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Analysis of Mathematical Literacy in Solving PISA Questions Based on Ethnomathematics in Junior High School Students

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Abstract

This research analyzes mathematical literacy skills in solving ethnomathematics-based PISA questions in junior high school students. The method was used qualitative research with a descriptive approach to the subject of 3 State Middle School students in Batanghari. The instruments in this research were PISA test questions and interview guidelines. These scores were categorized into High-Level Ability, Medium-Level Ability, and Low-Level Ability. The results were based on student performance in the PISA test. The PISA test questions cover various cultures. The research results show that students' mathematical literacy abilities in solving literacy problems are reviewed from several aspects, namely 1) the understanding aspect, students can solve and understand existing problems and provide appropriate solutions; 2) the application aspect, students can understand it clearly. The overall problem, namely being able to use concepts, facts, and procedures to formulate, present, and solve problems, being able to write down information and answers to questions; 3) the reasoning aspect, students are required to understand the problem so they can solve it, question number 2, will but students still make mistakes in working on PISA questions, and 4) in the communication aspect, students can communicate their opinions well and accurately.

1. Introduction

Education is a planned effort, starting from not knowing to becoming knowledgeable, resulting in mental changes (Mudjiono & Dimyati, 2019). Learning at school encourages students to participate and provides interactive, inspiring, fun, and challenging spaces that suit students' interests, talents, and physical and psychological development (Selan et al., 2020). The education system in Indonesia requires people to study for approximately 12 years. This learning contains several subjects, one of which is mathematics.

Mathematics is one of the fields of science taught at every level of education, from elementary school to university. Mathematics has a vital role in solving problems in other subjects, work, and everyday life (Kholifasari et al., 2020). It is proven that mathematics has been used since prehistoric times. This is proven by the connection between mathematics and everyday life in society. As human civilization develops from prehistoric times to the present day, the pattern of life also follows societal developments. Every pattern of life in a society originates from the customs or culture of each region (Yudantia, Satitib, & Angelinea, 2022). Students' abilities in mathematics are measured by their ability to calculate and reason logically and critically when solving problems (Harisman et al., 2023). Good mathematical literacy is needed to develop the ability to calculate and reason logically and critically.

Mathematical literacy, one of the focuses of the PISA study, refers to a person's ability to formulate, use, and interpret mathematics in different real-life situations that help a person to recognize the role of mathematics in the real world and prepare them for their future life and work (Dewantara et al., 2015). In 2015, the Ministry of Education and Culture (*Kemendikbud*) created the School Literacy Movement (GLS) to empower students to become lifelong learners. In addition, the 2013 curriculum began to be developed,

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and literacy skills were integrated into teaching and learning activities (*KBM*), including mathematics subjects (Nilasari & Anggreini, 2019). Mathematical literacy skills are advanced skills. This is to the PISA core survey, namely reading ability, scientific ability, and mathematical ability (Masfufah & Afriansyah, 2021).

PISA *(Programme for International Student Assessment)* is an international assessment program for 15-year-old students who have acquired the knowledge and skills essential for full participation in modern society. PISA is carried out every three years and focuses on core school subjects, namely reading, mathematics, and science, and includes space and shape content, change and relationship content, number content, and uncertainty and data content (Fazzilah et al., 2020). PISA questions test content, context, and competency (Selan et al., 2020). This assessment aims to provide an overview of student literacy in various participating countries and is carried out in 4 areas, including mathematics (Kurniasari, 2019).

OECD data in 2016 shows that the criteria used by PISA to measure students' mathematical literacy abilities include: (1) communication, (2) mathematization, (3) representation, (4) reasoning, (5) building problem-solving strategies, (6) using symbolic, formal, technical and operational language, (7) with mathematical tools (Qadry et al., 2022). From 2000 to 2015, Indonesia was still in the lowest ranking, and its average score was still far from the international score (Ovan & Eka Nugroho, 2017). Based on the 2015 PISA results, Indonesia is ranked 62nd out of 70 countries in mathematics performance, with a score of 386, lower than the average score for OECD countries, namely 490, and still included in level 1 (Nilasari & Anggreini, 2019). This shows that students still need to improve their mathematical literacy. Meanwhile, the results of PISA 2022 show a decline in international learning outcomes due to the pandemic. Even so, Indonesia's ranking in PISA 2022 rose 5-6 positions compared to the previous year's PISA results. This increase in ranking shows the resilience of the Indonesian education system in overcoming learning loss due to the pandemic (Kemendikbudristek, 2023).

The PISA study focuses on students' ability to identify, understand, and use the basics of mathematics needed in everyday life. PISA questions can also be related to the culture in Indonesia. Several researchers have discussed PISA questions in a cultural context, such as (Prahmana & D'Ambrosio, 2020) using the context of Yogyakarta, (Dasaprawira et al.,2019) using the Bangka context, and (Putra, et al., 2016) using the Lampung context. Studies that contain culture and mathematics are called ethnomathematics.

Ethnomathematics was popularized in 1977 by a Brazilian mathematician named D'Ambrosio. Etymologically, *"ethno"* refers to sociocultural context, language, terminology, codes of ethics, myths, and symbols. The word *"mathema"* means knowing, explaining, understanding, and carrying out activities of coding, measuring, clarifying, reasoning, and making models. Finally, the word *"tics"* comes from techne, which means technique (Astuti et al., 2023). Ethnomathematics is a method of learning mathematics practiced in certain cultures, making it easier for someone to understand it, even though it is still relatively new education (Saputra et al., 2022). Ethnomathematics is a bridge that connects culture with mathematics. Through ethnomathematics studies, mathematical knowledge can also be rediscovered which originate from the cultural roots of different societies so that it can connect and revive students' critical reasoning and dialogue and can foster students' democratic and tolerant character by embracing cultural differences and seeing them as opportunities for mathematics education (Prahmana & D'Ambrosio, 2020).

Improvements and updates are needed in education to create quality human resources and increase Indonesia's PISA score. Knowing and recognizing students' abilities must be done to improve aspects of education.

In connection with the problems described, this research was carried out to determine the mathematical literacy abilities of students aged 15 years from the results of solving the PISA question. This research analyzes mathematical literacy skills in solving ethnomathematics-based PISA questions in junior high school students.

2. Methods

The research method used was qualitative research with a descriptive approach. Descriptive research collects information or data based on facts, then compiles, processes, and selects data for analysis according to the research focus.

The subjects in this research were junior high school students from three different schools in Batanghari District. Each school has three people. The test results showed that one student had high ability, two had medium ability, and six had low ability. Next, the researcher took 3 subjects to conduct targeted interviews. Subjects were in different categories of mathematical ability levels, namely students with high, medium, and low mathematical abilities. The sampling technique used was purposive sampling. Purposive sampling is a sample selection method with specific considerations. In this research, considerations were taken based on 1) students who have high, medium, and low abilities and 2) students who have good communication skills.

The data collection technique in this research was carried out in two stages: written tests and interviews. The written test given to students is an ethnomathematics-based PISA question comprising six questions PISA. Next, an interview was conducted with a series of questions to validate the students' work in solving the PISA questions. Triangulation will be carried out to test the validity of the data. Researchers used triangulation techniques consisting of test triangulation and interview triangulation. Triangulation is a data examination technique with several data collection techniques and sources.

3. Results and Discussion

The following are the mathematical literacy abilities of State Middle School students in Batanghari:

Table 1. Results of solving PISA questions in each category

Name (Initials)	Which school are you from	Ability Level
APS	School 2	High
NR	School 1	Medium
IY	School 2	Medium
GKR	School 1	Low
AF	School 1	Low
FI	School 2	Low
DS	School 3	Low
LJN	School 3	Low
KVAS	School 3	Low

The test results showed that one student had high ability, two had medium ability, and six had low ability. Next, the researchers took three subjects for analysis based on differences in abilities.

Table 2. Label students by ability level.

Ability Category	Name (Initials)	Informant Code
High	APS	STI-2
Medium	NR	SSI-1
Low	KSAV	SRI-3

ST labels for high-level abilities, SS for medium-level abilities, and SR for low-level student abilities. The label is I-1 for the first school, I-2 for the second school, and I-3 for the third school. The following is the labelling determined by the author.

To determine the level of student ability after completing PISA questions. There are references based on interval classes. The following is a reference table for measuring students' mathematical literacy abilities (Wati, 2023).

Table 3. Mathematical Literacy Ability Level Category.

Interval Class	Ability Level
48 < score ≤ 72	High
24 < score ≤ 48	Medium
0 < score ≤ 24	Low

The following are the results of the answers for students with a high level of ability in mathematical literacy.

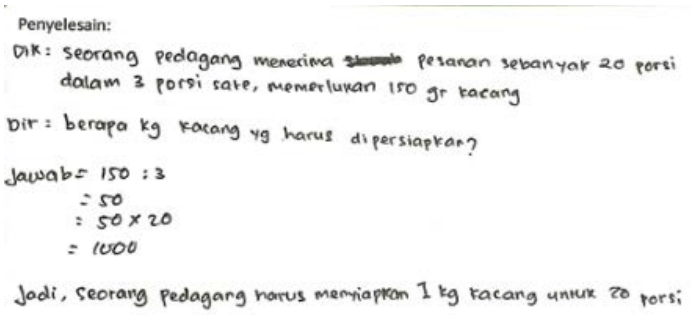
Penyelesain:
Dik: Seorang pedagang menerima [redacted] pesanan sebanyak 20 porsi dalam 3 porsi sate, memerlukan 150 gr kacang
Dit: berapa kg kacang yg harus dipersiapkan?
Jawab: 150 : 3
= 50
= 50 x 20
= 1000
Jadi, Seorang pedagang harus menyiapkan 1 kg kacang untuk 20 porsi

Figure 1. (a) STI-2 student answers.

The following interview results are to the statement above:

P : What information do you get from this statement?
STI-2 :A trader receives an order for 20 portions; making 3 portions of satay requires 150 grams of peanuts
P :What is asked about this?
STI-2 :How many kg of nuts should be prepared
P :How do you solve this problem?
STI-2 : I understand the problem first, then write down my knowledge. Then, I divide the number of nuts by the portion; after that, I get each gram of nuts and multiply the number of portions ordered. After that, change the grams to kilograms.

Based on understanding, the STI-2 subject can understand the questions presented correctly in the solution. The STI-2 can solve it well. STI-2 was able to understand the questions given, as seen in the interview process, and was able to explain them well. This is by research conducted by (Mujulifah et al., 2015) that students know facts and concepts and can interpret the problems in the questions.

Based on the reasoning aspect of STI-2, the solution procedure is to summarize and write down the information in the problem. Activities in subject interviews can explain again what has been written on the answer sheet. This is by research conducted by (Wati, 2023) that in solving problems on subject questions, they can solve them using a solution procedure, namely by making examples and writing down the information known from the problem.

Based on the implementation aspect of STI-2, it can understand the problems in the questions to provide the existing information. Then, during the interview, the research subjects can provide information about

the questions. This is by research conducted by (Mujulifah et al., 2015) that students can apply their knowledge and understanding in the application aspect.

Based on the communication aspect of STI-2, I can understand problems by reasoning in everyday life during interviews and can answer confidently and accurately. This differs from research conducted by (Mujulifah et al., 2015) that students still need to fully express their thoughts clearly in the communication aspect. This is because students need to get used to and be trained in expressing their arguments, especially in writing. Students need to be more fluent in mathematical language and rules to express mathematical ideas correctly.

The following results are for students with a medium ability level category in mathematical literacy.

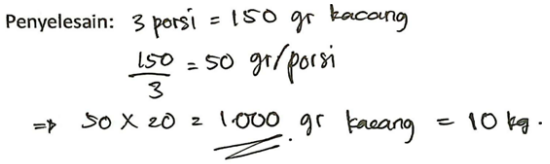

Figure 2. (a) SSI-1 student answers.

The following interview results are to the statement above:

P : What information do you get from this statement?
SSI-1 : To make three servings of satay, you need 150 grams of nuts
P : what is asked about this?
SSI-1 : How many kg of nuts should be prepared
P : How do you solve this problem?
SSI-1 : First find out how many grams of nuts are used in one serving, then multiply it by the number of servings ordered. After that, change the grams to kilograms.

Based on the SSI-1 understanding aspect, you can understand the questions that have been presented. SSI-1 can be solved well. SSI-1 understood the questions given, as seen in the interview process, and explained them well. However, they needed to be more careful in completing the final result. This is by research conducted by (Mujulifah et al., 2015) that in the aspect of understanding, students can interpret contextual problems. However, many students need to learn the facts and concepts well.

Based on the reasoning aspect of SSI-1, the solution procedure is to use examples and write down the information in the question, but the subject does not provide information. Activities in subject interviews can explain again what has been written on the answer sheet. This is to research conducted by (Wati, 2023) that the aspect of students reasonable to solve the questions and able to provide information contained in the questions.

Based on the application aspect of SSI-1, it can understand the problems in the questions to provide existing information. Then, during the interview, the research subjects can provide information about the questions. This is due to research conducted by (Mujulifah et al., 2015) that the aspect of student reasoning can apply their knowledge and understanding. However, only a few students provide the correct procedures.

Based on SSI-1, communication aspects can be explained and argued well and can be explained again when interviewed. However, it cannot provide an exact answer. This is not to research conducted by (Mujulifah et al., 2015) that the aspect of student communication still needs to be able to express the results of his thoughts clearly. This is because students are not used to and have yet to be trained in expressing their arguments, especially in writing, and more often present incorrect answers. Students must still become fluent in mathematical language and rules to express mathematical ideas correctly.

The following are the results of answers for students who have a low ability level category in mathematical literacy.

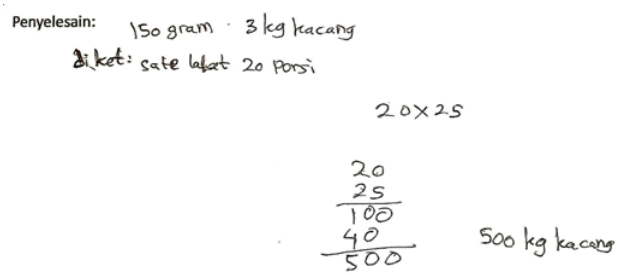

Figure 3. (a) SRI-3 student answers.

The following interview results are to the statement above:

P : What information do you get from this statement?
SRI-3 : To make three servings of satay, you need 150 grams of nuts
P : What is asked about this?
SRI-3 : How many kg of nuts should be prepared
P : How do you solve this problem?
SRI-3 :I multiplied the number of orders by 25 because there are 25 satay fillings per portion.

Based on the SRI-3 comprehension aspect, they need help understanding the questions that have been presented. SRI-3 cannot solve questions well. This is not by research conducted by (Wati, 2023) in the aspect of understanding are able to show and understand the purpose of the problem in question number 1 and can solve it.

Based on the SRI-3 reasoning aspect, the solution procedure summarizes and summarizes the information in the question. However, the subject did not provide information—interview subjects needed help explaining their answers. This is to research conducted by (Mujulifah et al., 2015) that in the aspect of student are unable to show their reasoning because they only write things that are not clear.

Based on the implementation aspect of SRI-3, it can understand the problems in the questions to provide the existing information. Then, during the interview, the research subjects can provide information about the questions. This is due to research conducted by (Mujulifah et al., 2015) that student applications need help applying their knowledge and understanding in solving problems. From the analysis of students' answers, many lower-ability students completed their answers with incorrect calculation procedures.

Based on the communication aspect of SRI-3, can understand the problem, but the communication aspect needs to be better.This is due to research conducted by (Mujulifah et al., 2015) that student communication tends to be unable to express their thoughts accurately. This is because students are not used to and have yet to be trained in expressing their arguments and presenting inappropriate answers. Students must still become fluent in mathematical language and rules to express mathematical ideas correctly.

Based on the description above, students' mathematical literacy abilities in solving PISA level 2 questions have each ability. Judging from 4 aspects, namely understanding, application aspects, reasoning aspects, and communication aspects in solving PISA level 2 questions, in terms of mathematical literacy abilities, the students have the most superior aspect of understanding. Meanwhile, what students do not master are the reasoning and communication aspects because these aspects require accuracy, and they must understand the questions to arrive at conclusions. In this case, to improve mathematical literacy, students should practice more questions with a tiered level of difficulty.

4. Conclusion

Based on the test results, analysis, and discussion of mathematical literacy abilities, seen from 4 aspects: understanding, application, reasoning, and communication, it is concluded that State Middle School students in Batanghari have mathematical literacy abilities in solving PISA questions in number 2. This is known based on the aspect of understanding that students can solve and understand existing problems and

provide appropriate solutions. Based on the implementation aspect, students can fully understand the existing problems; they can use concepts, facts, and procedures to formulate, present, and solve problems, and they can write down information and answers to questions. In reasoning, students must understand the questions to solve question number 2; however, students still need to improve when working on PISA questions. Judging from the communication aspect, students are required to be able to communicate explanations and solve problems. The questions presented are related to everyday life so that students can examine existing problems based on daily life and communicate their opinions well and accurately. In this case, to improve mathematical literacy, students should practice more questions with a tiered level of difficulty.

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