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Analysis of the Elementary School Students Difficulties of in Solving Perimeter and Area Problems

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Abstrak: Tujuan penelitian ini adalah untuk menganalisis jenis (konsep, prinsip, dan verbal) dan bentuk kesulitan yang dilakukan siswa sekolah dasar dalam menyelesaikan soal bangun datar (keliling dan luas) berdasarkan tingkat kemampuan penyelesaiannya. Metode penelitian ini adalah kualitatif dengan jenis studi kasus. Teknik pengambilan subjects penelitian menggunakan *purposive sampling* dengan memilih tiga subjects siswa kelas V sekolah dasar berdasarkan tingkat kemampuan matematika (rendah, sedang, dan tinggi) dalam menyelesaikan soal keliling dan luas bangun datar. Teknik pengumpulan data menggunakan tes dan wawancara. Teknik analisis data meliputi kondensasi data, penyajian data, dan menarik kesimpulan sesuai dengan indicator kesulitan. Temuan penelitian adalah siswa dengan tingkat kemampuan rendah mengalami kesulitan verbal dalam bentuk tidak dapat mengerjakan soal sesuai instruksi. Siswa dengan tingkat kemampuan sedang mengalami kesulitan konsep dalam bentuk ketidakmampuan dalam membuat keputusan dari satu atau lebih syarat penyelesaian yang diperlukan. Selain itu, siswa mengalami kesulitan prinsip dalam bentuk ketidakmampuan dalam menentukan faktor yang relevan dan salah dalam menggunakan satuan keliling untuk satuan luas. Siswa dengan dengan tingkat kemampuan tinggi mengalami kesulitan prinsip dalam menggunakan rumus, sehinga cenderung mengalami ketidaktelitian dalam menyelesaikan soal. Temuan lain dalam penelitian ini memberikan keyakinan bahwa beberapa siswa sekolah dasar mengalami kesulitan dalam menyelesaikan keliling dan luas bangun datar karena masalah mendasar, yaitu mengalami hambatan dalam masalah verbal dan pengetahuan konseptual yang belum memadai.

Kata kunci: kesulitan siswa; penyelesaian soal; keliling dan luas; tingkat kemampuan matematika

Abstract: *The purpose of this study was to analyze the types (concepts, principles, and verbal) and forms of difficulties that elementary school students did in solving problems of perimeter and area of plane figures based on their level of completion ability. This research method is qualitative with a case study type. The technique of taking research subjects used purposive sampling by selecting three subjects of fifth-grade elementary school students based on the level of mathematical ability (low, moderate, and high) in solving perimeter and area of plane figures. Data collection techniques using tests and interviews. Data analysis techniques include data reduction, data presentation, and concluding. The results showed that students with low ability levels experienced verbal difficulties in not working on the questions according to the instructions. Students with a moderate level of ability face conceptual difficulties in the form of being unable to make relevant decisions according to the requirements of the questions. In addition, students experience principle difficulties in the form of an inability to determine the relevant factors and incorrectly using the perimeter unit for the area unit. Students with a high level of ability experience principle difficulties in using formulas, so they tend to experience inaccuracies in solving problems. Other findings in this study provide that elementary school students have difficulty solving problems of perimeter and area of a plane figure because of basic problems, namely experiencing obstacles in verbal problems and inadequate conceptual knowledge.*

Keywords*: student difficulty; problem-solving; perimeter and area; math skill level*

Introduction

Geometry is a branch of mathematics that is important in solving everyday problems (Cherif, Gialamas & Stamati., 2017; Panaoura, 2014; Rofii, Sunardi & Irvan, 2018). Geometry encourages students' visualization, intuition, critical thinking, problem-solving, deductive reasoning, argument, and logical proof (Jupri, 2017; Seah, 2015). However, students still struggle to understand geometry material (Fauzi, Dirgeyase & Priyatno, 2019; MdYunus, Ayub & Hock, 2019). Students face difficulties forming accurate real constructions, measurement accuracy, and long-time consistency. The level of elementary school students who experience obstacles in proving their answers reaches the range of 40-50% (Noto, Priyatna & Dahlan, 2019).

Perimeter and area of plane figures in geometry are essential subjects that elementary school students must master because they are relevant to real-life problems (Winarti, Amin, Lukito & Gallen, 2012). In addition, an understanding of the perimeter and area of plane figures is the most supporting factor so that students have a good performance on the subject of three-dimensional space (Battista, Clements, Arnoff, Battista & Borrow, 1998). For elementary school students who have a good understanding of perimeter, length is used to measure the distance perimeter of a figure; they will be familiar with finding the perimeter of a plane figure by adding up each side. However, those who do not have an adequate understanding of the perimeter will find it difficult to determine the length of the side if it is not expressed with a clear symbol (Yeo, 2008). Elementary school students who have a good understanding of perimeter can measure and partition length units (Clarke & Roche, 2018). Meanwhile, elementary school students who have good spatial knowledge in the plane figure area realize that the area consists of area units in length and width dimensions (Clements et al., 2018; Wickstrom, Fulton & Carlson, 2017). In this case, elementary school students are in relational understanding (Amir, Rahayu, Amrullah, Rudyanto & Afifah, 2020). Students who understand calculating the perimeter can solve the plane figure area problem (Fauzan, 2002).

The results of previous studies found elementary school students had difficulty in completing the perimeter and area of a plane figure. A common difficulty regarding perimeter and area for elementary students is measuring plane figures' side lengths and areas (Romberg, Carpenter & Dremock, 2005). Many elementary school students have difficulty determining the area of a plane figure with several perimeter shapes from a complex plane figure (Winarti et al., 2012). In some cases, elementary school students have misconceptions about the concept of area and perimeter, so they tend to think that plane figures with the same area have the same perimeter (Clements & Sarama, 2004). In addition, in understanding the perimeter and area, students must memorize and apply formulas and apply the concepts they have acquired to gain a new understanding that is useful in everyday life (Rohman, Karlimah & Mulyadiprana, 2017). The difficulty of elementary school students in completing the perimeter and area of a plane figure is based on a misconception. Students tend to have a procedural understanding of perimeter and area rather than conceptual and relational understanding (Sugiarto, 2014).

In contrast to a perimeter, an area is a more complex concept for students in the early stages of the material (Winarti et al., 2012). Perimeter is in line with the concept of length, known as linear measurement. Meanwhile, the area is not about length but the entire surface covering a shape (Castellanos, Castro & Gutierrez, 2009). Understanding area measurement can be achieved by learning the link between numbers and measurements. Measuring the area requires understanding in placing the unit area in the dimensions of length and width (Clements & Sarama, 2004). Understanding this area requires understanding in dividing the

length measurement, which is essential knowledge in perimeter measurement (Wickstrom et al., 2017).

Based on the literature review above, elementary school students still have difficulties solving the perimeter and area of plane figure problems. Therefore, a more in-depth analysis of students' difficulties in solving the perimeter and area of plane figure problems is needed. This needs to be done to reveal the mistakes made by students in working on the questions so that it can be an indication of the extent to which students master the material obtained (Wulandari & Gusteti, 2020). Several studies regarding the analysis of the difficulties of elementary school students in solving the perimeter and area of plane figure problems have been carried out (Agustina, 2018; Fauzi & Arisetyawan, 2020; Sukmawati & Amelia, 2020). However, these studies have not included an analysis of the forms of difficulty of each type of Cooney difficulty (concept, principle, and verbal) by reviewing the level of mathematical ability. Analysis of the types of difficulties in terms of concepts, principles, and verbal plays a crucial role in knowing the forms of student barriers to achieving ideal learning outcomes (Yusmin, 2017). Meanwhile, research on the review of mathematical ability in solving problems has an important role in evaluating the level of depth of knowledge and understanding of students in receiving information during teaching (Castellano et al., 2009; Mursidik, Samsiyah & Rudyanto, 2015; Mursidik, Samsiyah & Rudyanto, 2014; Zhang, Shang, Pelton & Pelton, 2020). Therefore, research on the analysis of each type of students' difficulties in concepts, principles, and verbal in terms of the level of mathematical ability in solving perimeter and area of plane figure problems needs to be carried out.

Method

Research Design

This study applies a qualitative method with the type of case study (Cresswell, 2012). The analysis was carried out on cases of difficulties made by elementary school students based on the level of mathematical ability in solving perimeter and area of plane figures. The forms of these difficulties are classified on concepts, principles, and verbal.

Research Subjects and Its Characters

The research participants were 24 students (9 boys and 14 girls) in fifth grade at SDN Mangaran 01 in 2020-2021. The elementary school where the study participants are located is in a rural area in Jember City, East Java. Meanwhile, the participating students have a background in the age range of 11-12 years.

Research subjects were determined purposively based on mathematical ability in solving perimeter and area of plane figures. Determination of purposive criteria is done by categorizing research participants into the level of ability to solve the perimeter and area of plane figure problem according to Table 1. The level of mathematical ability in solving this problem is adopted from (Malikha & Amir, 2018). Of the total, one student was selected from each category, namely low, moderate, and high.

Table 1. Category Level of Ability in Solving Problems

Scores	Ability Level	Number of Students	Subject (Na)
$0 \leq Na < 60$	Low	9	S1 (10)
$60 \leq Na < 80$	Moderate	11	S2 (65)
$80 \leq Na \leq 100$	High	4	S3 (90)
	Total	24	3

Description: Na = Students' grade S1-S3 = Subject 1 to Subject 3

(Malikha & Amir, 2018)

In this study, students with low abilities obtained the lowest scores. Students with moderate abilities get scores closest to the median value of the moderate ability criteria in Table 2. Meanwhile, students with high abilities get the highest scores in solving perimeter and area of plane figures. In addition, purposive criteria are also based on students' communication skills. As a result, subject 1 (S1), subject 2 (S2), and subject 3 (S3) had scores of 10, 65, 90, respectively.

Table 2. Indicators of Students Difficulty

Aspect of Difficulty	**Indicators**	
	Difficulty According to Cooney	**The Difficulty of in the Material**
Concept	The inability to remember one or more of the conditions necessary for an object to be expressed in terms representing it.	• Students ignore perimeter and area units, and students do not include units. Students use perimeter units as area units. • Students do not understand how to read units correctly.
	The inability to classify objects as examples of a concept from objects that are not examples.	• Students do not understand and distinguish between words, symbols, and signs. • Students do not use the formula correctly.
Principal	The inability of students to determine the relevant factors and consequently unable to abstract the patterns.	• Students find it difficult to interpret the form of the questions that have been presented. • Students feel confused with the form of the questions. • Students cannot describe each separate plane figure to find the plane figure area.
	Students can state a principle but cannot express its meaning and apply it.	• Students can abstract part of the pattern in the plane figure, but they cannot conclude what they are looking for.
Verbal	Knowledge and ability of students in using concepts and principles.	• Students cannot understand the context of the questions presented. • Students experience difficulties understanding geometric material, applying formulas, and understanding theorems. • Students have difficulty understanding the problem in a question.

Research Instrument and Indicators

The research instrument includes a combined perimeter and area determination test of plane figures and interview guidelines. The test determining the perimeter and area of the combined plane figure was adapted from (Clarke & Roche, 2018). Adaptation is made by modifying the side pattern of the plane figure so that it is possible to explore students' difficulties in solving problems. This test consists of two items to construct and justify the perimeter and area of the combined plane figure of students (See Figure 1). Meanwhile, the interview guide contains questions about the forms of difficulties experienced by students to

deepen the results of student test work. Interview guidelines were prepared in a semi-open manner based on the aspects of Cooney's difficulties, namely in terms of concepts, principles, and verbal (Yusmin, 2017).

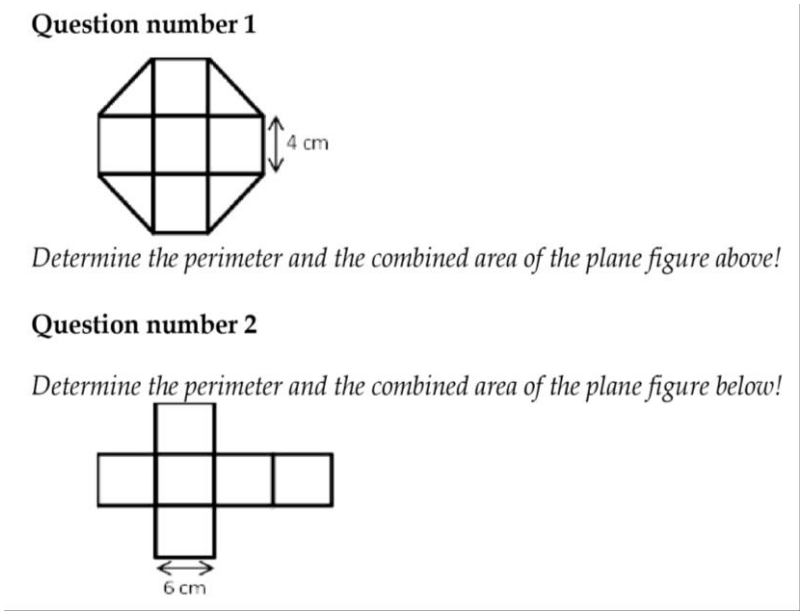

Figure 1. Test Description Perimeter and Area of Plane Figure

Research Procedure

This research procedure follows data collection steps to give tests, observations, and interviews. The first step is to provide tests for all participants to get selected subjects according to purposive criteria. The second step is to ask the chosen subjects to re-complete the test and observe the completion process. The third step is to conduct semi-structured interviews when subjects solve questions using interview guidelines.

Data Analysis

Data analysis was done by data condensation, data presentation, and conclusion according to the indicators of student difficulty adapted from Cooney (Yusmin, 2017), as shown in Table 2. Triangulation techniques guarantee the credibility of the difficult forms of subjects by synthesizing the forms of difficulty of subjects obtained from tests, observations, and interviews (Miles, Huberman & Saldana, 2014).

Results and Discussion

Based on the results of student work, one student was selected for the categories of the low, moderate, and high ability levels in solving perimeter and area of plane figures, respectively. In this study, students with low, moderate, and high ability categories were coded with subjects 1 (S1), subjects 2 (S2), subjects 3 (S3), respectively.

Students with Low Ability

The results of S1's work in solving the perimeter and area of plane figure problems are shown in Figure 2 and Figure 3. The difficulty experienced by S1 in questions number 1 and number 2 is solving problems verbally.

Verbal Difficulty 1 on Question Number 1 and 2

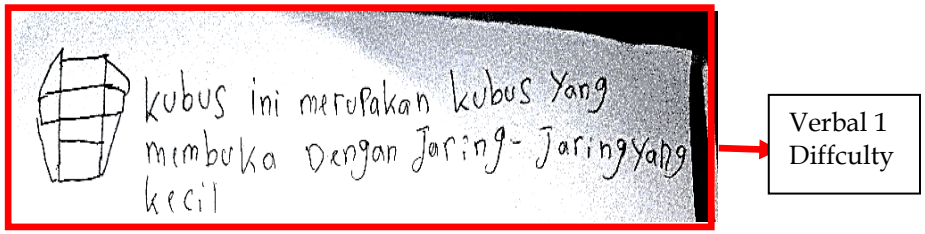

Figure 2. S1 Result in Question Number 1

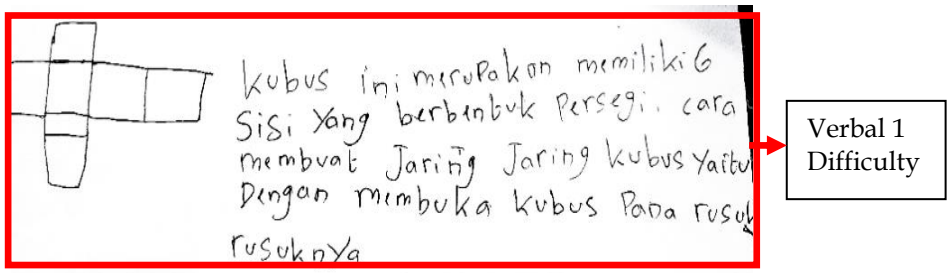

Figure 3. S1 Result in Question Number 2

As shown in Figure 2 and Figure 3, S1 had difficulty with verbal problems because S1 did not do the questions according to the instructions. The instruction in the problem is to find the perimeter and area of the combined plane figure, but S1's answer is about the nets of the cubes. It can be assumed that S1 experienced the most incredible difficulty related to the inability to understand the context of the questions presented, so that S1 could not work according to the instructions for the questions. This statement is reinforced by the results of the interviews obtained. S1 said, "I can't answer, sir, because I don't understand the command questions." S1 also mentioned, "the problem being worked on is about the cube." In this case, S1 decides to answer the perimeter and area of the plane figure in problem one and problem two because S1 assumes that the plane figure presented is a cube. In addition, because S1 did not understand the meaning of the problem instructions, S1 answered the questions by simply describing the answers by writing down the characteristics of the cube nets.

Students with Moderate Ability

The results of S2's work, which are students with moderate ability levels in solving perimeter and area of plane figures, can be seen in Figures 4 to 8. The difficulty experienced by S2 in questions number 1 and number 2 is in using concepts and principles.

Concept Difficulty 1 in Problem Number 1 and Number 2

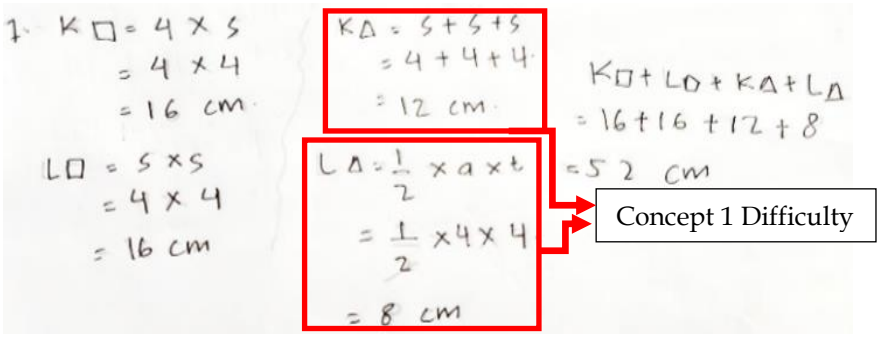

Figure 4. S2 Result on Question Number 1

Figure 4 shows that S2 has difficulty using the concept because S2 uses the perimeter unit as the unit area. S2 does problem number 1 by finding each plane figure unit. However, S2 uses the correct formula for finding answers when looking for the area of triangles and squares. S2 does not use area units but uses perimeter units. This statement is reinforced by the results of the interview obtained, in which S2 said: "yes, I often forget to add the square (^{2}) to the unit area." When asked why the area unit uses a square (^{2}), S2 said, "the teacher teaches that the area and perimeter units are different, that is, the area unit uses a square, and the perimeter does not." In this case, S2 only accepts rote knowledge. S2 does not understand the concept of a quadratic unit area because the two-dimensional plane figure consists of area units covering the dimensions of the length and width of the plane figure. In contrast, the concept of the perimeter unit is a unit of length or width.

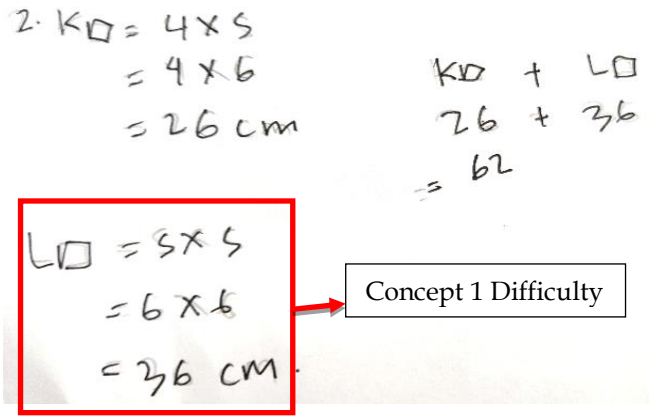

Figure 5. S2 Result on Question Number 2

In Figure 5, S2 has difficulty because it uses the concept of the perimeter unit as a unit area. S2 does problem number 2 by finding each plane figure unit. S2 uses the square formula correctly; S2 does not use the unit area but the perimeter unit instead. S2 said, "often forget to write the square (^{2}) in the area unit and look at the square shape in the area unit as a rule from the teacher." In this case, the cause of the difficulty of the S2 concept in questions number 2 and number 1 is the same; namely, S2 does not understand the difference in the concept of area unit and length unit significantly.

Principle Difficulty 1 in Problem Number 1

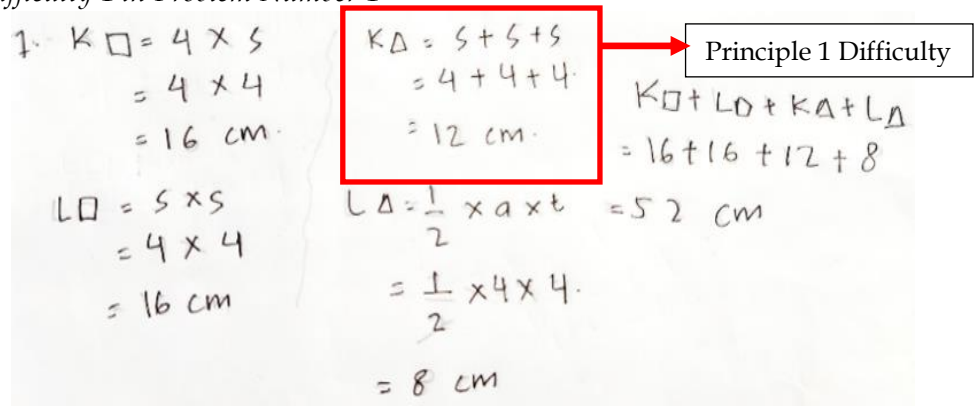

Figure 6. S2 Result on Question Number 1

Figure 6 shows that S2 has difficulty using the principle when determining the perimeter and interpreting the form of the problem that has been presented. S2 does not need the perimeter of the triangle when finding the perimeter in problem number 1 but only

requires the hypotenuse using the Pythagorean formula. The result was and then 16 + 16 =c^2 and$\sqrt{32} = c^2$, and finally, S2 get the hypotenuse of the triangle cm. This statement was reinforced by the results of the interview obtained; S2 said: "I don't know if you are asked to find the hypotenuse, I think it's the same, so I calculate using the number of 4 cm".

Principle Difficulty 2 in Problem Number 1 and Number 2

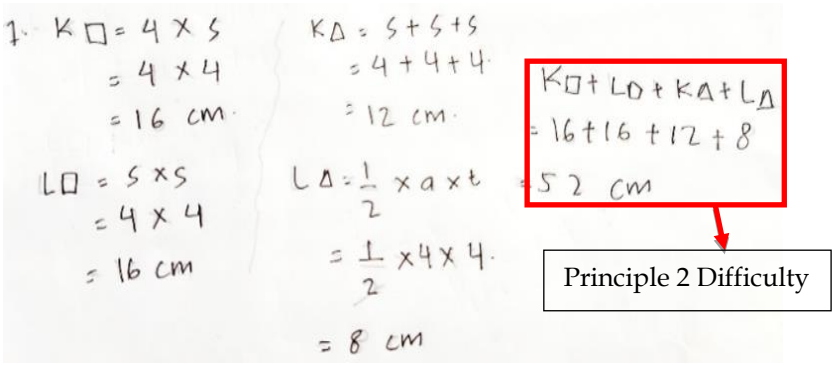

Figure 7. S2 Result on Question Number 1

Figure 7 shows that S2 has difficulty using the principle when determining the combined area. S2 can abstract part of the pattern contained in the plane figure. However, S2 was unable to conclude what the problem ordered because of the instructions to find the combined area of the plane figure. However, S2 combines the perimeter and area of the plane figure in the problem. S2 hoped that he would answer the plane figure combined area. This statement is reinforced by the results of the interview obtained. S2 said: "Is it not in the question that you were asked to find the perimeter and area of the combined plane figure? So I add up all."

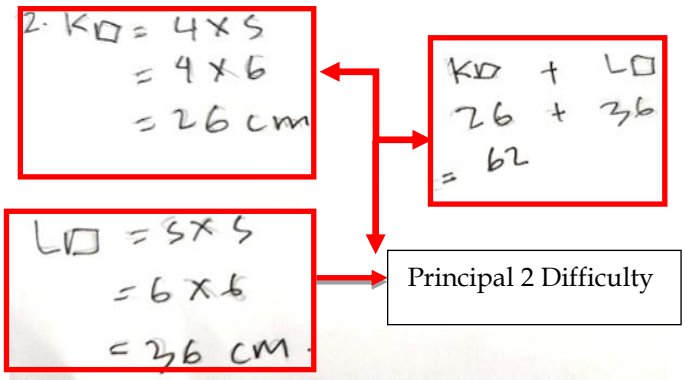

Figure 8. S2 Result on Question Number 2

Figure 8 shows that S2 has difficulty using the principle, especially in abstracting the part of the pattern contained in the plane figure. However, S2 could not conclude what they were looking for according to the instructions on the problem of finding the combined perimeter and area. S2 answers only for one square instead of 6 squares in the problem. As a result, S2 gets 14 x sides equal to 84 cm, and 6 x sides get 216 cm^2. When S2 looks for the combined area, S2 adds the perimeter of one square with the area of one square. This statement was reinforced by the results of the interview obtained; S2 said: "Is it a matter of being asked to find the combined perimeter and area? So, I added all of them."

Students with High Ability

S3 is a student with a high level of ability in solving perimeter and area of plane figures in Figure 9. The difficulty experienced by S3 only occurs in problem number 1 in using principles.

Principle Difficulty 2 on Question Number 1

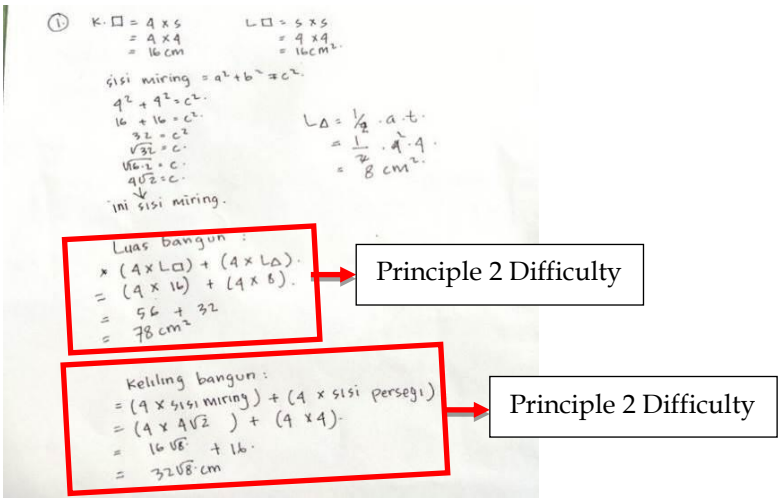

Figure 9. S3 Result on Problem Number 1

Figure 9 shows that S3 is doing it right even though it has a bit of principle difficulty where S3 can use the formula correctly. However, S3 was not careful in adding up, so the results obtained were in error. When looking for the building area, S3 experienced inaccuracies in calculating the area and perimeter of the building, so the results obtained were wrong. The S3 also had difficulty operating the 4x with the result it should have been. This statement is reinforced by the interview results obtained; S3 said: "I have difficulty operating numbers with roots, so I operate all of them."

Table 3. Forms of Difficulty Based on the Level of Ability to Solve Problems

Level of Ability	Question Number	Type of Difficulty	Form of Difficulty
Low	1	Verbal 1	Not doing the questions according to the instructions
	2	Verbal 1	Not doing the questions according to the instructions
Moderate	1	Concept 1	Not using area units, but using perimeter units
	1	Principle 1	Difficulty interpreting the form of questions that have been presented
	1	Principle 2	Unable to conclude what the question ordered
	2	Principle 1	Not using area units, but using perimeter units
	2	Principle 2	Unable to conclude against what they are looking for
High	1	Principle 2	Inaccuracy in calculating the area and perimeter of the building

The results in Table 3 showed that the research subjects (divided based on low, moderate, and high ability levels) still experienced conceptual, principal, and verbal difficulties in solving perimeter and area of plane figures. Students with moderate abilities

encounter difficulties in using concepts, causing factual errors where students do not include units, use perimeter units as units of area, and read units correctly. This result match with the result found by Prielipp (1978) that this error occurred due to an error in associating an incorrect concept. It was then strengthened by Tall & Razali (as cited in Layn & Kahar, 2017), who stated that students' difficulty in working on math problems is in the problem of concepts and understanding in learning. Meanwhile, Ovez (2012) and Widodo (2013) revealed that conceptual errors consist of students misunderstanding the question's meaning and using formulas, theorems, or definitions that do not adjust to the prerequisite conditions. Wulandari and Gusteti (2020) added that indicators of students mastering prerequisite skills are two aspects: (1) remembering previously studied lesson material, (2) being able to connect new ideas or lessons with ideas or lessons that have been studied previously.

Students also experience difficulties in using the principle with moderate and low ability levels due to difficulties in interpreting the form of the questions that have been presented. In addition, students have difficulties breaking down into each separate plane figure to find the combined plane figure area. It parallels Sari and Aripin (2018), who stated that difficulties experienced by students in understanding commands, doubts, and inability to interpret the story points contained in the questions. Students also feel confused with the form of the questions given. Lack of concentration when doing calculations results in errors in getting results. Romika and Amalia (2014) also agreed that students were less careful when carrying out writing procedures, incomplete writing procedures, and errors in the process of operating answers. In addition, students' mistakes in solving math problems are procedural errors, such as miscalculations due to carelessness (Muzangwa & Chifamba, 2012; Wulandari & Gusteti, 2020).

Students experience difficulties in solving verbal problems with low abilities, especially the inability to understand the context of the questions presented, resulting in students not getting the correct answer. Kristofora and Sujadi (2017) stated that this error occurred because one of them was because students had errors in interpreting language. This shows an error in understanding the meaning of the question. Then students still have difficulty understanding geometric material, applying formulas, and understanding theorems.

Conclusion

Based on the research results, it was found that students with a high level of ability experienced a form of principle difficulty in the form of inaccuracy in performing arithmetic operations. Meanwhile, students with a moderate level of ability have difficulty with concepts and principles in the form of difficulties in interpreting questions. Meanwhile, students with low ability levels experience complex difficulties, namely difficulties in using concepts, principles, and verbally solving perimeter and area questions combined with plane figures, so that students cannot answer correctly.

This study indicates that some elementary school students with different problem-solving levels can solve the perimeter and area of plane figure problems. However, difficulties in using concepts accompany them, principles and verbal. This research implies that learning and teaching in measuring perimeter and area in elementary schools need to familiarize with perimeter and area questions related to daily life by paying attention to students' mathematical difficulties and abilities to reduce students' difficulty in solving problems.

This study also found and analyzed the forms of difficulty of some elementary school students in solving perimeter and area combined plane figures problems based on their level of mathematical ability in solving perimeter and area of plane figures problems. The implications of the results of this study prove that elementary schools have difficulty using

concepts, principles, and verbal in solving problems. However, the difficulties found are still based on a small number of elementary school students. In addition, this study has not identified the relationship of knowledge with students' difficulties in solving problems in detail. Therefore, it is recommended that future studies carry out a statistical analysis of the relationship between knowledge and difficulty in solving elementary school students' questions.

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