Journal of Physics: Conference Series

PAPER • OPEN ACCESS

The teachers' ability in mathematical literacy for space and shape problems on Program for International Student Assessment (PISA) adaptation test

To cite this article: H Julie *et al* 2020 *J. Phys.: Conf. Ser.* **1470** 012096

IOP Conf. Series: Journal of Physics: Conf. Series **1470** (2020) 012096 doi:10.1088/1742-6596/1470/1/012096

The teachers' ability in mathematical literacy for space and shape problems on Program for International Student Assessment (PISA) adaptation test

H Julie, F Sanjaya, A Y Anggoro, M A Rudhito and D P W Putra

Mathematics Education Department, Sanata Dharma University

Email: hongkijulie@yahoo.co.id

Abstract. The teacher's mathematical ability is one of the factors that influence the achievement of students' mathematical abilities. In Indonesia, almost all research related to PISA, the subject of research was a student. It is still rare that the subject of research was a teacher. How is the math literacy ability of the teachers? This question will be answered by researchers in this study, especially in the field of space and shape. The subjects were seven Mathematics teachers who taught in junior high schools from seven different schools in Yogyakarta and surrounding areas. In the process of this research, the researcher makes a test adapted from PISA questions. There were 13 questions in the test consisting of three questions in the quantity field, three questions in the uncertainty field, three questions in the field of change and relationship, and four questions in the field of space and shape. In this paper, we will present our result just for the Space and Shape part. The study found that (1) 7 teachers could achieve level 4 for problem 1a, (2) 6 teachers could achieve level 5 for problem 1b, (3) 2 teachers could achieve level 5 for problem 2, (4) 1 teacher could achieve level 5 and 6 for problem 3, and (4) 6 teachers could achieve level 6 for problem 4.

1. Introduction

In general, the focuses of research on PISA in Indonesia were only on how students' mathematical literacy skills [1, 2, 3, 4]. In this study, researchers will examine the mathematical literacy skills of the teachers. Descriptions of the mathematics literacy ability of junior high school mathematics teachers in quantity, space and shape, change and relationship, and uncertainty areas in Yogyakarta and surrounding areas were goals that researchers want to achieve, but in this paper, researchers would only describe the results of the research for teachers' solution on PISA adaptation tests in the space and shape.

One that affects student performance in learning mathematics is determined by the mathematics and pedagogical skills of teachers [5, 6]. From the research results obtained the fact that (1) the teacher's beliefs about how to manage mathematics learning and teaching processes affect the achievements of students in Mathematics, and (2) the teacher's attention to the Mathematics skills and knowledge of their students influences the learning process and outcomes achieved by their students [5, 6]. The results also revealed that the teacher's mathematical knowledge and skills influence on the teacher's attention to the students' mathematical knowledge and skills [5, 6]. So, it is very important to know how the mathematics literacy ability of the teachers is if we want to improve the students' mathematics literacy ability. Follow-up suggestions that need to be done to improve students' mathematical literacy skills can be recommended after the researchers have obtained results in this study.

The mathematics literacy was the ability of the individual in understanding mathematics and applying it in daily life [7, 8]. Students could understand and apply the role of mathematics in the context of real life using their mathematical literacy [9, 10]. According to Jan de Lange, the ability of a person to identify and understand the role of mathematics in real life, to make a process of drawing correct conclusions, to apply mathematics in various ways in their efforts to meet their needs as a reflective, constructive life and dedicated citizen called as the mathematics literacy ability. There are seven skills that build mathematical literacy skills, namely (1) mathematical thinking and argumentation skills, (2) logical thinking skills, (3) mathematical communication skills, (4) building model from a problem skills, (5) problem solving mathematical skills, (6) skills in presenting ideas, and (7) skills in building and using formal mathematical language [9, 11].

B. Ojose, defines the ability of mathematical literacy is the ability of a person in building and applying mathematical knowledge and skills through the process of solving problems that they faces in everyday life [7]. In other words, students' mathematical literacy skills could be built if (1) students could build mathematical knowledge and skills through the process of solving problems and (2) students could apply the knowledge and mathematical skills that they build to solve problems [7, 8].

R. Skemp (2009) explains that there are two types of understanding that students build in the process of learning mathematics, namely instrumental understanding and relational understanding. Instrumental understanding means knowing about how to use a rule or knowing how to use a formula to solve a problem, without understanding how the formula is derived, and why the formula can be used to solve the problem. Relational understanding means knowing (1) the relationship between concepts in mathematics, (2) how to use a rule, (3) how to use a formula to solve a problem, (4) how the formula is derived, and (5) why the formula can be used to solve the problem [9]. If a student has good mathematical literacy skills, then the student will have a relational understanding. Because if a student has good mathematical literacy skills, then he or she will have seven abilities that build mathematical literacy abilities that have been described previously. As a result, students will be able to build a relational understanding in the learning process.

From several studies reported that in order to be able to have usefulness in human life in the 21st century, humans must have the skills that are called as 21st century skills. There are nine skills in 21st century life skills, namely (1) critical thinking skills, (2) problem solving skills, (3) creative and innovative thinking skills, (4) communication and collaborating skills with various parties, (5) skills adapt in facing new and cross-cultural environments, (6) initiative skills, (7) productivity and accountability skills, (8) leadership and responsible skills, and (9) information and digital literacy [10, 11]. Mathematical literacy became one of the components necessary to build 21st century skills.

The questions in the PISA test have six levels of ability. The description of each level of matter could look at table 1 [12].

Table 1. Mathematical literacy ability levels

Level	Criteria
1	1. Teachers can answer questions by using all relevant information already available in the problem. 2. Teachers may use routine procedures. 3. Teachers can take action based on the stimulus provided by the teacher.
2	1. Teachers can interpret the information in the problem to solve the problem. 2. Teachers can extract information and create a representation of one source. 3. Teachers can use basic procedures. 4. Teachers are able to give a reason and can interpret the settlement obtained.
3	1. Teachers may use sequential procedures. 2. Teachers can choose and apply simple problem solving strategies, 3. Teachers can extract information and create models of representation from different sources. 4. Teachers can communicate briefly the interpretation, result, and reason made.
4	1. Teachers can work with explicit models of a complex situation and can make an assumption. 2. Teachers can choose and integrate different representations. 3. Teachers can use well-developed skills and provide a flexible reasoning. 4. Teachers can construct and communicate arguments based on their interactions, arguments, and actions.

5	1. Teachers can build and work with complex models, identify constraints, and use calibrated assumptions. 2. Teachers can evaluate resolution strategies to solve complex problems. 3. Teachers can work strategically. 4. Teachers can reflect on their solutions and communicate their interpretations and reasons.
6	1. Teachers can generalize the results of investigation and modeling of complex situations. 2. Teachers can connect information from various sources and representations. 3. Teachers can think and communicate by using advanced mathematics. 4. Teachers can apply their understanding.

2. Research Method
A design research developed by Akker and Gravemeijer was implemented in this research [13]. Because in this study, researchers wanted to achieve these aims, i. e. (1) to design a test adapted from the PISA test and (2) to describe the solution profiles of the junior high school mathematics teacher in completing the test. There are three phases in the design research developed by Akker and Gravemeijer,: (1) design development, (2) design implementation, and (3) retrospective analysis [13]. There were two activities undertaken by researchers in the first phase, namely (1) adapting the PISA test, and (2) validating the adaptation PISA test. The research process conducted by researchers can be seen in Figure 1.

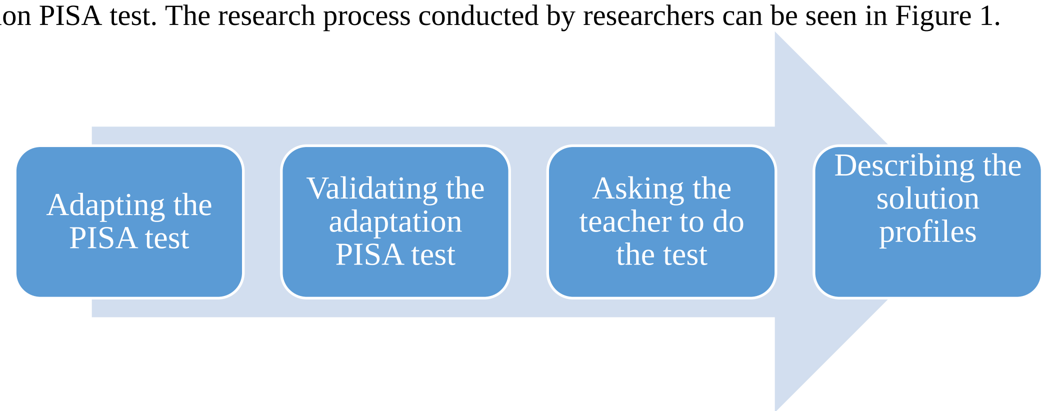


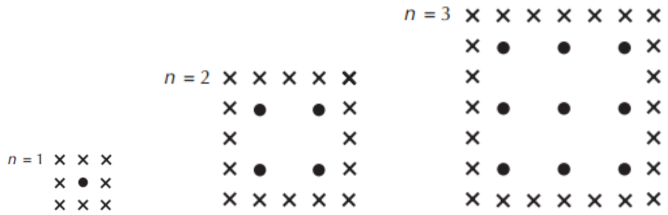
Figure 1. Stages of the research process

This test contained 13 questions, namely: (1) 3 questions for quantity, (2) 3 questions for uncertainty, (3) 3 questions for change and relationship, and (4) 4 questions for space and shape. The test was done by the teacher within 90 minutes. This research used 7 Junior High School teachers as the subject of research in Yogyakarta and surrounding areas. The selection of schools as the subjects of this study was conducted randomly proportional, then the best teachers from each school were selected as research subjects.

3. Results and Discussion
The research results that would be presented in this paper were the result test for the PISA adaptation test on the space and shape area. The results obtained were as follows:

Problem 1: Investment of Apple and Cypress Tree

A farmer planted an apple tree in a square pattern. To protect the apple tree from wind blowing he planted cypress trees around the apple tree. Below you see a diagram showing how the pattern of planting an apple tree and a cypress made by the farmer [14, 15].



Description:
× = the cypress tree and ● = the apple tree.

a. Complete the following table!

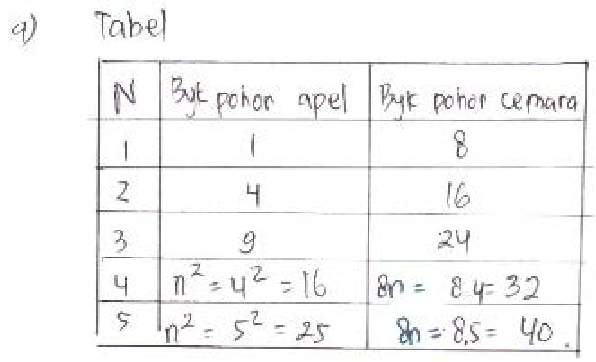
n	The number of the apple tree	The number of cypress tree
1	1	8
2	4	
3		
4		
5		

For n = 4, and n = 5 explain how you got the number of apple and cypress trees!

b. There are two formulas that can be used to calculate the number of apple tree and the number of cypress tree of the pattern described above. The formula for stating the number of apple tree is n^2, the formula for stating the number of cypress tree is 8n, with n representing many rows of apple tree grown. There is a value of n where the number of apple tree is the same as the number of cypress tree. Determine the value of n and show your way to calculate it!

Teacher's answer for the 1a section of the table:

a. There were 7 teachers who complete the table as follows:



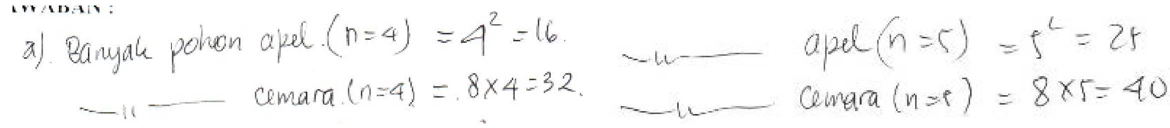
a) Tabel

N	Byk pohon apel	Byk pohon cemara
1	1	8
2	4	16
3	9	24
4	$n^2 = 4^2 = 16$	8n = 8.4 = 32
5	$n^2 = 5^2 = 25$	8n = 8.5 = 40

Figure 2. Example of a solution made by seven teachers for problem number 1a section of table for a space and shape problem

Teacher's answer for the 1a section after the table:

a. There were seven teachers who answered like this:



a) Banyak pohon apel (n=4) = 4^2 = 16. —"— apel (n=5) = 5^2 = 25
—"— cemara (n=4) = 8x4=32. —"— cemara (n=5) = 8x5 = 40

Figure 3. Example of a solution made by seven teachers for problem number 1a after the table section for the space and shape problem

From the problem, there was a diagram showing the pattern of planting an apple tree and a cypress tree for n = 1,2, and 3. Therefore, to fill the table for n = 1, 2, and 3, the teacher could do in two ways, i.e., counting from the image in the problem, or find patterns from the available diagrams. To fill the table for n = 4 and 5, the teacher could already find the pattern. The teacher found that for n = 4, the number of apple tree was 42 = 16 and the number of cypress tree was 8 x 4 = 32. The teacher found that for n = 5, the number of apple trees was 52 = 25 and the number of pine trees was 8 x 5 = 40. The process of the teacher in finding the pattern of rows to find many apple and cypress trees for n = 4 and 5 could be leveled into level 4 because the teacher could explain that to search for many apple trees based on the pattern of squared numbers and many cypress tree based on the pattern of sequences multiples of 8. This means that teachers could select and integrate different representations and relate to each other in real-world situations.

Teacher's answer to question 1b:

a. There were two teachers who answered like this:

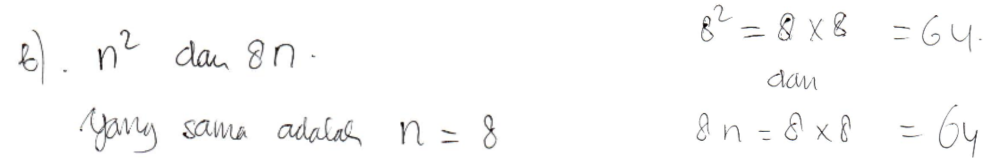


Figure 4. Example of completion made by two teachers for problem number 1b for the space and shape problem

From section 1a, the teacher has found that if n denotes many rows of apple trees grown, then many apple trees are n^2, and the number of cypress tree is 8n. From this result, the teacher then thinks when n is worth what causes the value of n^2 to be equal to 8n. Teachers discovered that this is the case for n = 8. The invention process began with seeing that the number of cypress tree is 8n, if n is taken the same value as coefficient of the 8n, then the teacher would find the value of n which causes the value of n^2 equal to 8n. The teachers' solution process as mentioned above could be leveled into level 5, because teachers could reflect on the actions that they did, and teachers could formulate and communicate their interpretations and reasons.

b. There were four teachers who answered like this:

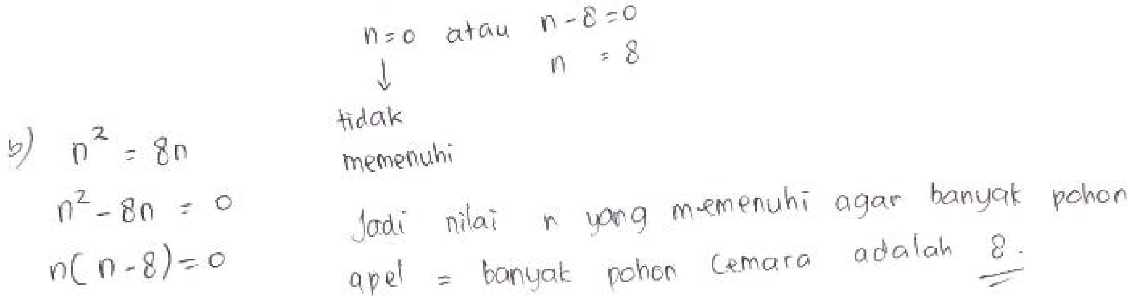


Figure 5. Example of a solution made by four teachers for problem number 1b for the space and shape problem

From section 1a, the teacher had found that if n denotes many rows of apple tree grown, then the number of apple tree was n^2, and the number of cypress tree was 8n. Then, the teacher transforms the question, that is, when n is worth how the value of n^2 is equal to 8n into the mathematical question, that is, what is the value of n that makes $n^2 = 8n$. The existence of this transformation process causes the teacher to deal with the problem of finding the root of a quadratic equation, i.e. how to find the value of the variable n satisfying the equation $n^2 = 8n$. From the quadratic equation, the teacher could find that the roots of the quadratic equation were 0 and 8. After that, the teacher eliminated the root 0 with the context of the problem, i.e. the value of n is not possible 0 because n denotes many rows of apple trees grown. Consequently, the teacher found that the value of n making apple trees equal to the number of cypress trees was 8. The teacher process in solving this problem could be leveled into level 5 because teachers could develop and work with mathematical models for complex circumstances, identify obstacles, and make the assumptions used to find solutions.

c. There is 1 teacher who does not answer this question.

Problem 2: The Vast of Continent

Here is an Antarctic map!

Estimate the area of Antarctica in the image on the side using the map scale. Write down your answers and explain how you found the answers to those questions! [14, 15]!

Teacher's answer to question 2:

a. There were four teachers who answered like this:

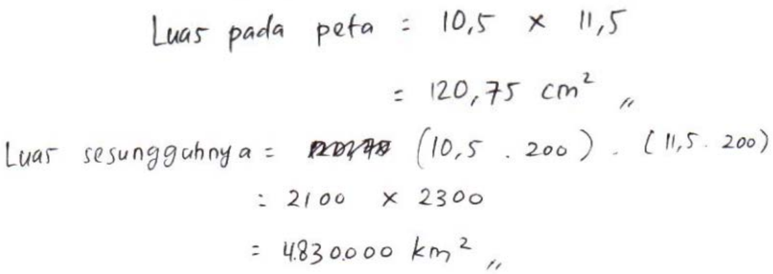
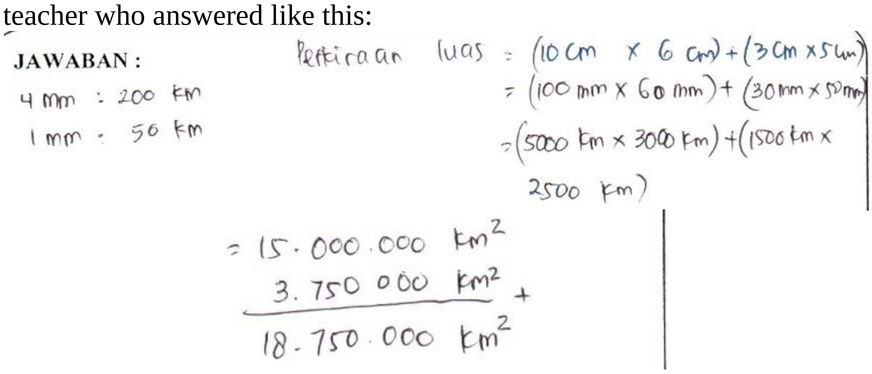


Figure 6. Example of completion made by four teachers for problem number 2 for the space and shape problem

From the problem, the teacher got information that the distance of 1 cm on the map represents the actual 200 cm distance. The teachers' idea was to create a small rectangle that could frame the Antarctic region, and the teachers could measure the length and width of the rectangle. After that, the teachers seek the length and width of the actual rectangle by using the known scale information in the problem. Next, the teachers seek the actual square area, by multiplying the length and width of the rectangle, to obtain the Antarctic area. The teachers' solution processes could not be classified into level 5 because in the process of completion, teachers have not been able to develop and work with mathematical models for complex circumstances, identify barriers, and made assumptions used to find solutions.

b. There is one teacher who answered like this:



IOP Conf. Series: Journal of Physics: Conf. Series **1470** (2020) 012096 doi:10.1088/1742-6596/1470/1/012096

Figure 7. Example of completion made by a teacher for problem number 2 for the space and shape problem

From the problem, the teacher got information that the distance of 1 mm on the map represents the actual 50 km distance. The teacher's idea was to create the smallest rectangles that could frame the Antarctic region and the teacher could measure the length and width of the four rectangles. After that, the teacher looked for the length and width of each real rectangle by using the known scale information in the problem. Next, the teacher looked for the area of the two real rectangles, by multiplying the actual length and width of the rectangle. After that, the teacher would gain an area from the Antarctic region by adding the actual breadth of the two rectangles. The teacher's solution process like this could be classified into level 5 because in the solution process, the teacher could develop and work with mathematical models for complex circumstances, identify barriers, and specify assumptions that are used to find solutions.

c. There is one teacher who answered like this:

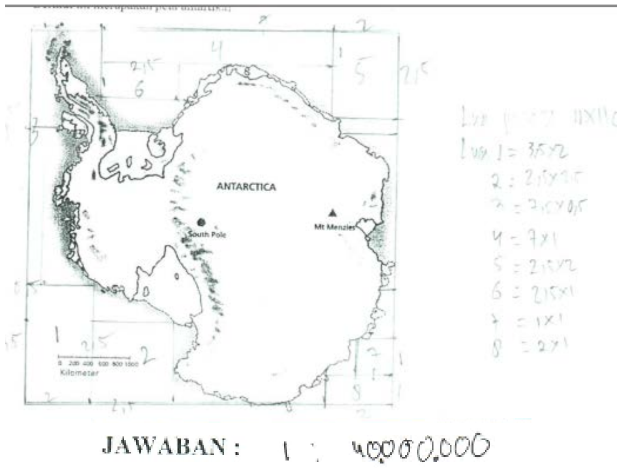
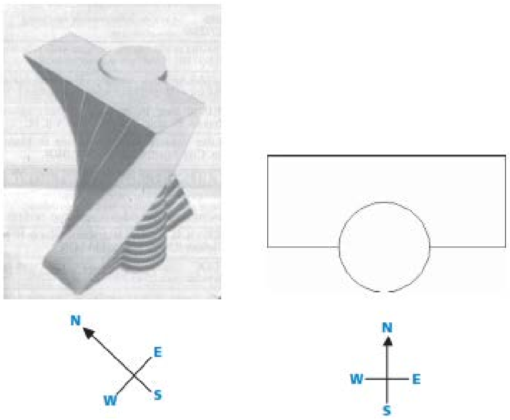


Figure 8. Example of completion made by one teacher for problem number 2 for the space and shape problem

From the problem, the teacher got information that the distance of 1 cm on the map represents a distance of 400 km or 40.000.000 cm actually. The teacher's idea was to create a small rectangle that could frame the Antarctic region, and the teacher made the smallest 10 rectangles that could cover the area outside of Antarctica but still inside the frame. The teacher measures the length and width of the ten rectangles. After that, the teacher looked for the area of each rectangle. To find the widest Antarctic, the teacher subtracts the frame area on the map with the tenth rectangular area on the map. To find the area of Antarctica, the teacher multiplies the obtained area multiplied by 40,000,000 m^2. The teacher's solution process could be classified into level 5 because in the solution process, teacher could develop and work with mathematical models for complex circumstances, identify barriers, and specify assumptions that were used to find solutions.

d. There is a teacher who did not answer this question.

Problem 3: A Twisted Building



In modern architecture, buildings often have unusual shapes. The picture on the side shows a computer model of a "twisted building" and a plan of ground floor shape. The direction of the compass showed the direction of the building. The ground floor of the building contained the main entrance and had some space for shops. Above the ground floor, there were 20 levels of apartments. The plan for each floor was the same as the plan for the ground floor, but each floor had a slight direction difference from the previous floor. The tube section contains a hole for the lift and the elevator would stop on every floor.
Estimate the height of the building in meters!

Explain how you found the answer [14, 15]!
Teacher's answer to question 3:
a. There is 1 teacher who answered like this:

Tinggi gedung :
lantai dasar 1
Lantai diatasnya ada 20 lantai
Jadi ada 21 lantai
jika tinggi masing masing lantai 4 m
maka tinggi gedung 21 x 4 = 84 meter

Figure 9. Example of completion made by a teacher for problem number 3 for the space and shape problem

From the problem, the teacher got information that there was one ground floor and there were 20 floors above the ground floor inside the building. So, there were 21 floors inside the building. The height of each floor was not known in the matter, so the teacher assumed that the rational height of one floor was 4 meters, so that the height of the building could be searched by multiplying the number of floors assuming with the height of each rational floor. Thus, the teacher obtaining the height of the building was 21 x 4 meters = 84 meters. The teacher's solution process in solving this problem could be incorporated into level 6, because the teacher could formulate and communicate precisely what they did, reflected and interpreted their findings, and applied the arguments that they made in real situations.
b. There is one teacher who answered like this:

Perkiraan tinggi gedung = 20 x 3 meter
= 60 meter.

Figure 10, Example of completion made by one teacher for problem number 3 for a space and shape problem

From the problem, information obtained by the teacher there were only 20 floors above the ground floor inside the building. He or she did not get information that inside the building there was one ground floor. The height of each floor is unknown in the matter, so the teacher assumes that the rational height of one floor is 3 meters, so that the height of the building could be found by multiplying the number of floors assuming with the height of each rational floor. Thus, the teacher obtaining the height of the building is 20 x 3 meters = 60 meters. The teacher's solution process in solving this problem could be incorporated into level 5, because the teacher could reflect on his or her actions, formulate and communicate the interpretations and reasons that he or she made even though his or her understanding of what was known from the problem was incomplete.

c. There were two teachers who answered like this:

Jika lantai dasar memiliki tinggi x meter,
dan tinggi setiap lantai sama dengan lantai dasar,
Maka tinggi gedung = (1 lantai dasar + 20 lantai) . x meter
= 21 x meter.

Figure 11. Example of completion made by 2 teachers for problem number 3 for a space and shape problem

From the problem, the teacher got information that there was one ground floor and there were 20 floors above the ground floor inside the building. So, there were 21 floors inside the building. The height of each floor was not known in the problem, so the teacher assumed the height of each floor with the variable x, so the height of the building was still expressed by the variable x, which was 21 x. The teachers' solution process in solving this problem could not yet be incorporated into level 6 because teachers have not been able to formulate and communicate precisely what they did, reflected and interpreted their findings, and applied the arguments that they made in real situations.

d. There were 3 teachers who did not answer this question.

Problem 4: PIZZA

The pizza restaurant sells two kinds of pizzas that have the same thickness but with different diameters. Small pizza price 30 cm in diameter is Rp 30.000,00 and the price of large pizza diameter 40 cm is Rp 40.000,00. Which pizza is more profitable if you buy it? Explain your reasons [14, 15]!

Teacher's answer to question 4:

a. There was one teacher who answers the following:

lebih menguntungkan membeli pizza ya
besar

karena: perubahan diameter yang sebesar 10 cm dari 30 cm ke 40 cm menyebabkan perubahan luas pizza yang besar yaitu sekitar $(40^2-30^2)3,14$
$= 700 \times 3,14$
$= 2198$ cm

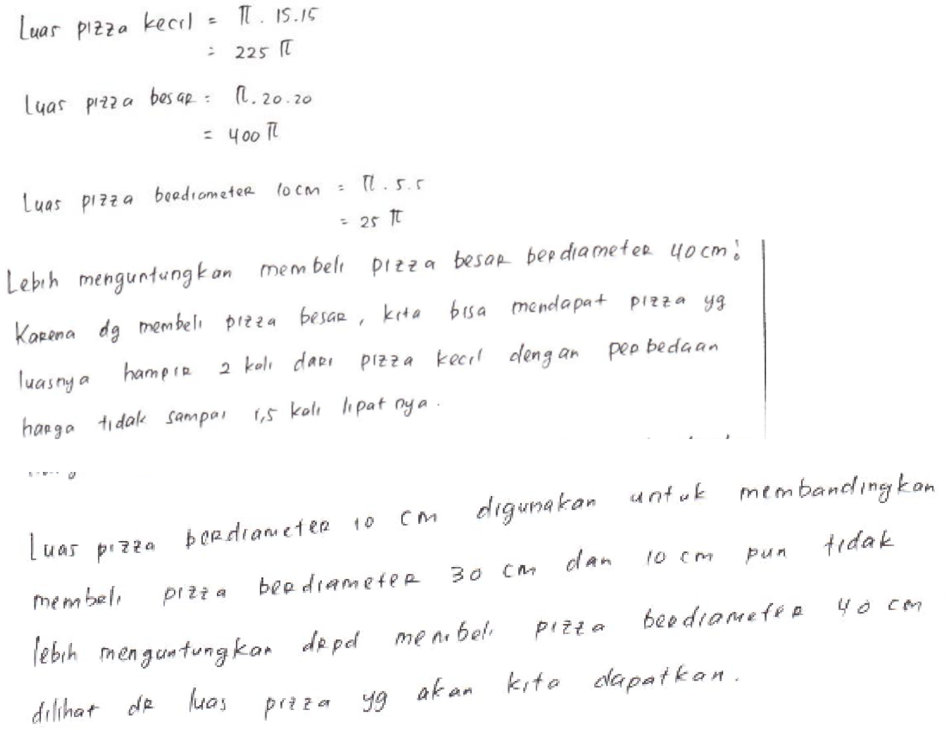
atau $\frac{2198}{30^2 \cdot 3,14} \times 100\% = 77\%$

padahal kenaikan harga hanya $\frac{10.000}{30.000} \times 100\% = 33\%$

Figure 12. Example of completion made by a teacher for problem number 4 for a space and shape problem

From the problem, the teacher got information about the diameter and price of large and small pizzas, and the thickness of each type of pizza is the same. The idea of the teacher to answer this problem was to compare the rate of changes in the surface area of the pizza because the thickness of each type of pizza was equal to the rate of change in the price. For the rate of broad change, teachers get 77%, while for the rate of change the price of teachers get 33%. Therefore, the teacher concludes that it is more profitable to buy a pizza with a larger diameter. The teacher's thinking process in solving this problem can be leveled at level 6, because the teacher could conceptualize, generalize, and use the information contained in the problem underlying his or her investigation.

b. There were two teachers who answered like this:


Luas pizza kecil = π . 15.15
= 225 π

Luas pizza besar = π.20.20
= 400 π

Luas pizza berdiameter 10cm = π . 5.5
= 25 π

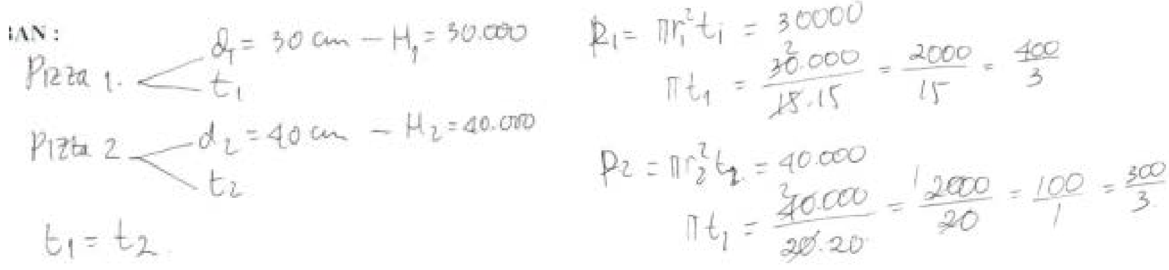
Lebih menguntungkan membeli pizza besar berdiameter 40cm.
Karena dg membeli pizza besar, kita bisa mendapat pizza yg luasnya hampir 2 kali dari pizza kecil dengan perbedaan harga tidak sampai 1,5 kali lipatnya.

Luas pizza berdiameter 10 cm digunakan untuk membandingkan membeli pizza berdiameter 30 cm dan 10 cm pun tidak lebih menguntungkan dpd membeli pizza berdiameter 40 cm dilihat dr luas pizza yg akan kita dapatkan.

Figure 13. Example of completion made by 2 teachers for problem number 4 for space and shape problem

From the problem, teachers got information about the diameter and price of large and small pizzas, and the thickness of each type of pizza is the same. The idea of the teacher to answer this problem was to compare the changing surface area of the pizza because the thickness of each type of pizza was the same as the price change. Teacher explained that the change of the area of pizza was almost 2 times while the price change was not up to 1.5 times, Therefore, the teacher concluded that it is more profitable to buy pizza with a larger diameter. The teachers' thinking process in solving this problem could be classified at level 6, because the teacher could conceptualize, generalize, and use the information contained in the problem underlying his or her investigation.

c. There were 3 teachers who answered like this:


IAN :

Pizza 1. < $d_1 = 30$ cm — $H_1 = 30.000$; t_1

Pizza 2 < $d_2 = 40$ cm — $H_2 = 40.000$; t_2

$t_1 = t_2$

$P_1 = \pi r_1^2 t_1 = 30000$

$\pi t_1 = \frac{30.000}{15.15} = \frac{2000}{15} = \frac{400}{3}$

$P_2 = \pi r_2^2 t_2 = 40.000$

$\pi t_1 = \frac{40.000}{20.20} = \frac{2000}{20} = \frac{100}{1} = \frac{300}{3}$

Figure 14. Example of completion made by 3 teachers for problem number 4 for space and shape problem

From the problem, teachers got information about the diameter and price of large and small pizzas, and the thickness of each type of pizza was the same. The teachers' idea to answer this problem was to compare the price per cm 3 of each pizza. For small diameter pizzas, the teacher earning a price per cm 3 was $\frac{400}{3}$, while for large diameter pizza, the teacher earning the price per cm 3 was 100. Therefore, the teacher concluded that it is more profitable to buy a pizza with a larger diameter. The teachers' thinking process in solving this problem could be classified at level 6, because the teacher could conceptualize, generalize, and use the information contained in the problem underlying his or her investigation.

d. There was one teacher who answered like this:

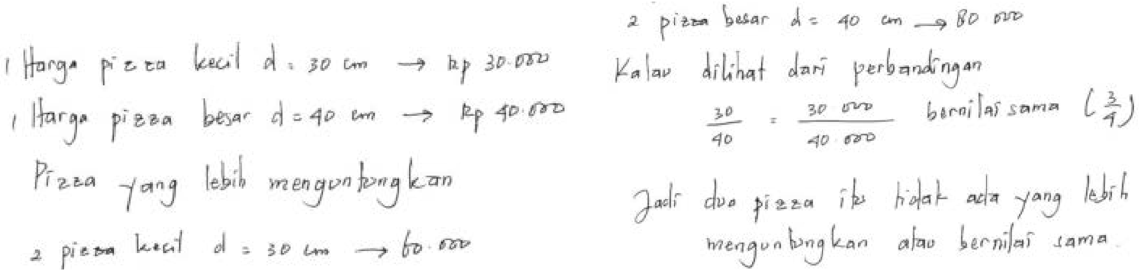


Figure 15. Example of completion made by a teacher for problem number 4 for space and shape problem

From the problem, the teacher got information about the diameter and price of large and small pizzas, and the thickness of each type of pizza was the same. The teacher's idea to answer this problem was to compare the rate of change in pizza diameter because the thickness of each pizza type was the same as the price change. The teacher explained that the rate of change of diameter was equal to the rate of change of price. The teacher's thinking process in solving this problem could not yet be leveled in level 6, because the teacher has not been able to conceptualize, generalize, and use the information contained in the problems underlying his or her investigation.

The results achieved by teachers could be summarized in the following table 2.

Table 2. Teacher's achievement summarized

Problem	Teacher's Achievement Level	The Number of Teachers	Percentage
1a	4	7	100
1b	5	6	85.71
2	5	2	28.57
3	5	1	14.29
	6	1	14.29
4	6	6	85.71

4. Conclusions

From the results and discussion part, there were several things that could be concluded, namely: (1) For problem 1a, all teachers' answer could be classified in level 4, (2) For problem 1b, six teachers' answer could be classified in level 5, (3) For problem 2, two teachers' answer could classified in level 5, (4) For problem 3, a teachers' answer could classified in level 5 and 6, and (5) For problem 4, six teachers' answer could classified in level 6.

From the analysis results obtained that the teacher has mathematical literacy ability in the field of space and shape, because the teacher could reach a minimum level 4 for problems in the field of space and shape. Therefore, the follow-up that can be suggested by researchers is that the teacher needs to be guided in managing learning so that after following the learning process carried out by the teacher, students can have a relational understanding. In addition, in the learning process, teachers need to provide opportunities for students to build high order thinking skills (HOTS).

Acknowledgments
Our thanks to the Ministry of the Research, Technology and Higher Education has been funding this research so we could finish this research and present this publication through Penelitian Terapan grant at 2019 distributed through the Sanata University Dharma.

References

[1] Wulandari N F and Jailani 2018 Mathematics skill of fifteen years old students in Yogyakarta in solving problems like PISA *IndoMS Journal Mathematics Education* **9** 129–44
[2] Ahyan S, Zulkardi, and Darmawijoyo.2014 Developing mathematics problems based on pisa level of change and relationships content *IndoMS Journal Mathematics Education* **5** *47–56*
[3] Hongki J, Sanjaya F and Anggoro A Y 2017 The Teachers' ability in mathematical literacy for quantity problems on PISA adaptation test *AIP Conference Proceedings* **1868** 050026; doi: 10.1063/1.4995153
[4] Hongki J, Sanjaya F and Anggoro A Y 2017 The students' ability in mathematical literacy for the quantity, and the change and relationship problems on the PISA adaptation test *Journal of Physics Conference Series* **890** 012089
[5] Campbell P F *et al* 2014 The relationship between teachers' mathematical content and pedagogical knowledge, teachers' perceptions, and student achievement *Journal for Research in Mathematics Education* **45** 419–59
[6] Cochran K F, King R A and De Ruiter J A 1991 Pedagogical content knowledge: A tentative model for teacher preparation *The Annual Meeting of the American Educational Research Association Chicago*
[7] Ojose B 2011 Mathematics literacy: Are we able to put the mathematics we learn into everyday use? *Journal of Mathematics Education* **4** 89 – 100
[8] Christiansen I B 2006 Mathematical Literacy as A School Subject: Failing The Progressive Vision? *Pythagoras* **64** 6 – 13
[9] Skemp R R 2009 *Psychology of Learning Mathematics* (New York: Routledge Taylor & Francis Group)
[10] Stacey K 2011 The PISA view of mathematical literacy in Indonesia *Journal Mathematics Education* **2** 95 – 126
[11] Wijaya A 2016 Students' information literacy: A perspective from mathematical literacy *IndoMS Journal Mathematics Education* **7** 73 – 82
[12] Julie H dan Marpaung Y 2012 PMRI dan PISA: suatu usaha peningkatan mutu pendidikan matematika di Indonesia *Widya Dharma* **23**
[13] Akker Den J V, Gravemeijer K, McKenney S and Nieveen N 2006 *Educational Design Research* (New York: Taylor and Francis Group)
[14] OECD 2012 *Assessment Framework. Key Competencies in Reading, Mathematics and Science* (Paris: OECD)
[15] OECD 2013 *PISA 2012 Results: What students know and can do. Student Performance in mathematics, reading, and science* (Paris: OECD)