pieces of wajik cake can be placed in the box.

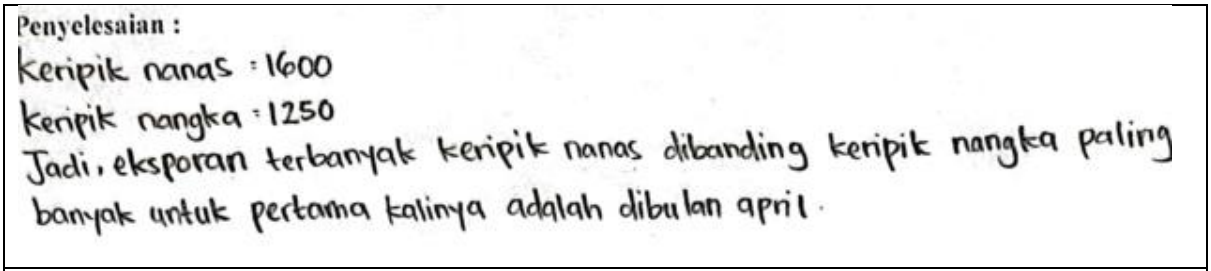
Figure 10. Subject DA's Answer to TIMSS Question No. 2

Based on Figure 10, subject DA can write the answer to the problem given correctly. The strategy used by subject DA is to find the volume of the box first and then find the volume of the wajik cake. After finding all the volumes, to determine the number of diamonds that can be put in the box, subject DA divided the volume of the box by the volume of the diamonds so that 166.67 diamonds were found. Because the number obtained was in decimal form, subject DA rounded it up to get the final result of 166 diamond cakes that could be put in the box. Subject DA was very sure that the answer he wrote was correct.

Based on the interview, subject DA said that he had no difficulty in solving the given problem. In addition, subject DA also knew the formula used to determine the volume of diamond cakes and the volume of the box smoothly, so that the calculation results were error-free. Subject DA also explained that the results obtained were in decimal form, and it was impossible for the number of diamond pieces to be in decimal form. So subject DA decided to round it up to 166 diamond cakes. Based on the results of the answers and interviews, subject DA was able to interpret the calculation results and use them for decision making correctly, so that subject DA could meet the interpretation indicator.

Analyze Indicator

In the analyze indicator, students must be able to analyze various information displayed in the form of graphs, charts, diagrams, tables. The following is an excerpt from subject DA's answer in solving PISA question number 3 shown in figure 11.


Penyelesaian :
Keripik nanas : 1600
Keripik nangka : 1250
Jadi, eksporan terbanyak keripik nanas dibanding keripik nangka paling banyak untuk pertama kalinya adalah dibulan april.

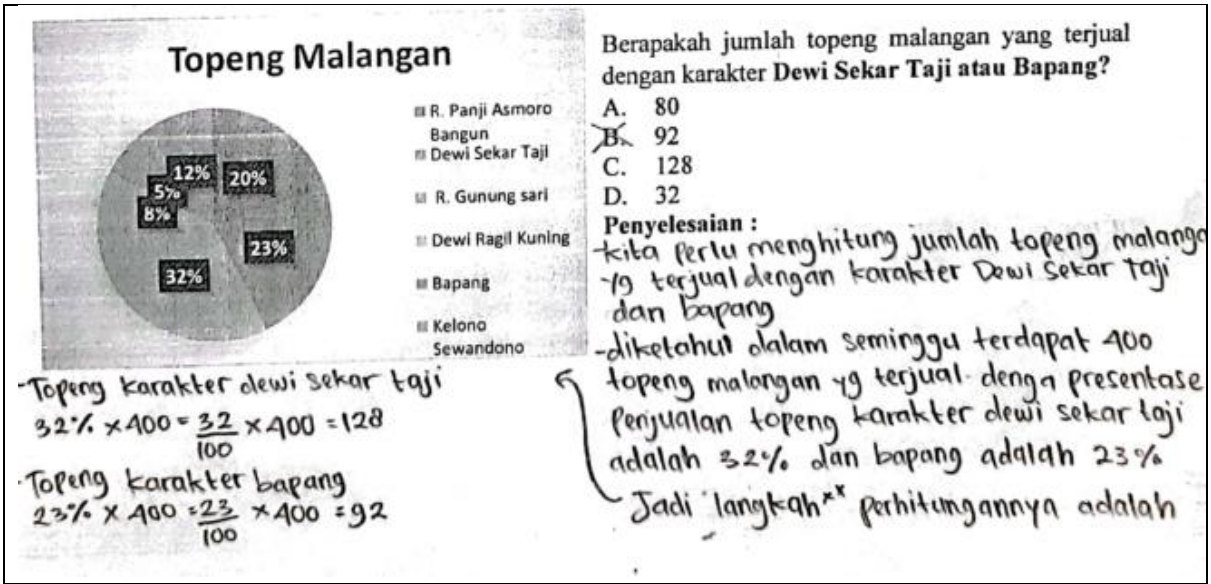
Solution:
Pineapple chips = 1600
Jackfruit chips = 1250
So, pineapple chips were exported more than jackfruit chips for the first time in April.

Figure 11. Subject DA's Answer to PISA Question No. 3

Based on figure 11, subject DA can solve the given problem correctly. Subject DA can read and understand the graph given to solve the problem. Subject DA wrote down the number of pineapple chips and jackfruit chips first as an initial comparison, namely 1600 pineapple chips and 1250 jackfruit chips. Then based on the information that has been written, subject DA can write the correct answer, namely that in April pineapple chips were exported more than jackfruit chips.

Based on the interview, subject DA said that he could understand the graph given, so he could write the answer correctly. Subject DA also said that he did not find it difficult to understand the various information presented in the form of the graph. Based on the results of the answers and interviews, subject DA can analyze various information displayed in graphical form correctly, so that it can meet the analysis indicators.

In the TIMSS question, subject DA has not been able to solve the given problem correctly. The following is an excerpt from subject DA's answer in solving TIMSS question number 3 shown in Figure 12.



Solution:

We need to calculate the number of Malangan masks sold featuring the characters Dewi Sekar Taji and Bapang.
It is known that in one week, 400 Malangan masks were sold, with the sales percentage for masks featuring the character Dewi Sekar Taji being 32% and Bapang 23%. Therefore, the calculation steps are as follows:
Masks with the Dewi Sekar Taji character

$$32\% \times 400 = \frac{32}{100} \times 400 = 128$$

Masks with the Bapang character

$$23\% \times 400 = \frac{23}{100} \times 400 = 92$$

Figure 12. Subject DA's Answer to TIMSS Question No. 3

Based on Figure 12, subject DA has not been able to solve the given problem correctly. Subject DA made a mistake in reading and understanding the diagram given to solve the problem. The subject wrote the percentage of Dewi Sekartaji masks sold as 32%, when in fact it was 23%. Then subject DA also wrote the percentage of Bapang masks sold as 23%, when in fact the correct one was 5%. This mistake made subject DA less precise in calculating and writing the final answer.

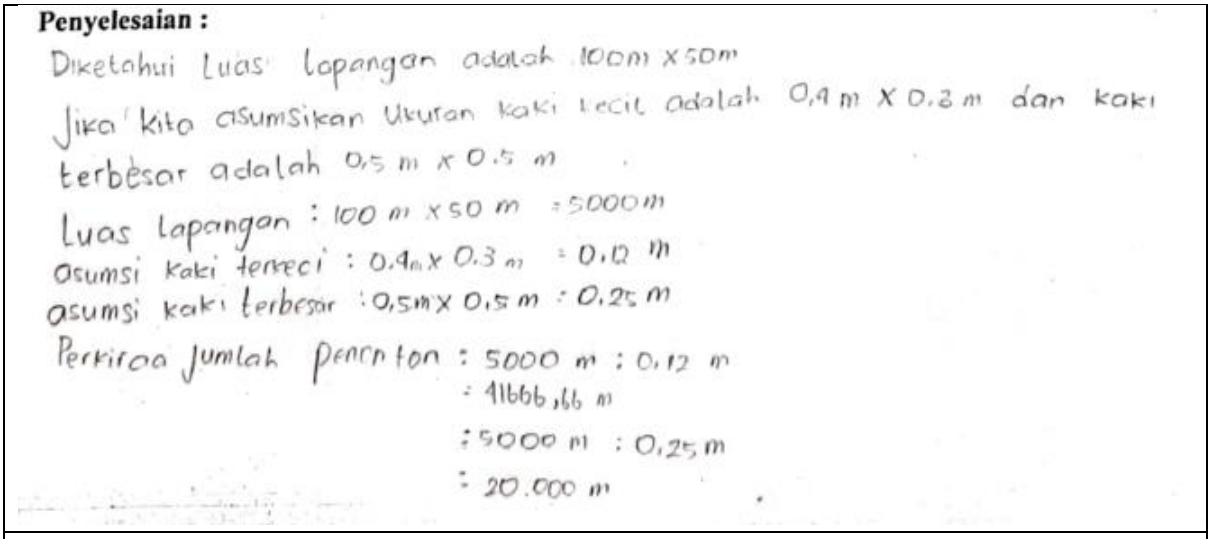
Based on the interview, subject DA said that he realized that he was wrong in reading the diagram given. Subject DA was not careful in seeing the color of the information in the diagram and the percentage amount. When asked to redo it according to the correct percentage, subject EI was able to write his answer correctly. This means that subject DA understands the purpose of the question, but because of his inaccuracy, he made a mistake in writing the answer. Based on the results of the answers and interviews, subject DA was able to analyze various information displayed in the form of diagrams correctly, so that he could meet the analysis indicator.

High Ability Category

Based on Table 3, the percentage of students' numeracy literacy skills in the high category is 2%, meaning that there are still very few students whose numeracy literacy skills are good. The following is an explanation of high category students for each indicator.

Applying Indicator

In the applying indicator, students must be able to apply various numbers and basic mathematical symbols in solving everyday mathematical problems. The subject selected in the high category is PI. The following is an excerpt from subject PI's answer in solving PISA question number 1 shown in Figure 13.



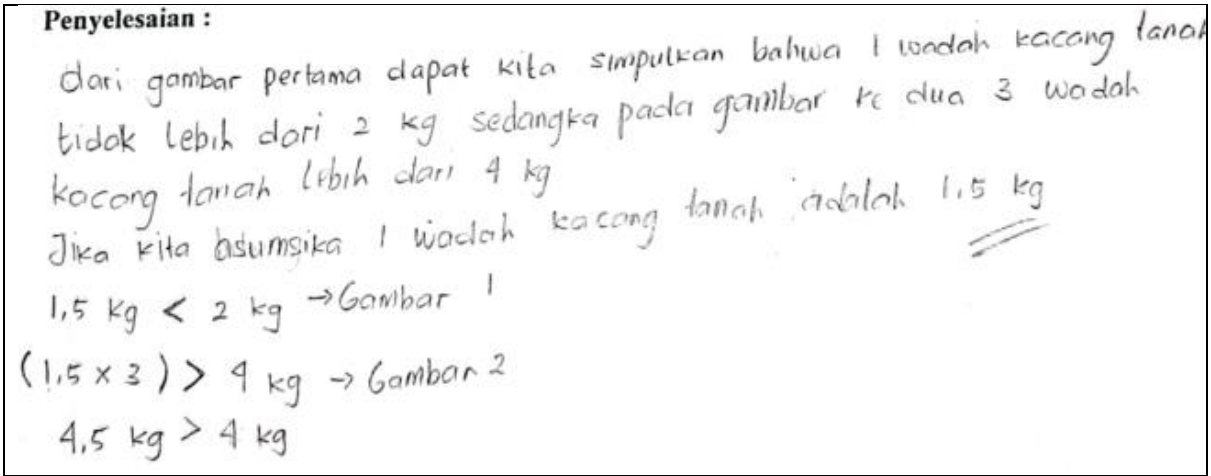
Solution:
The area of the field is known to be 100 m x 50 m.
If we assume that the smallest foot is 0.4 m x 0.3 m and the largest foot is 0.5 m x 0.5 m, the area of the field is 100 m x 50 m = 5000m^2.
Assumption for the smallest foot: 0.4 m x 0.3 m = 0.12 m^2
Assumption for the largest foot: 0.5 m x 0.5 m = 0.25 m^2
Estimated number of spectators:
5,000 m^2 : 0.12 m^2 = 4,166.66
5,000 m^2 : 0.25 m^2 = 20,000

Figure 13. Subject PI's Answer to PISA Question No. 1

Based on Figure 13, subject PI wrote down the answer to the problem correctly according to his ability. There are several steps to solving that he used to find the correct answer. The first step he used was to assume the size of the small foot, namely $0.4\,m \times 0.3\,m$, and the size of the large foot, namely $0.5\,m \times 0.5\,m$. Then subject PI determined the area of the field by multiplying the length and width of the field so that the result was 5000m^2. Then the PI subject divided the area of the field by the area of each assumption of the size of the large foot and the small foot, so that the result was 20,000. So the PI subject concluded that the maximum number of spectators on the field could reach 20,000 people.

Based on the interview, the PI subject said that the area for each person with a different foot size was indeed large. The PI subject also explained that 1m2 can be occupied by more than one person. The PI subject understood the intent of the question and could apply various information from the question to find the correct answer. Students who can meet the application indicator are able to design strategies that will be used to get the right solution (Khamidah & Azizah, 2022). Based on the results of the answers and interviews, the PI subject has been able to apply what is known from the question to solve the problem correctly, so that it can meet the application indicator.

In the TIMSS question, the PI subject can solve the given problem correctly. The following is an excerpt from the PI subject's answer in solving the TIMSS question shown in Figure 14.



Solution:
From the first image, we can conclude that 1 container of peanuts weighs no more than 2 kg, while the second image shows that 3 containers of peanuts weigh more than 4 kg.
If we assume that 1 container of peanuts weighs 1.5 kg
1.5 kg < 2 kg --> Image 1
(1.5 x 3) > 4 kg --> Image 2
4.5 kg > 4 kg

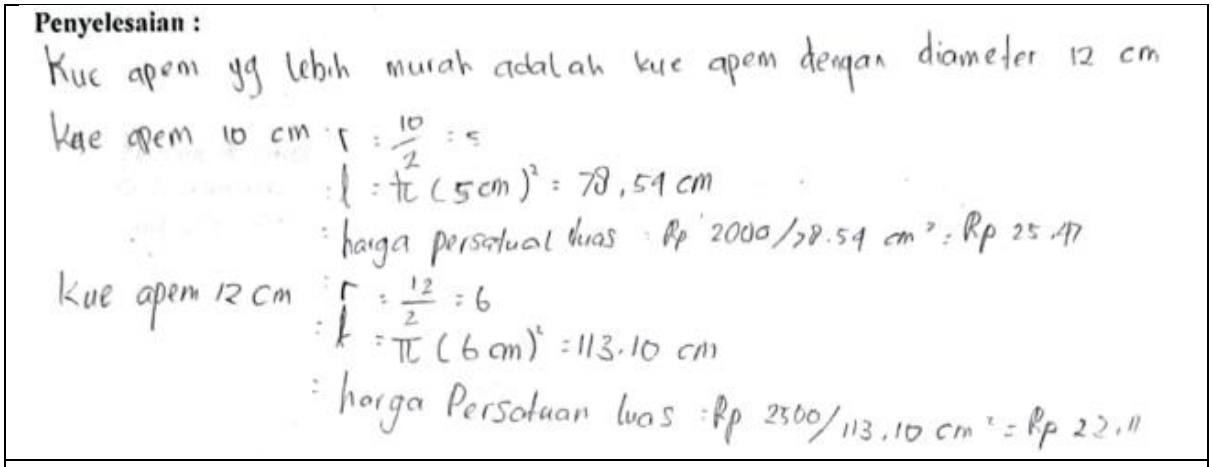
Figure 14. Subject PI's Answer to TIMSS Question No. 1

Based on Figure 14, subject PI can write the answer to the given problem correctly. The strategy used by subject PI is to write down all the information in the question, then assume that 1 container of peanuts weighs 1.5 kg. Then the next step is to compare using the inequality sign, so that the result is that the weight of the peanuts is 1.5 kg.

Based on the interview, subject PI said that the steps he took were based on what he understood in the question. Subject PI made an estimate to determine the weight of 1 container of peanuts and then assumed it. After assuming it, subject PI used inequality to check whether the assumption he made was right or wrong. It turned out that the assumption he made was correct, so subject PI was very sure of his answer. Based on the results of the answers and interviews, subject PI has been able to apply what is known from the question to solve the problem correctly, so that subject PI can meet the applying indicator.

Interpreting Indicator

In the interpreting indicator, students must be able to interpret the calculation results and use them for decision making. The following is an excerpt of the PI subject's answer in solving PISA question number 2 shown in figure 15.



Solution:
The cheaper apem cake is the one with a diameter of 12 cm.
10 cm apem cake

$$r = \frac{10}{2} = 5$$

$$L = \pi(5)^2 = 78{,}54\ cm$$

Price per unit area

$$\frac{Rp.2000}{78{,}54} = Rp.25{,}47$$

12 cm apem cake

$$r = \frac{12}{2} = 6$$

$$L = \pi(6)^2 = 113{,}10\ cm$$

Price per unit area

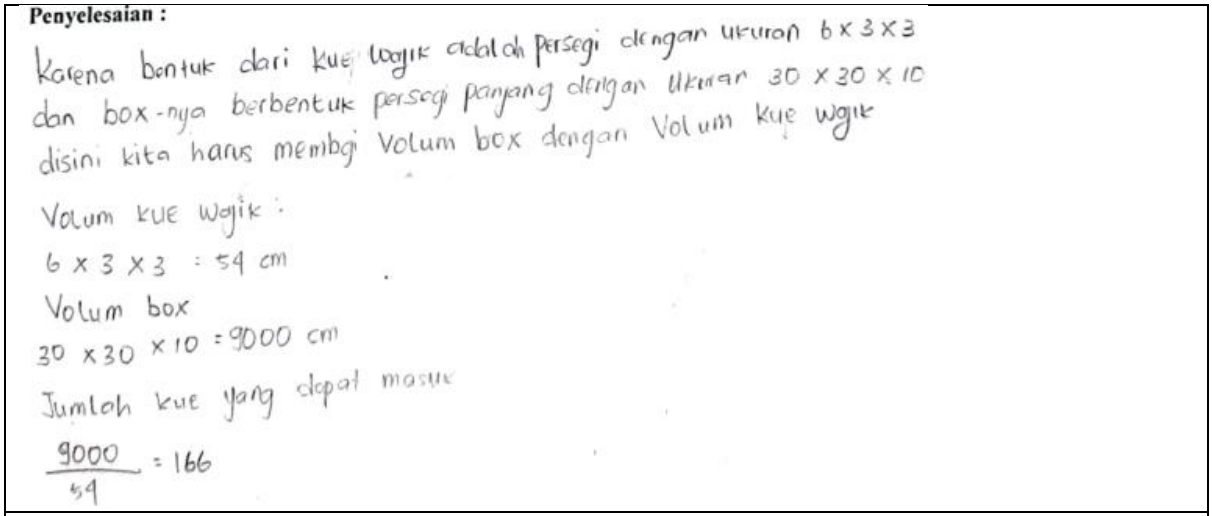
$$\frac{Rp.2500}{113{,}10} = Rp.22{,}11$$

Figure 15. Subject PI's Answer to PISA Question No. 2

Based on figure 15, subject PI has been able to solve the given problem correctly according to his ability. Subject PI took several steps to determine which apem cake was cheaper. The first step taken by subject PI was to find the area of each apem cake with a diameter of $10\ cm\ and\ 12\ cm$. Next, subject PI divided the price of each apem cake by each area that had been found. Based on these steps, subject PI found that the price of an apem cake with a diameter of 12 cm was cheaper than the price of an apem cake with a diameter of 10 cm.

Based on the interview, subject PI said that he understood what the question meant, so that subject PI had no difficulty in solving it. Subject PI was also fluent in explaining the steps used to solve the problem. In addition, subject PI was also very sure that the answer he wrote was correct. Based on the results of the answers and interviews, subject PI was able to interpret the calculation results and use them for decision making correctly, so that it could meet the interpreting indicator.

In the TIMSS question, subject PI can solve the given problem correctly. The following is an excerpt of subject PI's answer in solving TIMSS question number 2 shown in figure 16.



Solution:
Because the shape of the wajik cake is a square with dimensions of $6 \times 3 \times 3$ and the box is a square with dimensions of $30 \times 30 \times 10$
here we must divide the volume of the box by the volume of the wajik cake
volume of the wajik cake

$$6 \times 3 \times 3 = 54\ cm$$

Box volume

$$30 \times 30 \times 10 = 9000\ cm$$

Number of cakes that can fit
$\frac{9000}{54} = 166$

Figure 16. Subject PI's Answer on TIMSS Question No. 2

Based on figure 16, subject PI wrote the answer correctly. The strategy used by subject PI is to find the volume of the diamond first and then find the volume of the box used. After finding all the volumes, to determine the number of diamonds that can be put in the box, subject PI divides the volume of the box by the volume of the diamond so that 166 diamonds are found. Subject PI is very sure that the answer he wrote is correct.

Based on the interview, subject PI said that he had no difficulty in solving the given problem. In addition, subject PI also knows the formula used to determine the volume of the diamond cake and the volume of the box, so that the calculation results are not wrong. Subject PI also explained that the results obtained were actually in decimal form, but subject PI rounded it up so that the result was 166 diamond cakes. Based on the results of the answers and interviews, the PI subjects have been able to interpret the calculation results and use them for decision making correctly, so that the PI subjects can meet the interpreting indicator.

Analyzing Indicator

In the analyzing indicator, students must be able to analyze various information displayed in the form of graphs, charts, diagrams, tables. The following is an excerpt from the PI subjects' answers in solving PISA question number 3 shown in Figure 17.

Penyelesaian :

Pada bulan Apri keripi nanas mengekspor lebih banyak dari pada keripik nangka untuk pertamakalinya yaitu sebanyak 1600 dan keripik nangka 1250 tidak seperti bulan-bulan sebelumnya diman kenpik nangka selalu unggul dari pada keripik nanas.

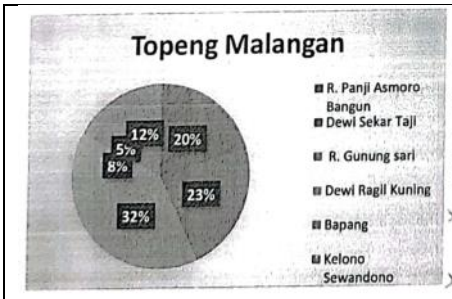
Solution:
In April, pineapple chips exported more than jackfruit chips for the first time, with 1,600 units compared to 1,250 units for jackfruit chips. This was unlike previous months, where jackfruit chips always outsold pineapple chips.

Figure 17. PI Subject's Answer to PISA Question No. 3

Based on Figure 17, the PI subjects can solve the problems given correctly. The PI subjects can read and understand the graphs given to solve the problem. The PI subjects write down the number of pineapple chips and jackfruit chips first as an initial comparison, namely pineapple chips = 1600 and jackfruit chips 1250. Then based on the information that has been written, the PI subjects can write the correct answer, namely that in April pineapple chips were exported more than jackfruit chips.

Based on the interview, the PI subjects said that they could understand the graphs given, so they could write the answer correctly. Subject PI also said that he did not find it difficult to understand the various information presented in the form of graphs. (Khamidah & Azizah, 2022) in their research also stated that high category students have characteristics that are easier to process information, so that their numeracy literacy skills are good. Based on the results of the answers and interviews, subject PI can analyze various information displayed in the form of graphs correctly, so that they can meet the analysis indicators.

In the TIMSS question, subject PI has not been able to solve the problem given correctly, because there are still incomplete answers. The following is an excerpt from subject PI's answer in solving TIMSS question number 3 shown in Figure 18



Berapakah jumlah topeng malangan yang terjual dengan karakter **Dewi Sekar Taji atau Bapang?**

A. 80
B. 92
C. 128
D. 32

Penyelesaian :

$> \frac{20}{100} \times 400 = 80$ $> \frac{5}{100} \times 400 = 20$

$> \frac{23}{100} \times 400 = 92$ $> \frac{12}{100} \times 400 = 48$

$> \frac{32}{100} \times 400 = 128$

$> \frac{8}{100} \times 400 = 32$

Solution:

$$\frac{20}{100} \times 400 = 80$$
$$\frac{23}{100} \times 400 = 92$$
$$\frac{32}{100} \times 400 = 128$$
$$\frac{8}{100} \times 400 = 32$$

$$\frac{5}{100} \times 400 = 20$$
$$\frac{10}{100} \times 400 = 48$$

Figure 18. Subject PI's Answer to TIMSS Question No. 3

Based on Figure 18, subject PI has not been able to solve the problem given correctly. The strategy used by subject PI is to find the number of each type of mask, not only the Dewi Sekar Taji or Bapang mask. After finding the number of each mask, subject PI did not write the final result according to what was asked in the question, so there was no conclusion written by subject PI. As a result, the answer written by the PI subject was incomplete.

Based on the interview, the PI subject stated that he realized that he had not completed the answer he wrote. This is because the PI subject was in a hurry to work on this question. When asked, the PI subject could answer fluently the number of Dewi Sekar Taji masks or Bapang masks according to the number that had been searched for previously. Based on the results of the answers and interviews, the PI subject has been able to analyze various information displayed in the form of diagrams correctly, so that it can meet the analysis indicators.

The analysis results are summarized in Table 4 below, showing the indicators that each subject can meet when solving PISA and TIMSS questions.

Table 4. Summary of Achievement

No	Category	Subject	PISA Questions			TIMSS Questions		
			M1	M2	M3	M1	M2	M3
1	Low	EI	×	×	√	√	√	×
2	Moderate	DA	×	×	√	×	√	√
3	High	PI	√	√	√	√	√	√

Notes:
M1: Applying indicator
M2: Interpreting indicator
M3: Analyzing indicator

Based on Table 4, students in each category meet different numeracy literacy indicators. According to Table 3, 44% of students have low numeracy literacy skills, meaning many students' skills are suboptimal. This aligns with the findings of a study (Rahayu, Mulyono, & Cahyono, 2019) which stated that students' numeracy literacy skills in Indonesia are suboptimal.

Students in the low and moderate categories can only meet the analysis indicator when solving PISA questions. For this indicator, students must analyze quantitative information visualized in graphs, tables, and charts. Meanwhile, low-performing students can meet the indicators of application and interpretation when answering TIMSS questions, but they cannot yet meet the indicator of analysis. These results are comparable to those of a study (Andrianti & Rahayu, 2022) which found that low-performing students can apply their knowledge but cannot write down a strategy for solving problems. Consequently, their solutions are incorrect.

Students in the middle category can meet the interpretation and analysis indicators when solving TIMSS questions but cannot meet the application indicator. This means that students cannot apply basic mathematical numbers and symbols to solve everyday mathematical problems. As stated, students in the moderate category can apply their knowledge to write problem-solving strategies, though some solutions are incorrect. (Ate & Lede, 2022) also stated that students' ability to apply basic number concepts and mathematical notation to real-life problems is limited.

High-performing students can meet all numeracy and literacy indicators when completing PISA and TIMSS questions, which range from application to interpretation and analysis. As research by (Andrianti & Rahayu, 2022) shows, high-performing students can apply their knowledge to write down problem-solving strategies to find the correct solution.

Numeracy literacy skills are essential because they form the foundation of other skills. These skills are closely related to mathematical principles, processes, and knowledge in daily life contexts, such as payment activities and understanding tables and graphs (Lamada et al., 2019). However, students' numeracy literacy skills in Indonesia are suboptimal. This study found that most students' numeracy literacy skills were in the low category (44%). Only 22% of students were in the moderate category. Only 2% of students achieved the high category. As previous studies have shown (Ate & Lede, 2022; Kaka et al., 2021) students' numeracy literacy skills are generally low.

Several factors can influence students' numeracy literacy skills. Some students do not read and understand the information in the questions carefully enough, some do not know what strategies to use, and some are not yet able to analyze the given problems optimally. According to (Lamada et al., 2019) personal factors, such as the way students process information, can influence their numeracy literacy skills. This is commonly known as students' cognitive styles. Students tend to have difficulty choosing the appropriate approach or steps to solve the given questions (Ate & Lede, 2022).

Conclusion

The analysis revealed that students in each category had different abilities when it came to meeting numeracy literacy indicators. Students in the low and medium categories could only meet the analysis indicator when answering PISA questions. Students in the low category could meet the application and interpretation indicators when completing TIMSS questions but could not meet the analysis indicator. Students in the moderate category could meet the interpretation and analysis indicators when solving TIMSS questions but could not meet the application indicator. This differs from students in the high category, who can meet all numeracy literacy indicators by solving PISA and TIMSS questions.

To develop students' numeracy literacy, teachers should incorporate various types of numeracy literacy questions into the learning process to help students become accustomed to analyzing and solving every day, contextual mathematical problems, such as those found in numeracy literacy questions. Since this study is limited to PISA and TIMSS questions, it is highly recommended that future researchers apply various other forms of numeracy literacy questions.

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