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Research Article

Mathematical problem-solving ability of junior high school students

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ABSTRACT

Mathematical problem solving is the process of using students' knowledge to find solutions to problems. Students are This study aims to describe the ability of mathematical problem solving in circle content. This research focuses on solving problems based on 4 stages of Polya, namely the ability to solve problems, organize, plan, and check results. This research uses descriptive qualitative method. The research subjects were 6th grade students of SMPN 1 Meureudu as many as 6 people. The selection of subjects was done by purposive sampling with the criteria that students who were recommended by mathematics' teachers based on the best grades and had participated in at least one Math Olympiad. The research instrument used mathematical problem-solving tests and interviews. Data analysis technique is done by analyzing student work data, interpreting, and concluding. The results of data analysis showed that students' mathematical problem-solving abilities were still low. The low problem-solving ability is seen based on indicators of prob-lem-solving ability that cannot be achieved by most students.

Keywords: Problem Solving Ability; Polya's Stage; Junior High School

1. INTRODUCTION

Problem solving has long been seen as an important aspect in mathematics learning (Liljedahl, 2016). Problem solving is even considered to be the heart of mathematics (Dossey, 2017; Schoenfeld, 2013). The Ministry of National Education (Kemendikbud, 2016) states the ability to solve problems as one of the objectives of studying mathematics. Developments in mathematics learning also require students to be able to master their problem solving abilities (Aydogdu & Kesan, 2014). Students who have the ability to solve problems can practice the ability to think, apply procedures, and deepen conceptual understanding (Das & Chandra, 2013). Problem solving skills involve high and low level thinking (Siagian et al., 2019). A question is said to be a problem if the problem or question is challenging to solve, and the procedure for solving it cannot be done routinely (Widjajanti & Bondan, 2009). Batubara et al., (2017) explain that problem solving skills are strategies or ways students solve problems using systematic action. Strategies or steps that can be used to solve problems according to Polya's stage (Polya, 1945) which are understand the problem and identify clearly what is asked, connect the problem to get ideas about solutions and plan solutions, carry out the idea of a solution, consider the solu-tion that has been obtained. But in reality, mathematical problems taught and studied in class often do not represent meaningful context of problem solving (Koedinger & Nathan, 2004; Walkington et al., 2013). Students have difficulty in solving problems because they are not used to working on problem solving skills (Windari et al., 2014). Novferma (2016) revealed that in solving prob-lem-solving test questions students felt that the time given was insufficient, gave up easily, was less thorough, often forgot, felt anxious, and students were in a hurry when working on the questions.

This condition causes students' problem solving abilities to be low (Mawaddah & Anisah, 2015; Nurhayati & Zanthy, 2019; Widodo & Kartikasari, 2017). The low ability of students' problem solving skills can be seen based on the results of the National Mathematics National Examination (UN) scores at the junior high school level especially in Aceh Province in 2015 to 2019 which dropped dramatically from 73.89 to 40.30. PISA 2019 (OECD, 2019) also shows that Indonesia is still ranked 72 out of 77 countries, with a student mathematical ability score of 379. This score is below the average score of 489. In addition, researchers have made preliminary observa-tions of several junior high schools located in the city of Banda Aceh and its surroundings, namely MTsN Model Banda Aceh, SMP Negeri 2 Banda Aceh, and MTsS MUQ Pagar Air. The results of observations and interviews from the three schools stated that the learning process in schools so far, especially during the pandemic, took place online. Teachers must change the learning method that was originally face-to-face to online learning. During online learning, lesson hours (JP) for math lessons have been reduced from 40 minutes to 30 minutes. Teachers must also prepare learning methods that are different from those that have been done before. The process of delivering learning materials online is carried out using the WhatsApp application, school e-learning links, Zoom, and so on.

The material is delivered in various ways, including making or downloading learning videos available on the internet according to the topics being taught, or simply sending teaching materials to WhatsApp groups that have been created, and even doing learning via Zoom or Gmeets. This makes the teacher as a teacher must be able to determine the right strategy and media to deliver teaching material so that it is easily accepted and understood by students.

Furthermore, the teachers explained that before learning took place, they had to first prepare a learning video which would later be distributed to students. Based on the explana-tion from the teacher, the learning videos distributed to students are short and simple videos. The video contains an ex-planation of material made using PowerPoint and followed by a brief explanation from the teacher via video conference and of course also adjusted to the agreed number of JP. The teacher also mentioned that learning that only relies on video con-ferencing without direct discussion in class results in ineffec-tive learning. This research will be different from previous research. This study will focus on how students solve mathematical problem solving skills based on polya stages in circle content and data collection techniques are carried out virtually. Based on the presentation of reality, the researcher wishes to conduct re-search related to the mathematical problem solving abilities of junior high school students.

2. RESEARCH METHOD

This research uses a qualitative approach with descriptive methods. The research subjects were 6th graders of SMPN 1 Meuredu as many as 6 of 30 students. The selection of subjects was done by purposive sampling with the criteria in question namely students who were recommended by mathematics' teachers based on the best grades and had participated in at least one Math Olympiad. The instrument used in this study was a test of problem-solving skills and interviews. There are 2 test-solving abilities that have been validated by the validator and a semi-structured interview guide sheet. The following is presented about the problem-solving abilities used:

1. A circular table with a diameter of 2 m will be placed on a table cloth. Determine the area of the tablecloth if the tablecloth must hang more than 1.5 m from the table?
2. You are asked to design a sports bag shaped as follows.

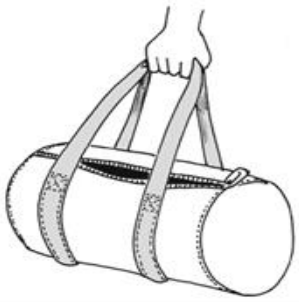


Figure 1. Bag

The following information is provided regarding the bag that will be designed:

1) The requested bag length is 60 cm, and has a circular end in the form of a circle with a diameter of 25 cm
2) The main part of the bag is made of 3 pieces, namely one for the curved middle, and 2 other pieces for the circular ends.
3) Each piece needs to be added by 2cm around it so that the pieces can be sewn together.

a. Make a sketch of each piece needed for the bag body. Sketches don't have to be scaled. Indicate all measurements required for the sketch created.
b. If this bag will be made from a roll of cloth 1 meter wide. What is the shortest length of fabric needed from the roll to make the bag? Explain the solution of the case using words and sketches.

Data was obtained via WhatsApp video call due to the Covid-19 outbreak. The results of answers that have been done by students are sent via WhatsApp contact. The data analysis technique is based on the concept of Miles and Huberman, namely: data reduction, data presentation, and concluding.

3. RESULTS AND DISCUSSION

The results showed that the problem-solving ability of students at SMPN 1 Meureudu still needed more attention. From the 2 questions given, most of the students 'answers were not as expected especially for question number 2. There were only 1 of the 6 students' answers that were correct, but the completion process that was done was not yet optimal. During the interview, the students claimed they did not know how to solve the problem given precisely because they were not accustomed to getting problems like the problem.

This statement is in accordance with the phrase (Saputri, 2017) that the lack of training experience on non-routine / similar problems can cause students to wrongly plan the solution of a problem. Students also find it difficult to analyze questions, especially questions number 2. This is in accordance with statements Kudsiyah et al., (2017) which reveal that in solving problems solving problems students tend to be difficult in analyzing problems, understanding problems, working

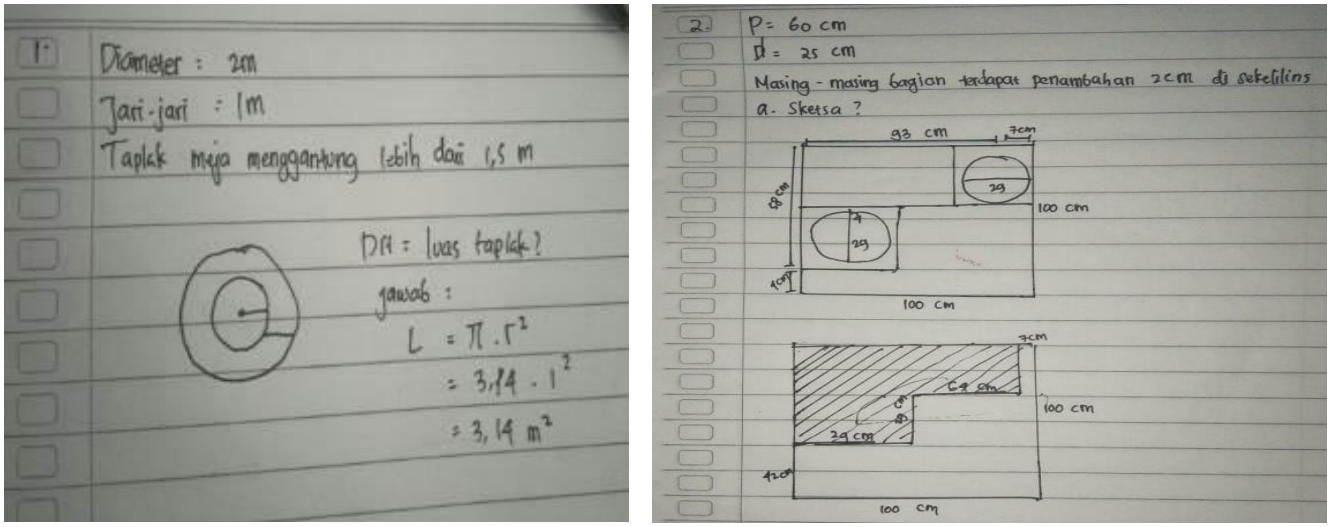
processes, forgetting formulas and even experiencing calculation errors. The focus of this research is to describe the process of solving students' problems according to Polya's stages. Baroody (1993) explains the criteria for each phase of problem solving according to Polya as follows:

1. Understand the problem by stating the problem in its own words, determining what is known, or determining what information is needed.
2. Make a plan by sketching, examining several examples, compiling data in a list, table, or diagram, and simplifying the problem and looking at the pattern, or using logical reasoning to eliminate possibilities that are not needed.
3. Carry out the plan that has been made, whether it can run or not.
4. Re-check by determining whether the solution obtained makes sense, answers the questions / problems provided or if there are other solutions.

Following are the results of students' answers to questions number 1 and number 2 for each subject that has been tested:

Subject 1

Subject 1 solved questions number 1 and number 2a by writing down the information given in the form of what is known, asked, and the conditions that must be met from the problem. This shows that Subject 1 has been able to fulfill the first stage of problem solving namely understanding the problem. Subject 1 has also been able to draw up a problem-solving plan by simplifying the problem through drawing/ sketching in accordance with the information about the problem. However, for question number 1, Subject 1 made a mistake in entering the value of the known radius of the formula. Based on the results of the interview, Subject 1 ignored additional information about the tablecloth hanging over 1.5 m. Subject 1 only focuses on the value of the previously written radius without linking it to further information. Therefore Subject 1 also experienced a miscalculation so that the answer for Subject 1 was declared wrong. As for problem number 2a, Subject 1 has made the sketch requested in great detail, but Subject 1 is still mistaken in measuring each side which is known from the given problem. Next to Problem number 2b, Subject 1 did not answer because it did not know how to solve the problem. Thus, it can be concluded that Subject 1 is only able to fulfill 1 stage of problem solving precisely namely understanding the problem.

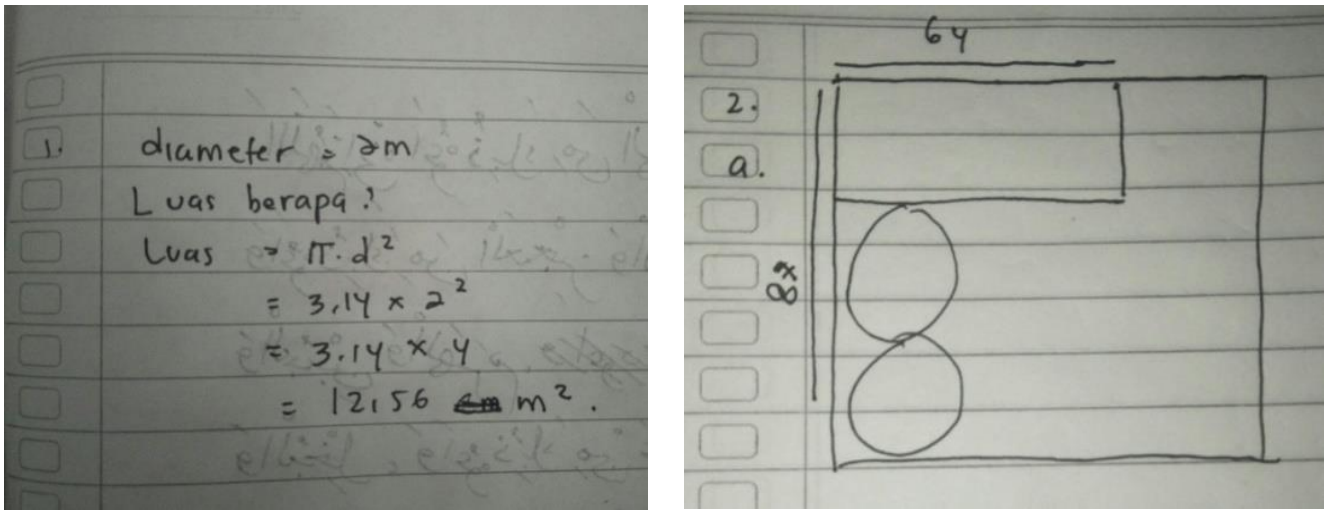


(a) (b)

Figure 2. Subject 1's answer to questions number 1 (a) and number 2 (b)

Subject 2

Subject 2 solves the problem by only writing information that is known in a manner concise without completing the information needed for the problem. Subject 2 is also wrong in writing the formula for the area of a circle. Subject 2 only relied on the short information of the problem so Subject 2's answers to problem number 1 were all wrong. Subject 2 also did not draw up a problem-solving plan. Likewise for question number 2 (a), Subject 2 sketches with unclear and unsystematic measurements. The results of the interview stated that Subject 2 felt the questions given had readings that were too long and difficult to understand so that the concentration of Subject 2 in answering the questions faded. Therefore, Subject 2 is said to be unable to fulfill any of the expected stages of problem solving.

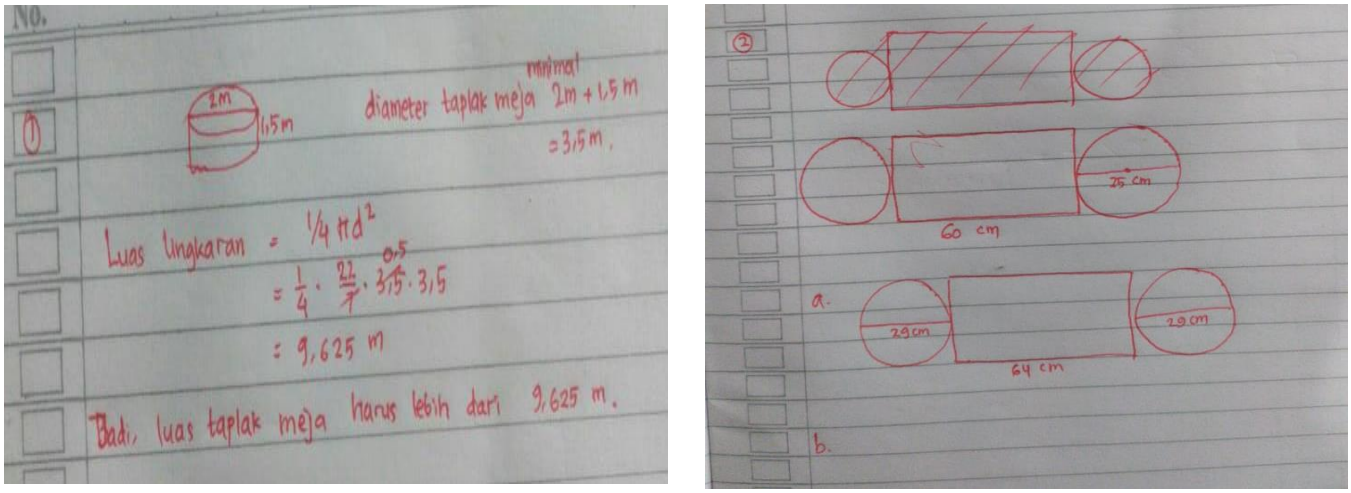


(a) (b)

Figure 3. Subject 2's answers for questions number 1 and number 2

Subject 3

Subject 3 resolves problem number 1 by compiling a plan for solving it, executing the plan and re-examining the method for solving the problem. But Subject 3's answer was wrong. Subject 3 thinks that the total diameter of the circle known is 3.5m. While the total diameter is 5 m. Subject 3 claimed to have forgotten to add 1.5m on the other side of the circle, so that even though the formula used was correct, Subject 3's calculations were still wrong. Subject 3's answers were not written systematically according to Polya's stages. Subject 3 immediately answers the problem by simplifying the information from the problem through the picture. It is also in line with the answer of Subject 3 for number 2, Subject 3 does not start working on the answer by writing down complete information related to the problem given.

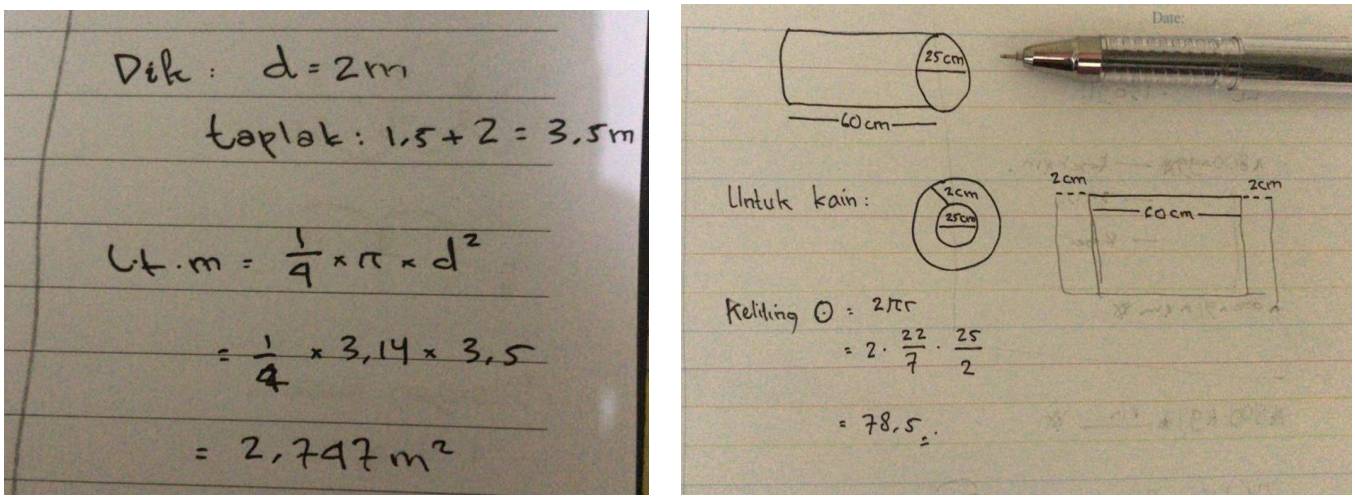


(a) (b)

Figure 4. Subject 3's answers for questions number 1 and number 2

Subject 4

Figure 4 below shows how to solve problems by Subject 4. Based on Figure 4, it can be seen that Subject 4 works on problem number 1 starting by writing down what is known, but not writing what is asked. Next, Subject 4 immediately wrote down the formula for the area of the tablecloth, which was shortened to ltm correctly, but as in the previous discussion, Subject 4 mistakenly summed up the total known diameter. Subject 4 also made a mistake in calculating the multiplication section of 3.5. As for problem number 2a, Subject 4 immediately sketches in accordance with the information that has been given to the problem without writing down what is known and asked. Subject 4 makes a simple sketch that has not been satisfactory.

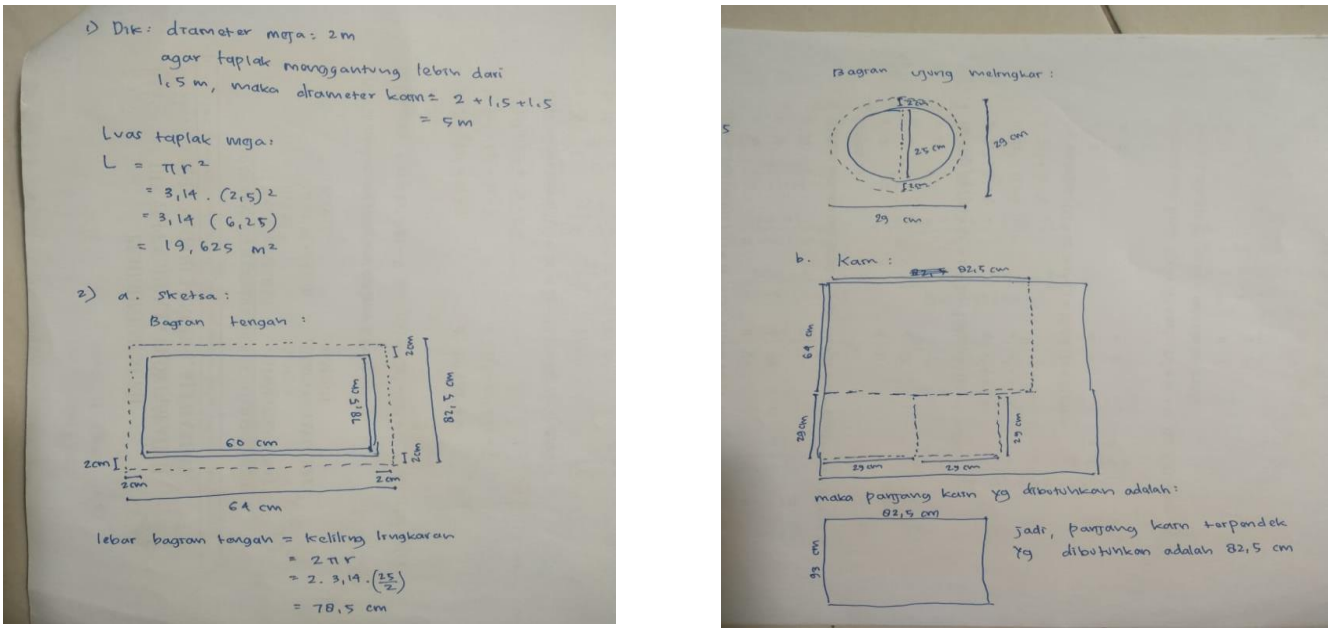


(a) (b)

Figure 5. Subject4's answers for questions number 1 and number 2

Subject 5

Subject 5 completing problem number 1 begins with writing down-information related to the problem given precisely. In figure 5 (a) it can be seen that Subject 5 has passed the stage of compiling an idea completion plan. Subject 5 immediately searched for the area of the tablecloth by entering the area formula that had been studied previously. The results of the interview stated, in fact Subject 5 had imagined how to sketch a circular image that fits the problem, but Subject 5 deliberately did not write it down because according to Subject 5, it was not necessary. Subject 5 also said that the problem was not instructed to draw a circle according to the problem story. Subject 5's answer to question number 1 is correct. However, Subject 5 should change the equal sign to be more than. That's because in the matter, tablecloths hang with an uncertain height.



(a) (b)

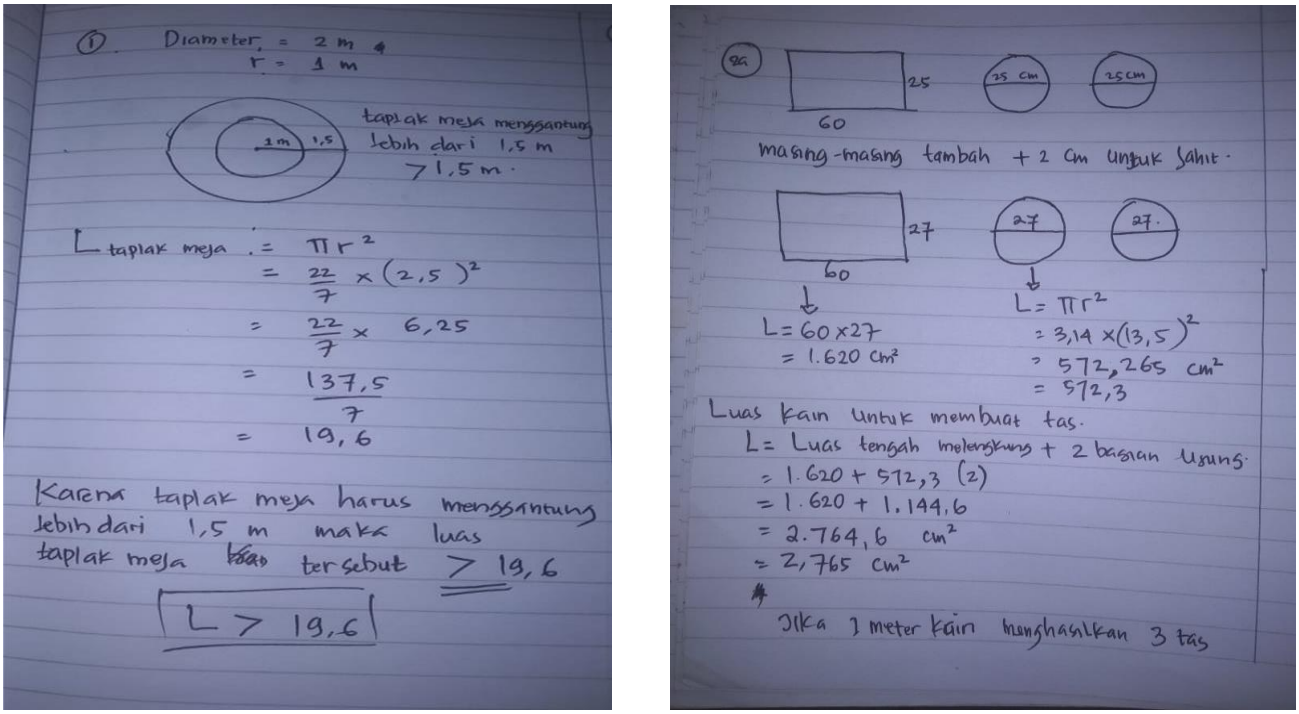
Figure 6. Subject 5's answers for questions number 1 and number

As for question number 2a, Subject 5 solved the problem very well. Subject 5 sketches the manufacture of bags with precise measurements. This is in accordance with the instructions given. Likewise for question number 2b, Subject 5 returned to sketch a picture so that it was easy to answer the given problem. However, Subject 5 passed the stage in writing clear information about the problem. Subject 5 immediately draws up a plan for solving the problem, implementing the idea of solving it, and checking the answers that have been done. According to the results of the interview, Subject 5 turned out to have gotten similar questions like this before when wheezing Kuti the Math Olympiad competition. Subject 5 says that

although it takes a long time to examine the problem, Subject 5 still tries to solve the problem perfectly.

Subject 6

According to this Figure 6 below, it can be seen that Subject 6 solved problem number 1 systematically and correctly. Subject 6 starts the answer by writing down the information given to the problem, followed by compiling the problem-solving plan, then implementing the idea of completion, to review the answers that have been done. Subject 6 said that question number 1 was indeed a little difficult, but because Subject 6 felt challenged by the problem given, Subject 6 tried to think of the best solution of the problem. Whereas for question number 2a the subject answers the question by directly sketching it based on the information contained in the problem. However Subject 6 was still mistaken in writing the size of each piece of bag in question. The lenght of the middle curve should be count by using the formula of circumference, and at the end of the circle, the diameter of the circle is not 27 cm, but 29cm. Furthermore, for question number 2b, Subject 6 is also wrong in answering questions. In problem number 2b, the subject is asked to determine the shortest length of fabric needed to make the bag. However, Subject 6 did the problem by finding the area of cloth to make the bag. The results of the interview said, Subject 6 guessed answer number 2b because it was influenced by the knowledge that had been obtained previously. Because with good initial knowledge, a student will try to link the relationship of several concepts that are appropriate and that will influence their completion steps.



(a) (b)

Figure 7. Subject 6's answers for questions number 1 and number 2

4. CONCLUSION

The students' ability to understand problems is still inadequate. This can be seen from the majority of students only able to mention what is known and asked, but other additional in-formation needed in solving problems is ignored by students. There are also errors in determining what is actually asked in the problem. The ability of students to plan ideas for completion is not yet a maximum lack of their knowledgefrom pre-requisite materials to solve the problem. Next, the ability of students to carry out the idea of completion must also be ad-dressed. The lack of students' ability to carry out settlement plans is due to students solving problems without following the rules of the appropriate concept, and many students are wrong in making accurate calculations about the problems given. So some students' answers are still wrong. There is only 1 of 6 student answers that are correct and as expected. Fur-thermore, the ability of students to re-examine answers is also very minimal. Students are more focused on the final results of the answers. Most students do not implement the stages of solving Polya correctly. Students do answer the questions given, but the answers are wrong.

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AUTHOR'S CONTRIBUTIONS

The author discussed the results and contributed to from the start to final manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the author.

REFERENCES

Aydogdu, M. Z., & Kesan, C. (2014). A Research on Geometry Problem Solving Strategies Used by Elementary Mathematics Teacher Candidates. *Journal of Educational and Instructional Studies in the World*, *4*(1), 53–62.

Baroody, A. J. (1993). *Problem Solving, Reasoning, and Communicating*.

Batubara, N. fauziah, Mukhtar, Surya, E., & Syahputra, E. (2017). Analysis Of Student Mathematical Problem Solving Skills At Budi Satrya Of Junior High School. *Ijariie*, *3*(2), 2160–2164.

Das, R., & Chandra, D. G. (2013). Math Anxiety : The Poor Problem Solving Factor in. *International Journal of Scientific and Research Publications*, *3*(4), 1–5.

Dossey, J. (2017). Problem solving from a mathematical standpoint. *The Nature of Problem Solving: Using Research to Inspire 21st Century Learning*, 59–72.

Kemendikbud. (2016). *Permendikbud Nomor 21 Tahun 2016 Tentang Standar Proses Pendidikan dan Menengah*. Kemendikbud.

Koedinger, K. R., & Nathan, M. J. (2004). The Real Story behind Story Problems: Effects of Representations on Quantitative Reasoning. *Journal of the Learning Sciences*, *13*(2), 129–164. https://doi.org/10.1207/s15327809jls1302_1

Kudsiyah, S. M., Novarina, E., & Lukman, H. suryani. (2017). Faktor-Faktor Yang Mempengaruhi Kemampuan Pemecahan Masalah Matematika Kelas X Di Sma Negeri 2 Kota Sukabumi. *Education: Prodi Pendidikan Matematika FKIP Universitas Muhammadiyah Sukabumi*, 110–117.

Liljedahl, P. (2016). Posing and Solving Mathematical Problems. *Posing and Solving Mathematical Problems*. https://doi.org/10.1007/978-3-319-28023-3

Mawaddah, S., & Anisah, H. (2015). Kemampuan Pemecahan Masalah Matematis Siswa Pada Pembelajaran Matematika dengan Menggunakag) di SMPn Model Pembelajaran Generatif (Generative Learning) di SMP. *EDU-MAT: Jurnal Pendidikan Matematika*, *3*(2), 166–175. https://doi.org/10.20527/edumat.v3i2.644

Novferma, N. (2016). an Self-Efficacy Siswa Smp Dalam Pemecahan Masalah Matematika Berbentuk Soal Cerita. *Jurnal Riset Pendidikan Matematika*, *3*(1), 76. https://doi.org/10.21831/jrpm.v3i1.10403

Nurhayati, N., & Zanthy, L. S. (2019). Analisis kemampuan pemecahan masalah matematik siswa mts pada materi pola bilangan. *Journal On Educaton*, *01*(02), 23–35.

OECD. (2019). *PISA 2019 Assessment and Analytical Framework: Mathematics, Reading, Science, Problem Solving and Financial Literacy*.

Polya, G. (1945). *How to solve it; a new aspect of mathematical methodNo Title*. Princeton University Press.

Saputri, S. D. (2017). Analisis Jenis Kesalahan Siswa Menyelesaikan Masalah Faktorisisasi Suku Aljabar Kelas Viii Smp Negeri 35 Semarang Tahun Ajaran 2016/2017. *Aksioma*, *8*(1), 87. https://doi.org/10.26877/aks.v8i1.1512

Schoenfeld, A. H. (2013). Reflections on Problem Solving Theory and Practice Let us know how access to this document benefits you . Reflections on Problem Solving Theory and Practice. *The Mathematics Enthusiast*, *10*(1), 9–34.

Siagian, M. V, Saragih, S., & Sinaga, B. (2019). *Development of Learning Materials Oriented on Problem-Based Learning Model to Improve Students ' Mathematical Problem Solving Ability and Metacognition Ability*. *14*(2), 331–340.

Walkington, C., Petrosino, A., & Sherman, M. (2013). Supporting Algebraic Reasoning through Personalized Story Scenarios: How Situational Understanding Mediates Performance. *Mathematical Thinking and Learning*, *15*(2), 89–120. https://doi.org/10.1080/10986065.2013.770717

Widjajanti, & Bondan, D. (2009). Kemampuan Pemecahan Masalah Matematis Mahasiswa Calon Guru Matematika: Apa

Dan Bagaimana Mengembangkannya. *Jurnal Pendidikan Matematika*, *3*(2), 402–413.

Widodo, S., & Kartikasari, K. (2017). Pembelajaran Pemecahan Masalah Matematis Siswa Sekolah Dasar Dengan Model Creative Problem Solving (Cps). *Prisma*, *6*(1). https://doi.org/10.35194/jp.v6i1.28

Windari, F., Fitriani, D., & Suherman. (2014). Meningkatkan Kemampuan Pemecahan Masalah Matematika. *Jurnal Pendidikan Matematika*, *3*(2), 25–28.