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ANALYSIS OF STUDENT NUMERACY LITERACY IN SOLVING PISA QUESTIONS

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Abstrak

Penelitian ini bertujuan untuk mendeskripsikan proses literasi numerasi siswa dalam menyelesaikan soal-soal PISA. Penelitian ini menggunakan pendekatan deskriptif kualitatif. Subjek dalam Penelitian sebanyak 2 orang dari 34 siswa kelas IX/B MTsN Ambon sebagai pertisipan, dengan perolehan data meliputi hasil observasi, wawancara, dan tes kemampuan literasi numerasi dari soal PISA. Teknik analisis data menggunakan klasifikasi data, reduksi data, penyajian data, penafsiran data, dan penarikan kesimpulan. Hasil penelitian ini menunjukkan bahwa proses literasi numerasi siswa dalam menyelesaikan soal-soal PISA, dideskripsikan sebagai: 1) kedua siswa memiliki kemampuan kompetensi pokok dalam berliterasi numerasi yakni mampu; mengkomunikasikan masalah, membuat pemodelan matematika, membuat representasi, berargument dan memberikan alasan yang tepat dalam mempertanggung jawabkan pekerjaanya, membuat strategi penyelesaian yang baik dan benar, menggunakan bahasa formal, bahasa simbol dan bahasa teknis serta menggunakan alat matematika untuk memudahkan pekerjaannya. 2) terdapat perbedaan penyelesaian dari kedua siswa tersebut yakni dalam penyelesaian soal nomor satu, ada siswa yang membuat pemodelan matematika dengan rumus dasar perbandingan dan ada siswa yang membuat pemodelan matematika dengan kebalikan dari rumus dasar perbandingan yakni perkalian.
Kata kunci: Literasi Numerasi; Penyelesaian Masalah; Soal-soal PISA

Abstract

This study aims to describe the process of student numeracy literacy in solving PISA questions. This study used a qualitative descriptive approach. The subjects in the study were two people from 34 students of 9th grade B MTsN Ambon as participants, with data acquisition including observations, interviews, and numeracy literacy ability tests from PISA questions. Data analysis techniques use data classification, data reduction, data presentation, data interpretation, and conclusions. The results of this study show that the numeracy literacy process of students in solving PISA questions, described as: 1) both students have the ability of the main competencies in numeracy literacy, namely capable; of communicating problems, making mathematical models, making representations, arguing and giving appropriate reasons in accountability for their work, making good and correct solving strategies, use formal language, symbol language and technical language and use mathematical tools to facilitate their work. 2) There are differences in the

solution of the two students, namely in solving problem number one, there are students who make mathematical modeling with the basic formula of comparison and there are students who make mathematical modeling with the opposite of the basic formula of comparison, namely multiplication.
Keywords: Numeracy Literacy; Problem Solving; PISA Questions

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INTRODUCTION

Numeracy literacy is one of the PISA survey standards. Therefore, numeracy literacy skills are important for Indonesian students. However, the numeracy literacy ability of Indonesian students as a result of the PISA survey is still very low. Based on the results of the PISA survey, the ranking of Indonesian students in numeracy literacy from 2012 to 2018 did not show a significant increase. In 2012 Indonesia ranked 64 out of 65 countries with a relatively low level of achievement, PISA results in 2015 showed that Indonesia's ranking experienced a slight increase in the order of 62 out of 70 countries (OECD, 2016). According the PISA 2018 assessment Indonesia is ranked 73 out of 79 countries (OECD, 2019). Looking at the results of the numeracy literacy ability survey issued by PISA, we can reflect that so far the ability of 15-year-old Indonesian students in numeracy literacy is still far from the average achievement of the survey participating countries. This means that the numeracy literacy of Indonesian students is still very low.

Numeracy literacy is the knowledge and ability to use various kinds of numbers and symbols related to basic mathematics to solve practical problems in everyday life, then analyze information displayed in various forms and interpret the results of the analysis to predict and make decisions (Kemdikbud, 2017). Ekowati said that numeracy literacy is defined as a person's ability to use reasoning (Ekowati et al., 2019). Reasoning means analyzing and understanding a statement, through the activity of manipulating mathematical symbols or language found in everyday

life, and expressing the statement through writing or verbally. Numeracy literacy can be expressed as the ability when use mathematical concepts to solve practical problems in everyday life in the form of knowledge and skills.

Mayer defines problem-solving as a process of many steps the problem solver must take in finding connections between his past experiences (schemas) and the problems he now faces and then acting to solve them (Kirkley & Rob Foshay, 2003). Whereas, according to NCTM, "Problem-solving is a hallmark of mathematical activity and a major means of developing mathematical knowledge" (Allen et al., 2020). The thought process can only be recognized when a person takes action through problem-solving (Sopamena et al., 2021). That is, that problem-solving is an activity in earnest to develop mathematical knowledge. So, problem-solving is an effort to find a way out by identifying the elements known, asked, and the adequacy of the necessary elements of a problem, as well as in answering PISA questions.

Math problems in PISA studies measure more reasoning, problem-solving, and argumentation skills (Wardhani & Rumiati, 2011). PISA framework 2012 explains that the PISA mathematics problem framework has 3 dimensions, including (1) content, (2) context, and (3) competency cluster. Meanwhile, the PISA framework in measuring numeracy literacy is distinguished in three aspects, namely content, context, and cognitive. The content or material aspect of PISA consists of content quantity, uncertainty and data, change and relationship, and space and shape. Aspek context consists of context personal, societal, occupational, dan scientific. The cognitive aspect consists of six levels ranging from the lowest level to the highest level of knowledge (OECD, 2016).

Furthermore, students' numeracy literacy skills need to be optimized by getting used to giving PISA questions (Sasongko et al., 2016). As revealed by De Lange, "Mathematics for Literacy (De Lange, 2003)." that is "students need to experience solving mathematics problems in different situations and contexts to develop their ability to transfer their knowledge from one area of application to

another". Students need to gain experience in solving mathematical problems presented in various contexts so that students can develop the ability to transfer knowledge into various forms of concept application. One of them is getting used to giving PISA questions. Often given questions such as PISA will train and improve Indonesia's ranking in PISA studies (Purnomo, 2016). Therefore, PISA questions are questions made to measure the ability to reason, solve problems, and argue (hone numeracy literacy) of 15-year-old students, where there are three aspects tested, namely context, content, and cognitive. Good PISA results will show a good student numeracy literacy process as well.

Researchers in Indonesia who examined numeracy literacy include research by Muhammad Rifqi Mahmud and Inne Marthyane Pratiwi found that student numeracy literacy in solving unstructured problems is that students can solve unstructured problems in the context of everyday life; Students can analyze the information obtained from the problem then use the interpretation of the analysis to predict and draw conclusions. The difficulties experienced by students are difficulty understanding the questions; lack of understanding of students on prerequisite material; difficulty building a settlement strategy; and difficulty in concluding (Mahmud & Pratiwi, 2019).

Another study by Holifatul Sa'dia found that the numeracy literacy ability of students who dominate of declarative knowledge is classified as capable in the ability to analyze information from graphs, tables, and diagrams; but incapable of using symbols in the material of space and form; and incapable in the skills of space concept shape, and measurement. The numeracy literacy ability of students who dominate procedural knowledge is classified as capable in the ability to analyze information from graphs, tables, and diagrams; able to use symbols in material spaces and shapes; and quite capable in the skills of space concepts and shapes, and measurements. In addition, the numeracy literacy ability of students who dominate conditional knowledge is quite capable in the ability to analyze information from graphs, tables, and diagrams; quite capable of using symbols in material spaces and

shapes; and able in the skills of space concepts and shapes, and measurements (Sa'dia, 2021). Other research on the numeracy literacy skills of Pre-service teacher's ability provides contributions to students to solve math problems (Nahdi et al., 2020)

Based on the description of the problem, analyzing the process of student numeracy literacy in solving PISA questions is an important thing to do, but no one has researched student numeracy literacy in solving the PISA problem. If anything, you don't really use PISA questions in the form of open-ended literacy questions, but using questions that can be solved directly formally. Therefore, this study analyzes the process of student numeracy literacy in solving PISA questions.

METHOD

Type

This research uses a qualitative approach (Creswell, 2014). The purpose of this study is to explore the process of student numeracy literacy in solving PISA problems, therefore this research is classified as qualitative research (Creswell, 2015).

Instruments

Based on this research approach, the researcher himself is the main instrument and is supported by numeracy literacy ability tests, interview guidelines, field notes, and recording devices. Researchers use 2 PISA questions where the first question is about change and relationship content and the second question is about a PISA quantity content problem. The PISA questions used are as follows:

1. The home industry produces sweet breads.

To make a jumbo-sized sweet bread, the following ingredients are needed:

Necessary materials	Size	Necessary materials	Suplai

Flour	250 gr	Flour	25000 gr
Sugar	40 gr	Sugar	4000 gr
Milk powder	10 gr	Milk powder	950 gr
Margarine	30 gr	Margarine	5000 gr
Salt	2 gr	Salt	350 gr
Yeast	4 gr	Yeast	750 gr

With the amount of stock in the warehouse, how many jumbo sweet breads are possible to make?

a) 100 b) 116 c) 167 d) 95

2. Body Mass Index

One measure of human fitness is to look at body mass index (BMI). BMI shows the relationship between the height (BB) and weight (TB) of somebody. Related to BMI, the following graph shows the average height of adult males by birth year for countries in Europe and Asia.

Body mass index can be calculated by the formula:

$BMI = BB : TB^2$

With BB in Kg and TB in meters. The average body weight of French males of adult age in 1980 was 77 kg. What was the body mass index of adult French males in 1980?

Subjects

This research was carried out in 9^{th} grade B MTs N Ambon, with the subject as many as 2 out of 34 students, hereinafter referred to as Subject 1 (S1) and Subject (S2). Subjects are taken based on the characteristics of the numeracy literacy process in solving PISA problems. The characteristics of the numeracy literacy process in this study are that the subject can; communicate problems, make mathematical models, make representations, argue and give appropriate reasons, make solving strategies, use formal language, symbol language, and technical language, and use mathematical tools.

Analyzes Date

Activities in data analysis are 1) Organizing and preparing data for analysis; 2) Reading or viewing all data (observations, interviews, field notes); 3) coding all data; 4) categorizing themes and describing them based on coding; 5) conduct descriptions in the form of qualitative narratives; and 6) interpret data in qualitative research from findings or results (Creswell, 2014).

RESULT AND DISCUSSION

The Numeracy literacy process of S_1 and S_2 in solving PISA questions is correct with a complete scheme/structure of thinking and the same in question number 1 but different when solving question number 2. The difference between S_1 and S_2 literacy processes lies in the ability to mathematize or make mathematical models. The following is the S1 numeracy literacy process in solving PISA questions, which is continued with the difference between the literacy process and S_2.

Numeration Literacy Process of Subject One (S_1) in Solving PISA Problems.

To analyze the process of Numeracy Literacy, S_1 in solving PISA problems can be done by reviewing the problem-solving scheme in the S_1 thinking process, he uses covariation from comparison, namely multiplication in solving problems. The following is the scheme of the S1 thinking process in solving PISA problems.

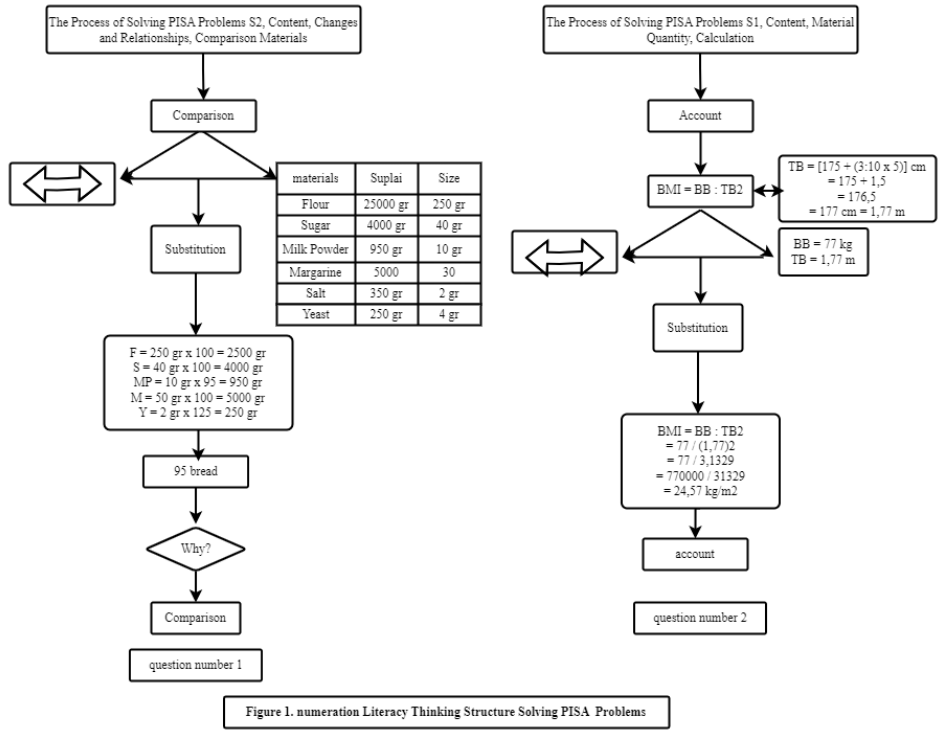

Figure 1. Analysis of the Occurrence of the S_1 Numeration Literacy Process in Solving PISA Problems

S_1 can carry out the Student Numeracy Literacy process in solving PISA questions, both in question number 1 in the form of change and relationship content and question number 2 in the form of material content. Before solving the problem, S_1 communicates the problem and presents it in the form of representations, as S_1's work follows.

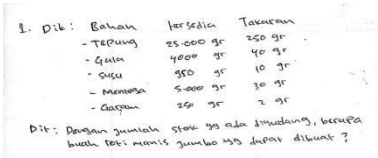

Figure 2. S1's Work in Communicating Problems

This is reinforced by the following S_1 statement.

P : *According to you from the problem, What is the information in the question?*
S_1 : In the first question, *the ingredients needed to make jumbo sweet bread are wheat flour 250 gr, sugar 40 gr, milk powder 10 gr, butter 30 gr, salt 2 gr,*

yeast 4 gr. Then in the warehouse, there are still stocks of wheat flour 25,000 gr, sugar 4,000 gr, milk powder 950 gr, butter 5,000 gr, salt 350 gr, yeast 750 gr. Second, it is known that the average body weight of adult French men in 1890, was 77 kilograms, the BMI formula is the same as BB for TB2, What is the body mass index of French adult men in 1980?

Based on the job and the results of the S_1 interview above, S_1 **has communication skills** because S1 is able to communicate problems and present those problems in the form of representations. This is in line with the indicators used as a reference to measure numeracy literacy skills as contained in the OECD (*Organisation for Economic Co-operation and Development*) (OECD, 2015).

Next, S1 performs mathematical modeling and formulas for completion, as seen in the following S_1 job.

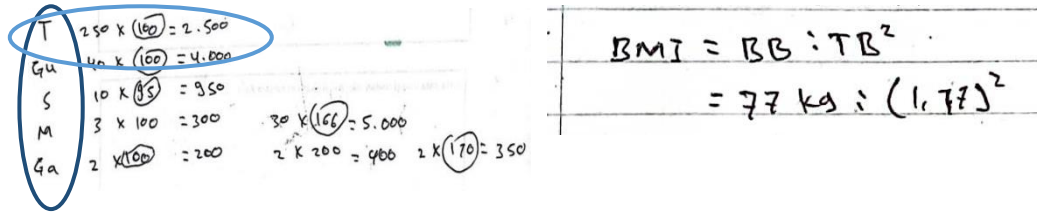

Figure 3. Results of S_1's Work in Creating Mathematical Modeling

This is reinforced by S_1's statement when interviewed as follows.

P : So you can explain why your solution became like this?
S_1 : Yes, sis, this is every ingredient I symbolize with the first letter, sis., flour T, sugar Gu like that sis. Then I counted each ingredient, such as wheat flour supplies in its warehouse 2.500 gr and what is needed 250 gr Then I compared sis. That way you can get how much bread can be made with wheat flour available, which is the same for sugar, milk powder, and other ingredients
P : What about number 2?
S_1 : If the BMI formula is the same as BB bagi TB^2, Find the value first TB Because it is not yet known, sis. So because here is 175, I think – think it will go up by 3 mm, then the distance between 175 and 180 is about 10 mm, so 3 by 10, then because the difference between 175 and 180 is 5 cm so 3 by 10 times 5. So TB = 175 plus 3 per 10 times 5, equals 175 plus 1.5 so 176.5 m rounded to 1.77 cm. After that, enter into the formula BMI is equal to BB for TB to the second power. So, BMI is equal to 77 kg for 1.77 m to the 2nd power. The result was operated at 24.57 kg / m^2, so sis.

Based on the statement and the results of the work, S_1 **carries out the mathematization process** because S1 can create mathematical models based on

information from problems. This is in line with the indicators used as a reference to measure numeracy literacy skills as contained in the OECD (*Organisation for Economic Co-operation and Development*) (OECD, 2015), and supported by research conducted by Nur et al. (2022), namely students (1) Able to name number symbols 1-20, (2) Have the ability to use number symbols to count, (3) Able to match numbers with number symbols (Situmorang & Sinaga, 2022), namely from the ability of high-level numeracy literacy, it can be seen that students are able to solve problems that occur in everyday life.

S_1 then uses a formula for completion and conveys the reasons and arguments for the work he does when asked why his job can be the way it is. The S_1 statement is as follows.

P : So the point is multiplied by a certain number to get the available material for what?
S_1 : Right here, 250 grams by 100 equals 2,500, so with 2,500 grams of ingredients you can make 100 loaves of bread
P : *Does it have to be made one by one like this??*
S_1 : *Yes, sis, because if it is made like this, you know how many ingredients can make each ingredient*
P : *and then after that, after all the ingredients are known how much bread can be made, then from where can you conclude the answer 95 loaves?*
S_1 : *Because milk can only make 95 pieces of breads, so even if other ingredients can make more milk powder can only make 95, so the answer is 95 bread*
P : *oh so you see the smallest or how?*
S_1 : *Yes, sis, because if you want to make 100 breads, there will be bread whose ingredients do not use milk, because milk can only make 95.*

Such is the case with the completion of question number 2, as shown in the following S_1 work results.

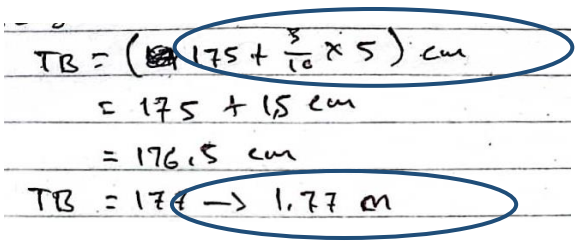

Figure 4. Work S_1 in Carrying out The Stages of Completion

Based on S_1's work, it can be seen that S_1 also performs symbolism, using **formal and technical language and mathematical tools such as measurement,**

multiplication, addition, and division. This is by the indicators used as a reference to measure numeracy literacy skills as contained in the OECD (*Organisation for Economic Co-operation and Development*) (OECD, 2015), and supported by research conducted by (Nur et al., 2022).

Furthermore, there are differences in the numeracy literacy process between S_1 and S_2. This difference can be seen in the completion of problem number 1, namely when doing mathematical mathematics or mathematical modeling. S2 solves this by first distributing the amount of each material, while S1 multiplication between the doses of each material with a certain number so as to produce a supply. This can be seen in the following S_1 and S_2 thinking structures.

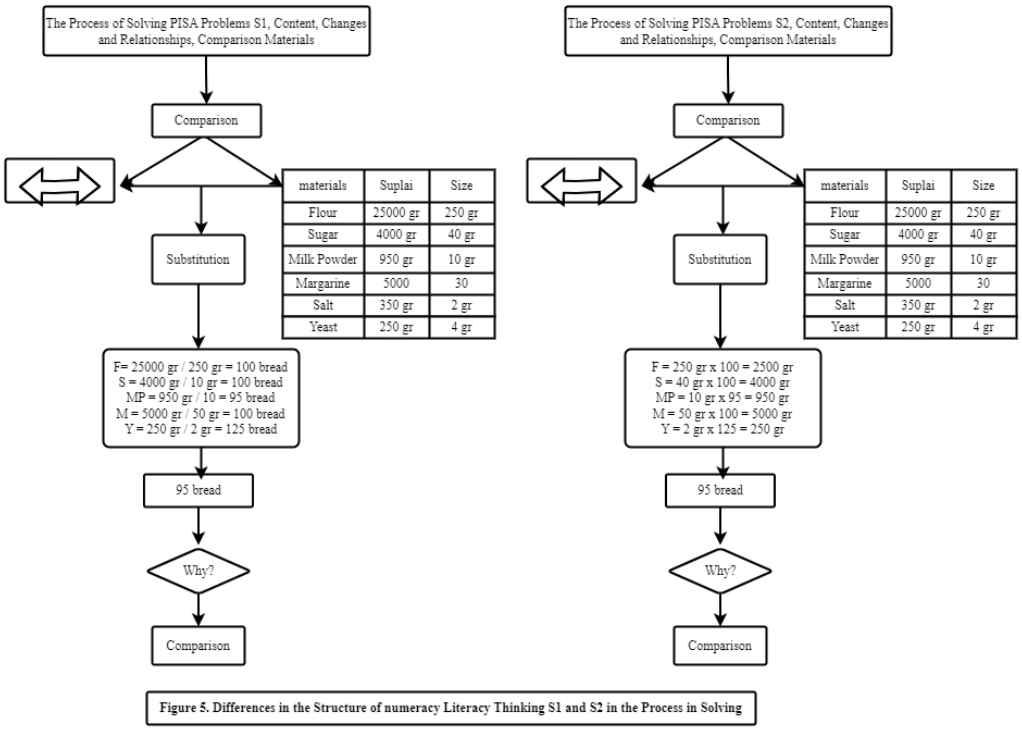

Figure 5. Differences in The Structure of Numeracy Literacy TS and S in The Process of Solving

Here are the results of the work and the reasons why S_2 makes a different settlement from S_1. S1 solves using comparisons while S2 uses multiplication or covariation. The following figure shows the completion of S2.

Known: supplies and doses of materials needed

Flour	250 gr
Sugar	40 gr
Milk Powder	10 gr
Margarine	30 gr
Salk	2 gr

Asked: how many jumbo sweet breads can be made?

Solutions:

$$Flour = \frac{25000}{250} = 100\ bread$$

$$Sugar = \frac{4000}{40} = 100\ bread$$

$$Milk = \frac{950}{10} = 95\ bread$$

$$Margarine = \frac{500}{50} = 100\ bread$$

$$Salk = \frac{250}{2} = 175\ bread$$

So, the number of sweet breads that can be made is 95 loaves

Figure 6. S1 work in solving question number 1

This is reinforced by the S2 statement as follows.

P : Now next, you already know the information listed in the question and what is asked, what is the next step?
S_2 : I compare sis, between what is available and the dosage. Flour ingredients available 2500 grams divided by 250 grams dose
P : Why?
S_2 : In my opinion, because I am asked which bread can be made from available ingredients, I compare it so that there can be many breads that can be made,
P : Why do you divide (:), not times or others? Why use surgery to find out how much bread?
S_2 : Because if divide (:) So know with the ingredients available can be bread how much sis. The division is the opposite of multiplication.

Based on the data from interviews and jobs above, these students have numeracy literacy skills, and each person has their own settlement process. This is supported by research by (Olaghere et al., 2021). This can be seen when they solve

the numeracy literacy criteria for the PISA problem. Thus, these students carry out the numeracy literacy process in solving PISA questions.

CONCLUSION

Based on the results of the research and discussion above, it can be concluded that the process of student numeracy literacy in solving PISA questions can be described as follows; 1) Students carry out the process of communicating problems, making mathematical models, making representations, being able to argue and provide reasons for being responsible for their work, being able to make good and correct solving strategies, being able to use formal language, symbol language and technical language and being able to use mathematical tools to facilitate their work. 2) There are differences in the student literacy process, namely there are students who make mathematical modeling for problem number one using comparisons and there are students who make mathematical modeling using the opposite of comparison, namely multiplication operations. Based on these conclusions, it is still possible for future research to examine how the mathematical literacy process affects students' basic mathematical abilities using PISA problems, or vice versa.

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