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Students' Mathematical Literacy on the Performance of PISA Questions: What is Gender Correlation?

Harfin Lanya[1], Moh. Zayyadi[2*], Sitti Karimah Sulfiah[3], Roziq[4]

[1,2,4]Mathematics Education Department, Madura University, Indonesia
[3]Mathematics Education Department, Muhammadiyah University of Malang, Indonesia
*Email: *zayyadi_unira.ac.id*

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Abstract. *Descriptive research with a qualitative approach method is used because it is accordance with the research objectives, namely to describe students' mathematical literacy towards the performance of the PISA questions in terms of gender. The subjects in this study were two students that 1 male and 1 female in the high math ability of category in grade 9 of junior high schools. Subjects were selected by purposive sampling by giving a mathematical ability test to 25 students to see their mathematical abilities, then also taking into account the mathematics teaching teacher, two students were obtained as research subjects in accordance with the purpose of the study, namely to describe students' mathematical literacy based on gender, especially students with high mathematical abilities.The instrument used was a mathematical ability test and a mathematical literacy test as well as an interview guide as research data. Based on data analysis, there is an influence of gender on students mathematical literacy level. Female's mathematical iteracy is better than male's mathematical literarcy, so there needs to be efforts to improve learning from both teachers and schools so that there are no longer differences in abilities between male and female, and gender does not affect mathematical literacy.*

Keywords*: mathematical literacy, PISA, gender*

Introduction

PISA or an abbreviation of Program for International Student Assessment is an assessment that is conducted every three years for students aged 15 years who are nearing the end of their learning throughout the world intending to assess students' knowledge and skills so that can participate fully in social and economic life (McComas, 2014; OECD, 2009, 2019; Turner & Adams, 2007). Literacy in PISA includes mathematical literacy, scientific literacy and literacy reading (Stacey, 2011; Thomson, Hillman, & Lisa De Bortoli, 2013) as a generation that can compete fully and participate in the world of globalization and modern society, with the focus of its assessment not on what students know, but rather what they can do with what they know both inside and outside school (OECD., 2016; OECD, 2019; Turner & Adams, 2007). From time to time, the focus of PISA is also on assessing non-curricular competencies according to the wishes of the participating countries (Turner & Adams, 2007).

Many studies describe that a person's ability to involve or use mathematics in his or her life which includes identification or interpretation and being able to understand the role of mathematics globally is mathematical literacy. (Breen, Cleary, & O'Shea, 2009; OECD, 2006; Yore, Pimm, & Tuan, 2007) or the ability to do a reasoning, using concepts and procedures as

well as facts and mathematical media in various contexts that involve the formulation, use and interpretation in an effort to reflect on mathematics in life (OECD., 2016). A mathematical knowledge that aims to find out and then apply the basics of mathematics in everyday life (Ojose, 2011). Important questions in mathematics learning (Zayyadi, Nusantara, Hidayanto, Sulandra, & Rahman, 2019). Use the term "literacy" to indicate the breadth of focus on the application of knowledge and skills learned inside and outside of school and not focus on curricular outcomes (Kastberg, Chan, Murray, & Gonzales, 2016). Skills development that includes mathematical reasoning and proof by using a context so as to understand a mathematical concept (Yore et al., 2007) as well as concluding (Machaba, 2018).

One of the abilities to be achieved in mathematics learning in junior high schools based on the Regulation of the Minister of Education Number 22 of 2006 concerning Mathematics Content Standards is mathematical literacy. Students are expected to understand mathematical concepts accurately, efficiently, and precisely, and focus on learning mathematics with a contextual problem-solving approach (Mendikbud, 2006). Mathematics is expected to develop students' abilities and confidence in numerical and spatial thinking so that they can interpret and analyze critically in the process of problems in their daily lives (Mendikbud, 2006). Skills and understanding must be taught in learning mathematics and emphasized more make the technical level higher (Stacey, 2011) according to the objectives of PISA, namely: focus of its assessment not on what students know, but rather what they can do with what they know (OECD., 2016) so that students are not only focused on memorizing formulas but more on understanding and skills in solving a problem. Indonesia has participated in PISA since 2003. From Indonesia's first participation to the last PISA implementation in 2015, Indonesia's ranking in mathematics literacy is still below the OECD average (OECD, 2016) and students' ability to solve PISA questions is still in the category low and below the OECD average (Wulandari & Jailani, 2018; Zayyadi & Kurniati, 2018). The obstacles faced by students in solving PISA problems are epistemological (Rahman, Suryadi, & Rosjanuardi, 2017; Sulfiah, Zayyadi, & Lanya, 2018; Wijaya, 2016). The internet, socioeconomic status and teachers are some of the things that influence the development of mathematical literacy (Kor, 2016). Also gender differences become one of the factors that influence in solving the PISA problem (Arora & Pawlowski, 2017; Lastuti, Maharani, & Pratini, 2018; Sulfiah et al., 2018).

The Gender Parity Index (GPI) in the last PISA assessment results in 2018 showed a parity index of 1.13, which means that there was no gender equality in the PISA results of Indonesian students (OECD, 2019). According to Brandell, Leder, & Nyström (2007) gender is a factor that continues to be a worldwide concern because of its influence on students' mathematical abilities. Gender shows male and female perceptions, femininity and masculinity, structuring hierarchical

and power relations in the society or perceptions, personalities, and relationships about power and leadership between male and female in social life (Locher & Scholten, 2000). Gender in this study is the difference between male and female which includes biological aspects such as biological and non-biological namely social, and cultural aspects.

The success of Indonesian students in completing PISA questions is determined by the development of students' mathematical literacy as a result of the evaluation of the system and the ability of teachers in schools (Johar, 2012) as well as homogeneity of classroom achievement and in schools (Uysal & Banoglu, 2018) and response questions that are built (Ozkan & Ozaslan, 2018) are among the achievement factors.

Based on this explanation and based on The Gender Parity Index (GPI) of PISA 2018, it is interesting to re-examine whether the gender correlation with students' mathematical literacy is a reference for teachers and schools in the future in carrying out the mathematics learning process, especially in schools. So, the formulation of the problem from this research is students' mathematical literacy towards the performance of the PISA questions in terms of gender

Method

This study is a descriptive study using a qualitative approach because it is in accordance with the research objectives, namely to describe students' mathematical literacy on the performance of PISA questions in terms of gender. The instrument used was the researcher as the main instrument and the following supporting instruments: 1) The test mathematical abilities to determine the research subject, 2) Mathematical Literacy Test (MLT), a test that contains PISA questions that have been modified and developed by previous researchers and translated into Indonesian. The form of questions is in the form of essay questions so that it can generate and develop students' ideas and creativity in thinking to find out how many indicators of student mathematics literacy can be achieved. The MLT given was in the form of essays questions consisting of 6 PISA questions that had been translated into Indonesian, with each item being representative of each PISA level. 3) Semi-structured interview guidelines, namely researchers bring interview guidelines that contain a complete and detailed set of questions to see and confirm the results of the subject's written test on mathematical literacy as research data, but if when there is an unusual interview or something that needs to be revealed more deeply, the researcher can ask new questions that are not contained in the guidelines, and 4) Validator Assessment Sheet to further validate MLT and interview guidelines to be used in research, then The author first validates it by asking the validator team to provide an assessment of the written test and interview guidelines that have been prepared by the researcher.

The selection of research subjects used a pruposive sampling technique so that two students that 1 male and 1 female in the high math ability category were selected in grade 9 of junior high schools. Subjects were selected by giving a mathematical ability test to 25 students in grade 9 of junior high schools to see their mathematical abilities, 10 questions taken from the National Examination questions are used as mathematical ability test. The test used is essay question. To be able to convince the results of the selection of subjects by consulting and asking for consideration from the mathematics teaching teacher and looking at the results of the previous semester's student report cards so that two students were obtained as research subjects

To obtain research data using the Mathematics Literacy Test (MLT) and interview guidelines. The MLT has been validated by the validator team. The interview in this study is a semi-structured interview. Each question represents each level of mathematical literacy in PISA, where the number one question represents level one and so on. The data were analyzed by first doing data reduction for then presenting the data and finally drawing conclusions. After students complete the mathematical literacy test, interviews are then conducted with students to get more information about students' test answers. Data from the results of test answers and student interviews are then reduced, the data considered to provide answers to the research are then analyzed to make a conclusion. Test the validity of the data in this study is to use time triangulation, namely by checking the degree of trust of several data sources obtained at different times. Thus, this data collection was carried out at least twice with different tasks but the contents of the tasks were the same and valid research data were obtained.

Therefore, students' mathematical literacy in solving PISA problems in terms of gender is the main focus in this study. Referring to Asmara, Waluya, & Rochmad (2017) and Johar (2012), The indicator of mathematical literacy ability that will be used in this study is the level of students' mathematical literacy ability at PISA as follows Table 1.

Table 1. Levels of Mathematical Literacy Ability in PISA

Level	Description
1	Students can solve routine problems that are the questions they usually receive at school as well as all relevant information available with clear statements.
2	Students are able to understand and translate contexts that can relate relevant information from data to be presented later. Students can work on basic algorithms, use formulas and can do simple procedures and conventions.
3	Students can carry out procedures well, they can choose and implement simple problem-solving strategies and carry out an interpretation and representation of the information and communicate the reasons
4	Students can choose, integrate a representation and connect a concrete and complex problem with real life. Students can use skills, express reasons and flexible views according to context
5	Students can find out existing problems and can make a prediction of completion. They can use broad abilities and reasoning so that they can connect their knowledge and skills in solving them
6	This level is a complex situation and requires knowledge above average. Students can conceptualize and generalize from different sources of information. At this level, students are able to think and reason in mathematics. They can apply knowledge, mastery, and relationships of mathematical symbols and operations, develop new strategies and approaches to deal with new situations. They can communicate and present what they find.

Results and Discussion

Discussion of research results is the next step after the research data are presented and analyzed descriptively qualitatively. In this article, we will only discuss one of the 6 PISA questions which is used as a research instrument as a representative of how the 6 questions are analyzed in this article to make it easier for the reader to understand and some other considerations.

One of the questions used in the study was modified Edo, Hartono, & Putri (2013) which shows the sixth indicator of mathematical literacy in PISA. The following is an analysis of the results of students' written answers and interview transcripts

Male Subjects in Solving PISA Questions

The following is one of the test results from male subjects in the questions that show the sixth indicator of mathematical literacy.

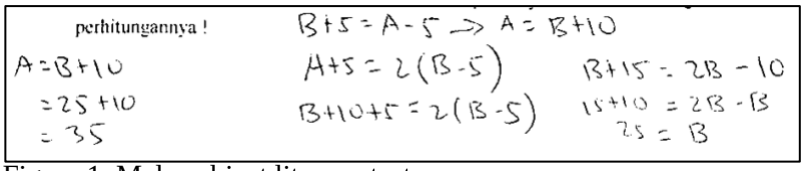

Figure 1. Male subject literacy test

The following are excerpts from interviews with male subjects. Henceforth, male subjects are called L and the researcher is P.

P35 : *Have you understand and solve problem number six?*
L35 : *yes*
P36 : *Try to explain how you solve problem number six*
L36 : *If number 6, the first statement Ira said "Ati, would you give me 3 of your candies? This means that if Ati's candy is distributed to Ira, it means B + 3 if Ati wants to give her candy to Ira, so Ati is reduced by 5 "(A - 3)". so B + 3 and A - 3, so B + 3 = A - 3.*
P37 : *So what?*
L37 : *The second statement, Ati said "No Ira why didn't you give me 4 of your candy to me, later my candy will double from yours" so if Ira gave 4 candies to Ati then the candy would be twice that of Ati's request ", can be written, A + 3 = 2 × (B-3).*
P38 : *Will you continue?*
L38 : *The first statement is B + 3 = A-3 It can be written A = B + 6 then enter into the second statement, the A is replaced by B + 6*

$$B + 6 + 4 = 2B - 8$$
$$B = 18$$

So, Ira's candy is 18 pieces, and Ati's candy is known 18 plus 6 means that Ati's candies have 24
P39 : *Please check the answer again!*
L39 : *Yes.*
P40 : *Are you sure about the answer?*
L41 : *Of course.*

Based on interviews conducted, subjects can conceptualize and generalize from different sources of information, namely based on interview excerpts: "If number 6, the first statement Ira said" Ati, would you give 3 of your candy to me? if you want then my candy will as much as your candy ", so it can be written for example Ira: B and Ati: A.

Meaning if the candy is distributed to Ira Ira means B + 3 if Ati wants to give candy to Ira so Ati is reduced by 5 "(A - 3)". so B + 3 and A - 3, so B + 3 = A - 3 "(L36)," the second statement, Ati said, "no Ira why don't you give me 4 of your sweets to me, later my candy will double from your candy "so if Ira gives 4 of her candy to Ati, the candy will be twice that of Ati's candy", it can be written, A + 3 = 2 × (B-3) sis "(L37). In this indicator, the subject has been able to think and reason mathematically, the subject can apply knowledge, mastery, and relationships of mathematical symbols and operations, develop new strategies and approvals her to deal with new situations. He can communicate and present what they find, namely: the first statement is B + 3 = A-3 It can be written A = B + 6 then enter it into the 2nd statement, the A is replaced by B + 6

$$B + 6 + 4 = 2B - 8$$

$$B = 18$$

So, Ira's candy is 18 pieces, and Ati's candy is known 18 plus 6 means that Ati's candies have 24.

Exposure is one of the indicators that is fulfilled by male subjects and based on data analysis it is found that referring to the six indicators of mathematical literacy, it reaches 4 indicators, namely: 1) Male subjects can solve routine problems that are the questions they usually receive at school as well as all relevant information available with clear statements. 2) Students are able to understand and translate contexts that can relate relevant information from data to be presented later. Students can work on basic algorithms, use formulas and can do simple procedures and conventionsple procedures and conventions. 3) Students can carry out procedures well, they can choose and implement simple problem-solving strategies and carry out an interpretation and representation of the information and communicate the reasons. 4) Subjects can conceptualize and generalize from different sources of information. At this level, students can think and reason in mathematics. They can apply knowledge, mastery, and relationships of mathematical symbols and operations, develop new strategies and approaches to deal with new situations. They can communicate and present what they find.

Female Subject in Solving PISA Questions

The following is one of the results of tests on female subjects namely on questions that show the sixth indicator of mathematical literacy. The following are excerpts from interviews with female subjects. Henceforth, female subjects are referred to as homework and researchers as P. Based on the interview excerpt above, the subject can conceptualize and generalize from

different sources of information, but in written mathematics the subject is not right in presenting ideas in mathematical form in eg many Ira candies and many Ati candies: "I think about it, namely Ira = x, Ati = y, the question is if Ati gives 3 of her candy to Ira, so Ati's candy is less 3, and ira's candy added 3, so

$y - 3 = x + 3$

$y - x = 6$ …… .. (1)

and then he said Ati if Ira gave 5 candies to Ati, then Ati's candy doubled Ira's candy, so

$2 (x - 4) = y + 4$

$2x - 8 = y + 4$

$2x - y = 12$ ……. (2) "(PR44)

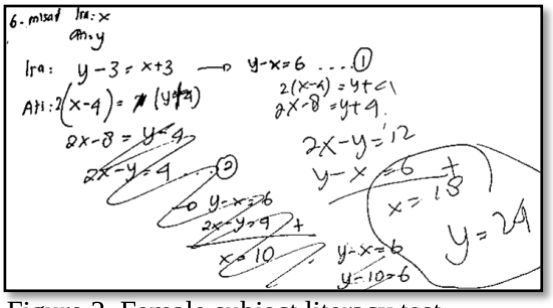

Figure 2. Female subject literacy test

In this indicator, the subject has been able to think and reason mathematically, the subject can apply knowledge, mastery, and relationships of mathematical symbols and operations, develop new strategies and approaches to deal with new situations. They got it. Communicating and presenting what they found, namely: "Then look for the values of x and y by elimination

$2x - y = 12 \rightarrow y - x = 6 \rightarrow x = 18$

substitution value x = 18 to equation 1

$y - x = 6 \rightarrow y - 18 = 6 \rightarrow y = 24$

So, the candy is Ira 18 candy and Ati 24 candy "(PR44)

Communicating and presenting what they found, namely: "Then look for the values of x and y by elimination

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substitution value x = 18 to equation 1

$y - x = 6 \rightarrow y - 18 = 6 \rightarrow y = 24$

So, the candy is Ira 18 candy and Ati 24 candy "(PR44)

The explanation is one of the indicators fulfilled by female subjects and based on the results of research, female subjects with high mathematical ability can meet 5 indicators of mathematical literacy, she has been able to solve 5 of the 6 PISA questions, where the highest question that can be solved is a question with level 6 namely: 1) Male subjects with high mathematical ability can

meet the first indicators of students' mathematical literacy on PISA questions, namely: Subjects can solve routine problems that are the questions they usually receive at school as well as all relevant information available with clear statements. 2) Students are able to understand and translate contexts that can relate relevant information from data to be presented later. Students can work on basic algorithms, use formulas and can do simple procedures and conventionsple procedures and conventions. 3) Students can carry out procedures well, they can choose and implement simple problem-solving strategies and carry out an interpretation and representation of the information and communicate the reasons. 4) Students can find out existing problems and can make a prediction of completion. They can use broad abilities and reasoning so that they can connect their knowledge and skills in solving themhand. 5) Subjects can conceptualize and generalize from different sources of information. At this level, students can think and reason in mathematics. They can apply knowledge, mastery, and relationships of mathematical symbols and operations, develop new strategies and approaches to deal with new situations. They can communicate and present what they find.

Based on the explanation of the research results, that there is a connection with the 2018 PISA results, namely there is a gap between male and female mathematical literacy and based on The Gender Parity Index (GPI) that female students' mathematical literacy is higher than male students (OECD, 2019) . A correlation with the research that had been done previously by Wulandari, Turmudi, & Hasanah (2015) that students can solve PISA questions for indicators 1-3 without experiencing too many obstacles in the process of the process, while for PISA questions indicators 4 and 5 students still experience various kinds of obstacles in solving these problems.

In contrast to previous studies by Lastuti et al., (2018) that the mathematical literacy of male students is better than female students. Judging from the achievement of the students' mathematical literacy indicators on the PISA questions in both of them, there is a difference between the two. This is reinforced by previous research that gender differences vary widely from country to country depending on variations in the topic and grade level of the study (Hana, 2000). Some of the reasons for these differences are because female students tend to be worried when they are not able to do math problems well and think that learning mathematics is very important for them to understand although this reason may be different in different places as well (Brandell et al., 2007).

Conclusion

Based on the analysis of the results of research on research subjects, it can answer the problems that have been raised in the formulation of research problems. Therefore, it can be concluded that the subject has the following mathematical literacy abilities: Male subjects with

high mathematical ability can meet 4 indicators of mathematical literacy based on PISA questions, namely, subjects can solve routine problems that are the questions they normally receive at school and all relevant information is available with clear statements. Students are able to understand and translate contexts that can relate relevant information from data to be presented later. Students can work on basic algorithms, use formulas and can do simple procedures and conventionsple procedures and conventions. Subjects can carry out procedures well, they can choose and implement simple problem-solving strategies. At this level, subjects can interpret and use representations based on different sources of information and communicate their reasons. Subjects can conceptualize and generalize from different sources of information. At different levels, this subject has been able to think and reason in mathematics. They can apply knowledge, mastery, and relationships of mathematical symbols and operations, develop new strategies and approaches to deal with new situations. They can communicate and present what they find.

Female subjects with high mathematical ability can fulfill 5 indicators of mathematical literacy based on PISA questions, namely: Subjects can solve routine problems that are the questions they normally receive at school as well as all relevant information available with clear statements. Students are able to understand and translate contexts that can relate relevant information from data to be presented later. Students can work on basic algorithms, use formulas and can do simple procedures and conventionsple procedures and conventions. Subjects can carry out procedures well, they can choose and implement simple problem-solving strategies and carry out an interpretation and representation of the information and communicate the reasons. The subject can work with models for complex situations, find out the constraints faced, and make guesses. At this level, the subject can work using broad thinking and reasoning, and precisely connect his mathematical knowledge and skills to the situation at hand. The subject can conceptualize and generalize from different sources of information. At this level, the subject has been able to think and reason mathematically. They can apply knowledge, mastery, and relationships of mathematical symbols and operations, develop new strategies and approaches to deal with new situations. They can communicate and present what they find.

Based on gender, the mathematical literacy ability of both them is seen as differences, namely female subjects are more fulfilling in achieving mathematical literacy indicators in the PISA problem. This mathematical literacy ability is seen when the subject can answer test questions correctly and correctly, then when interviewed the subject can be held accountable for what he has written on the answer sheet of test with confidence. So there needs to be efforts to improve learning from both teachers and schools so that there are no longer differences in abilities between male and female, and gender does not affect mathematical literacy.

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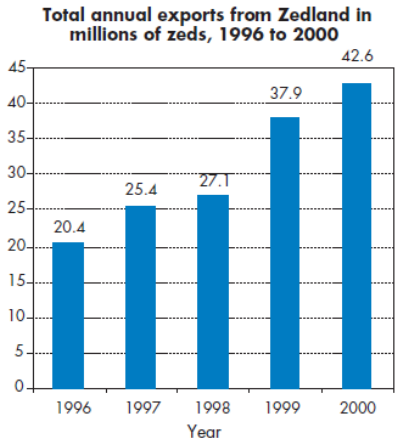
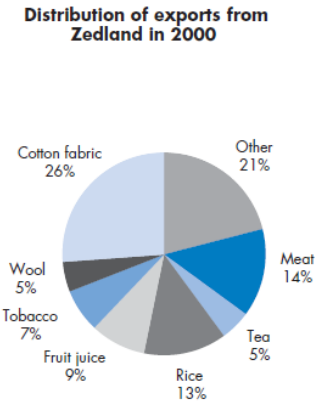
TEST QUESTIONS

The graphics below show information about exports from Zedland, a country that uses zeds as its currency.





1. What was the total value (in millions of zeds) of exports from Zedland in 1998?
2. What was the value of fruit juice exported from Zedland in 2000?
3. 

A toy car made of Balinese orange peel is one of the traditional toys of Indonesian children. Mr. Agus wants to make some of these toy cars for the children around his house. The materials needed to make the car are as listed in the table below:

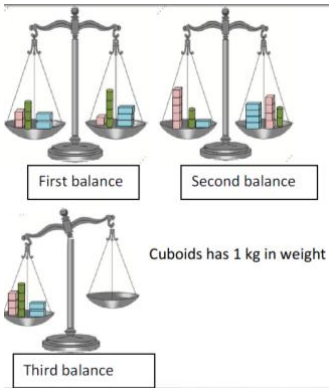
Material	Stick 	Skin for body car 	Car tires 
Amount needed to make a car	3	2	4
Quantity available	27	19	30

How many cars can Mr. Agus make from the available materials? give your reasons!

4. A pizzeria serves two round pizzas of the same thickness in different sizes. The smaller one has a diameter of 30 cm and costs 30 zeds. The larger one has a diameter of 40 cm and costs 40 zeds.

   Which pizza is better value for money? Show your reasoning!

5. How many cubes, cuboids, Cylinder that may be added at the right side of third balance such that the weights are in balance? Give 2 the combination of the types of things are possible.



6. Ira and Ati each have candies. Here is a conversation between Ira and Ati

Ira : Ati, will you give me 5 candies of yours so my candies as much with your own candies.

Ati : (Laughter) No Ira. Why do not you give me 5 candies so my candies as much twice of yours candies.

Question:

How many candies wholly owned by Ira and Ati? Write down how the calculations.