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Elementary School Students' Strategies for Solving Area Measurement Problems

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Abstrak

Penelitian ini bertujuan untuk mengidentifikasi strategi yang digunakan siswa sekolah dasar dalam menyelesaikan masalah pengukuran luas daerah. Metode penelitian yang digunakan adalah pendekatan kualitatif deskriptif. Teknik pengambilan data yang digunakan dalam penelitian ini adalah pemberian tugas, wawancara, observasi, dan dokumentasi. Teknik penyajian data yang digunakan adalah reduksi data, penyajian data, dan penarikan kesimpulan/verifikasi. Subjek penelitian yang digunakan adalah siswa kelas III, IV, V, dan VI Sekolah Dasar. Dalam penelitian ini menemukan bahwa terdapat enam strategi yang digunakan oleh siswa dalam menyelesaikan masalah pengukuran luas daerah, yaitu 1) menghitung jumlah satuan persegi, 2) menguraikan bentuk, 3) menerapkan penalaran panjang, 4) menghitung semua satuan, 5) mengalikan panjang dan lebar, 6) membagi keseluruhan dengan jumlah pembagian. Strategi menghitung semua satuan merupakan strategi yang paling banyak digunakan oleh siswa sekolah dasar. Dalam menyelesaikan masalah pengukuran luas daerah dipengaruhi oleh pengalaman siswa memperoleh materi pengukuran luas daerah. Hasil penelitian ini menyarankan agar siswa mengedepankan strategi dalam menyelesaikan masalah. Jika strategi yang digunakan siswa benar maka struktur susunan mengenai penyelesaian akan sesuai.

Kata kunci: *masalah kehidupan nyata; pengukuran luas daerah; penyelesaian masalah matematika; strategi*

Abstract

This study aims to identify the strategies used by elementary school students in solving area measurement problems. The research method used was a descriptive qualitative approach. The data collection techniques used in this research are task, interview, observation, and documentation. The data presentation techniques used were data reduction, data presentation, and conclusion drawing/verification. The research subjects used were elementary school students in grades 3, 4, 5, and 6. In this study, it was found that there were six strategies used by students in solving area measurement problems, namely 1) counting the number of square units, 2) decomposing the shape, 3) applying length reasoning, 4) counting all units, 5) multiplying length and width, 6) dividing the whole by the number of divisions. Counting all units is the most widely used strategy by elementary school students. Solving area measurement problems is influenced by students' experience obtaining area measurement material. The results of this study suggest that students prioritize strategies in problem solving. If the strategy students use is correct, then the arrangement structure regarding the solution will be appropriate.

Keywords: *world problem; area measurement; mathematics problem solving; strategies*

A. Introduction

Problem solving is an important learning in mathematics. Through problem solving students can build knowledge about mathematics while learning various strategies to solve problems based on their existing knowledge (Napitupulu, 2008). Problem solving can be interpreted as a process, meaning that solving a problem prioritizes procedures or steps in solving problems rather than just results. The ability in problem solving is a basic ability that students must possess (Hadi & Radiyatul, 2014). Students actively maximize their opportunities and abilities in the learning process (Darr & Fisher, 2005). Elementary school students who are basically 7-12 years old have limited reasoning. They cannot yet do hypothetical or abstract reasoning (Almadani & Setiabudi, 2022). Like Piaget's theory, children in this age range can only solve problems when the problems are real, not imaginary problems. Using real-world problems that make sense can help students understand the problem and the solution (Boaler, 2008). Problem solving requires a process. The solution strategy takes priority over just the result.

Problem solving in mathematics can be found in the area of measurement topic. Area measurement is an important aspect of mathematics that plays an important role in various fields. Area measurement can be thought of as the tiling of two-dimensional figures (Wheatley, 1996). Area measurement is often introduced at the elementary school level (Cullen & Barrett, 2020). The concept of area measurement was first introduced in 3rd grade, which became the basis for teaching in later grades (Zeybek & Francis, 2017). Concrete problems in the measurement area applied to elementary school students in 1st grade to 3rd grade use the concept of units of weight, length, and time, while in 4th to 5th grade, the topic presented uses measurements of weight, length, area, volume, angle, time, speed, and discharge (Anggraena, 2019). In NAEP 2011, measurement was a weak topic for 4th-grade elementary school students. Only 24% of students were correct in determining the area of a square. In addition, students are more often faced with using area models that are only divided into congruent parts (Zeybek & Francis, 2017). So that students think that equal shapes must have congruent parts (Lee & Lee, 2021). Because of this, students find it difficult to understand the basic concepts in understanding the basic concepts of area measurement and problem solving related to area measurement.

Based on the results of the researchers' initial observations and the results of interviews with one of the 5th-grade teachers at Sawotratap 1 State Elementary School. Initial observations were obtained from analyzing the results of the final exam of the first semester in the academic year 2022/2023. There were 25 results of the final exam of the first semester analyzed. In solving mathematical problems about comparison, 9 students only wrote the answer without writing the method used, 12 students applied the formula that the teacher had conveyed. And the rest wrote the way to solve the problem that they considered correct. Observations were further conducted through interviews with one of the 5th-grade teachers of Sawotratap 1 State Elementary School regarding the strategy of solving description problems

that students use; from the results of the analysis and interviews obtained information that in the strategy of solving mathematics problems, students tend to memorize formulas, not understand concepts. In solving mathematics problems, students immediately think of using algorithms or formulas, even shorter formulas will be used more than other longer formulas. Thus, the result or answer is more important to students than the process.

Piaget's statement cited in Funny (2014) that the concept of area measurement is the first step in mastering advanced area measurement. According to Piaget's cognitive psychology theory, there are four individual cognitive stages, namely the sensory-motor stage owned by individuals aged 0-2 years, the preoperative stage owned by individuals aged 2-7 years, the concrete operation stage owned by individuals aged 7-11 years, the formal operation stage owned by individuals aged 11 years and so on (Yuza, 2018). Based on this theory, the age of elementary school children is included in the concrete operation stage. The concrete operation stage is a stage where individuals can understand logical operations with the help of concrete objects and individuals in this stage can be applied to solve concrete problems (Wahid & Karimah, 2018). The concept of learning received by students affects the level of understanding of students' learning materials. Incorrect learning makes it difficult for students to learn because the ability to absorb material owned by students is not by what is presented. Area measurement is one of the topics that students must master because it is closely related to everyday life (Mulyani, 2017).

Previous research becomes comparative research with the research currently being studied. In research by Huang & Witz (2013), students are asked about area measurement problems, but do not apply real-world problems. Lee & Lee (2021) and Zeybek & Francis (2017) researched area measurement, but the research subjects used were prospective teachers. Therefore, through this study, the researcher will broaden the research base by documenting elementary school students' strategies in solving area measurement problems and linking them to related units. Dr. Lee attributes students' understanding of solving the problem to the learning progress shown in the learning process (Lee & Lee, 2021). To construct the strategies used by students based on empirical evidence that appears in the problem solving strategies used by students (Lee & Lee, 2021). This means that other solution strategies may emerge if students in solving problems do not use partial or geometric units. However, the use of geoboards affects students in solving area measurement problems, one of which is difficulty in what to calculate and how to coordinate linear and area units (Kamii & Kysh, 2006).

This study aims to analyze the strategies used by elementary school students in solving daily life problems regarding area measurement using geoboards. By analyzing whether the areas that have been divided have the same area, these findings will provide benefits in mathematics education, especially in terms of area measurement. Among the benefits obtained are finding students' completion strategies in solving area measurement problems and, as educators can determine the learning methods applied in

the classroom so that students do not have misconceptions about area measurement.

B. Methods

This type of research is descriptive research with a qualitative approach. The research subjects were 80 students from grades 3, 4, 5, and 6 of Sawotratap 1 State Elementary School, where each class had 20 students as samples. The selection of research subjects is based on students who have received material related to area measurement, where the concept of area measurement is first introduced to 3rd-grade students (Zeybek & Francis, 2017).

The data collection techniques used include task, interview, observation, and documentation. The instruments used in this research are problem solving strategies test questions, interview guidelines, and observation guidelines. This problem solving strategies test question consists of one question. The measurement area problem solving strategies test questions given to students are in Figure 1. The task of solving measurement area problems is modified from research (Lee & Lee, 2021). The modification made in this task question is in the form of a real-world problem. In this case, the problem given to students is about the area measurement of a room. The flat shape whose area is measured is square. Students are asked to determine whether the area measurement of the room is equal, along with the verification.

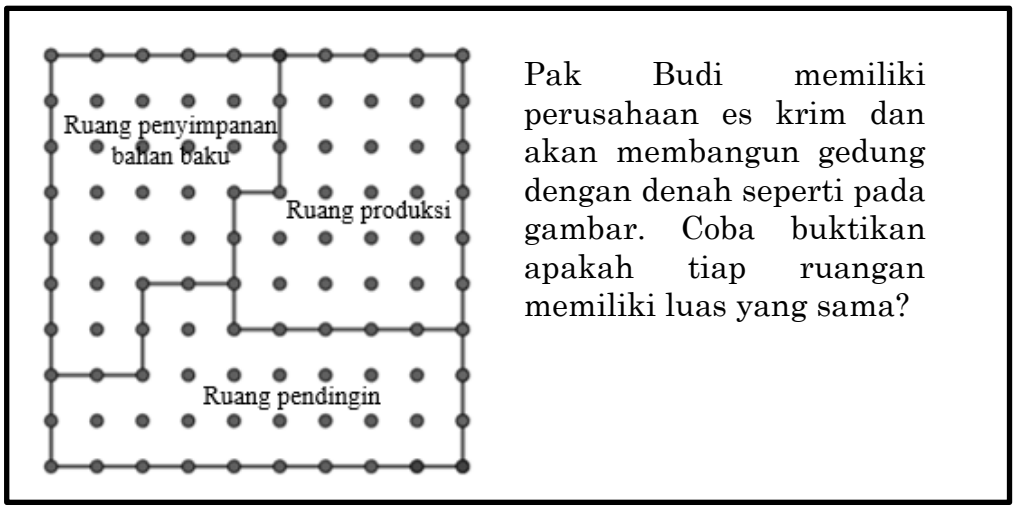

Figure 1. Instrument question

Data analysis techniques applied are data reduction, data presentation, and the conclusion (Miles, Huberman, & Saldaña, 2014). In the data reduction process, researchers sorted out the results of student work. Then, the researchers analyzed the strategies used in solving the problem. The researcher concluded the strategies used by students in solving problems.

This research uses triangulation of three data collection techniques. The technique first in the form of the task given to students used to obtain written

data from research subjects related to student strategies in solving measurement area problems then continued the second technique in the form of interviews conducted to deepen information about the results of student work on strategy in solving measurement area problems. The Third Technique follows this in the form of observations made when students work on the tasks that have been given, used to determine the strategies applied by students during the task.

C. Results and Discussion

Based on the results of student work, there are differences in strategies for solving area measurement problems for students in 3rd, 4th, 5th, and 6th grade, which can be seen in Table 1.

Table 1. Strategies applied in solving area measurement problems

No.	Strategies	Number of Students			
		3rd	4th	5th	6th
1	Count all unit squares	0	3	0	1
2	Decomposing the shape	0	4	0	5
3	Applies length reasoning	6	1	2	2
4	Compares unit	14	10	16	12
5	Multiples length and width	0	2	0	0
6	Divide the whole by the number of divisions	0	0	2	0

Then, the results of student work were analyzed and confirmed through interviews. Student coding can be seen in Table 2.

Table 2. Code of the research subject

Strategies	Code (class, strategy, subject)			
	3rd	4th	5th	6th
1	-	S4.1.1	-	S6.1.1
2	-	S4.2.1	-	S6.2.1
3	S3.3.1	S4.3.1	S5.3.1	S6.3.1
4	S3.4.1	S4.4.1	S5.4.1	S6.4.1
5	-	S4.5.1	-	-
6	-	-	S5.6.1	-

Strategy 1: Count all unit squares

There are 5 students who used the strategy of calculating the sum of square unit areas, namely 3 students from the 4th grade and 1 student from the 6th grade. In comparison, no students from 3rd and 5th grades calculated the sum of square units. This strategy uses the correct measurement by measuring the area using square units. The area of a flat shape is the number of units of area that can be used to cover an area tightly. In this case, students used square units to cover the square shape provided in the problem tightly.

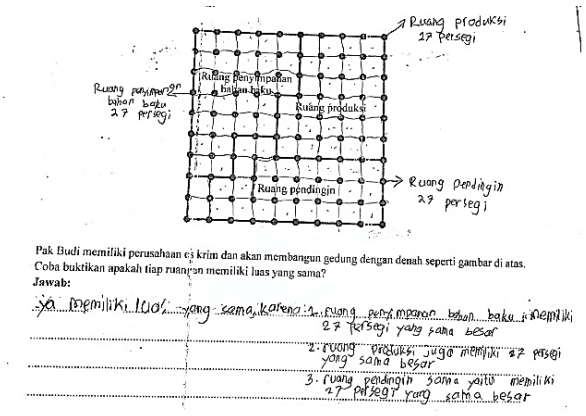

Figure 1. S4.1.1 answered by calculating using square units

S4.1.1 and S6.1.1 answered the question correctly by calculating the unit square formed from the line connected between the existing points as shown in Figure 2. This is reinforced by the student's expression in the interview results. S4.1.1 said, "I connected the points, then a small square was formed. Then I counted the number of small squares in each room. It turns out that the number is the same". Students use this strategy because they think the area combines square units, forming a field.

Strategy 2: Decomposing the shape

There were 9 students who used the strategy of decomposing shapes, namely 4 students from 4th to 6th grade. Meanwhile, no students from grades 3 and 5 used the strategy of decomposing shapes. In this strategy, students decompose the shape into several flat shapes in each part and then add each part. However, the final results obtained by students are different.

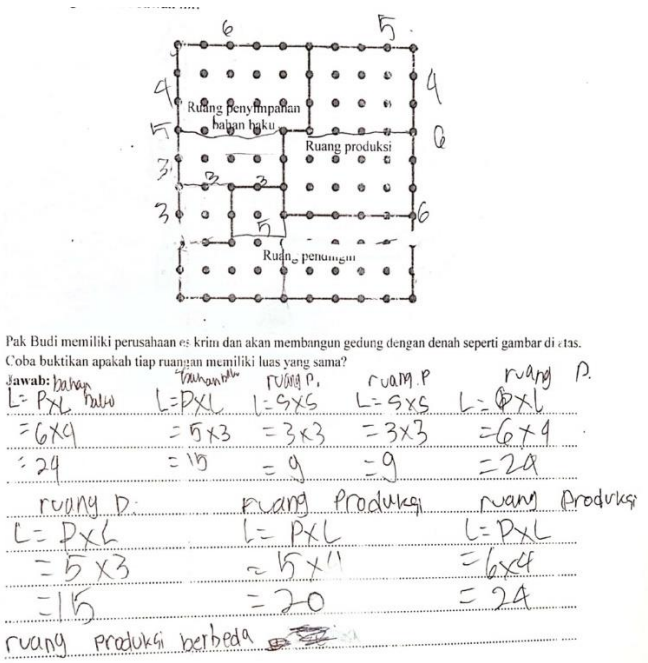

Figure 3. S4.2.1 answered by decomposing the shape

S4.2.1 and S6.2.1 decomposed the shape of each area into a rectangle and square, then calculated the area of each flat shape as shown in Figure 3. S4.2.1 in determining the length of the side, students counted the number of points on the side. When asked why counting the points, S4.2.1 answered, "Because the number of points is the length of the side." Students have a misconception that a point is a unit of area.

Strategy 3: Applies length reasoning

There are 11 students who apply the length reasoning strategy, namely 6 students from the 3rd grade, 1 student from the 4th grade, 2 students from the 5th grade, and 2 students from the 6th grade.

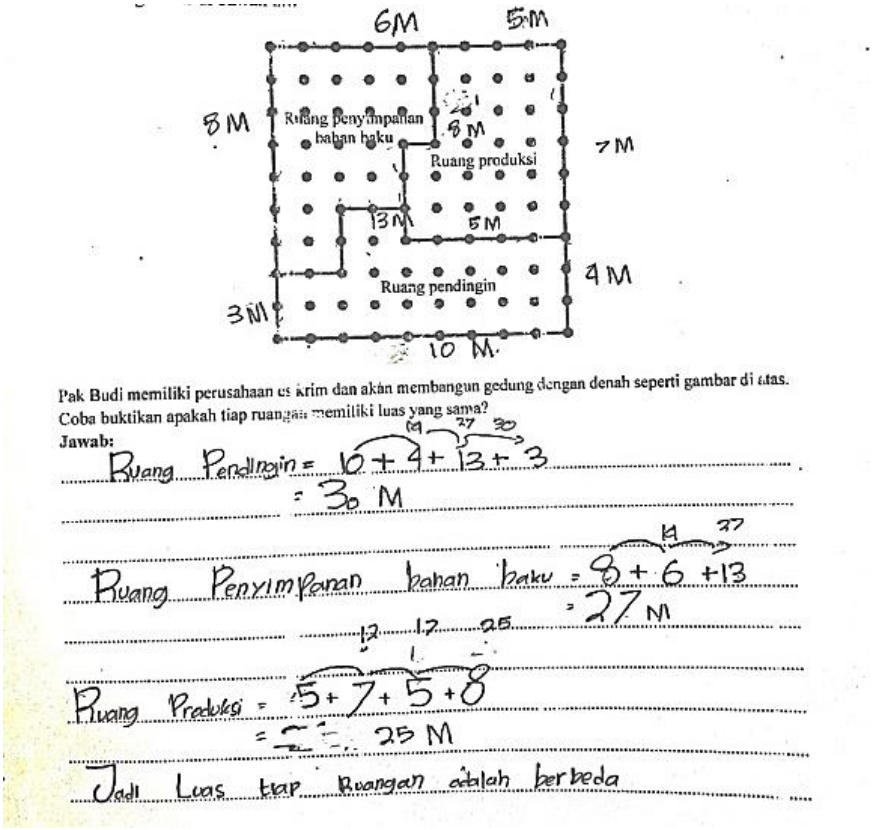

Figure 4. S4.3.1 answered by applying the length reasoning

S4.3.1, S3.3.1, S5.3.1, S6.3.1 considered the perimeter as the area as shown in Figure 4. Unlike S3.3.1, which counted the lines, S4.3.1 counted the number of points considered sides. When S4.3.1 was asked how to calculate each room's area, S4.3.1 answered, "I count the points on the outline of each room, then add them up." S4.3.1 also added standard units to the number of points considered as area.

Strategy 4: Compares unit

There are 52 students who apply the strategy of counting all units. There are 14 students from 3rd grade, 10 students from the 4th grade, 16 students from the 5th grade, and 12 students from the 6th grade.

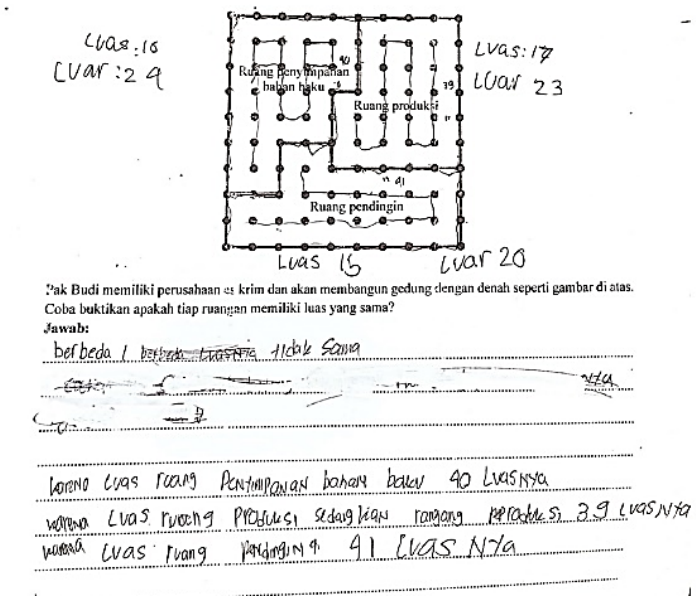

Figure 5. S4.4.1 answered incorrectly with the strategy comparing unit

S3.4.1, S4.4.1, S5.4.1, and S6.4.1 used the strategy to compare units and got the wrong answer as shown in Figure 5. S4.4.1 considers the points in each area to be units of area, but S4.4.1 calculates the total number of points in each area. This is reinforced by the results of interviews conducted on S4.4.1. When asked how to calculate each region's area, S4.4.1 answered, "I count the number of points inside and outside the line and then add them up."

Strategy 5: Multiples length and width

There are 2 students who apply the strategy of multiplying length and width. The students who use this strategy are 4th-grade students. In comparison, 3rd, 4th, 5th, and 6th grade students do not apply this strategy.

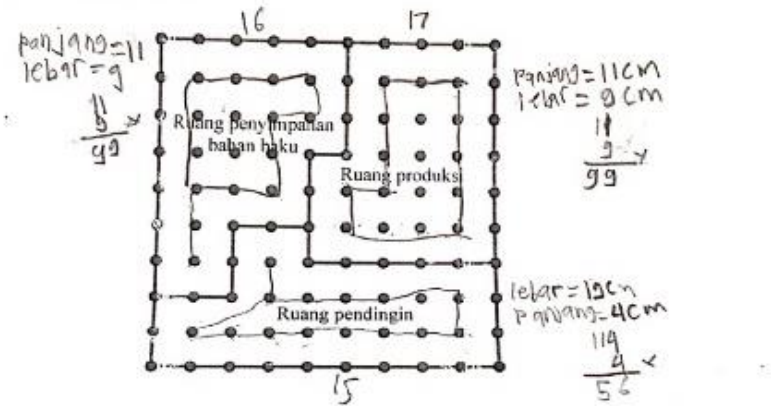

Figure 6. S4.5.1 answered incorrectly using the strategy of multiplying length and width

S4.5.1 drew a line by connecting the points inside each region as shown in Figure 6. S4.5.1 calculates the number of points on the horizontal line as the length and the number of points on the vertical line as the width. S4.5.1

considers that to calculate the area of the area, one must use the formula $p \times l$. This is reinforced by the results of interviews conducted by researchers in S4.5.1. When asked about how S4.5.1 can obtain the length and width of each room, S4.5.1 answered, "The length is the number of points on the sleeping line (horizontal) and the width is the number of points on the standing line (vertical)."

Strategi 6 : Divide the whole by the number of divisions

There are 2 students who apply the strategy by dividing the whole by the number of parts. Where students who use this strategy are 5th-grade students. While students in 3rd, 4th, and 6th grade did not apply this strategy.

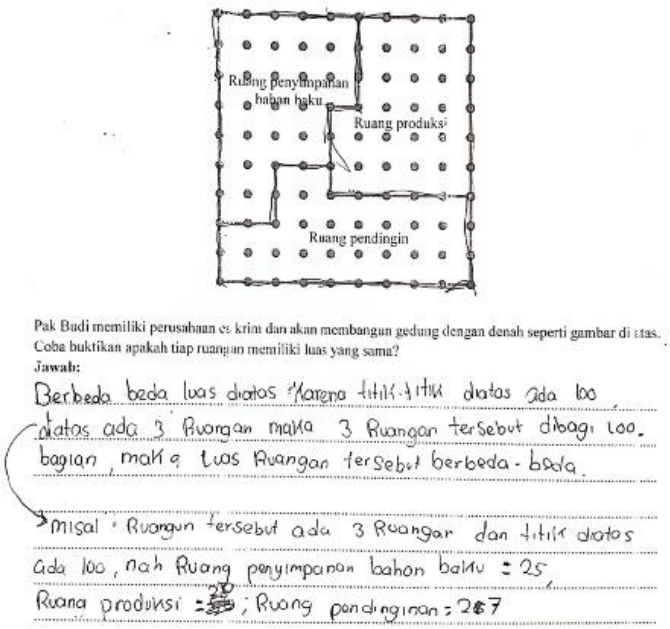

Figure 7. S5.6.1 answered incorrectly using the strategy of dividing the whole by the sum of the parts

S5.6.1 divided the whole by the number of parts. Students counted the number of all points in the figure and then divided it into three parts as shown in Figure 7. S5.6.1 said, "I counted the number of points there are 100, and if this room is the same area, this number 100 should be divided into three and produce the same number". Students get the result that the total number of hundred points if divided into three parts, does not get the same result.

The presentation of data on the use of strategies carried out by elementary school students in 3rd, 4th, 5th, and 6th grade can be seen in Figure 8.

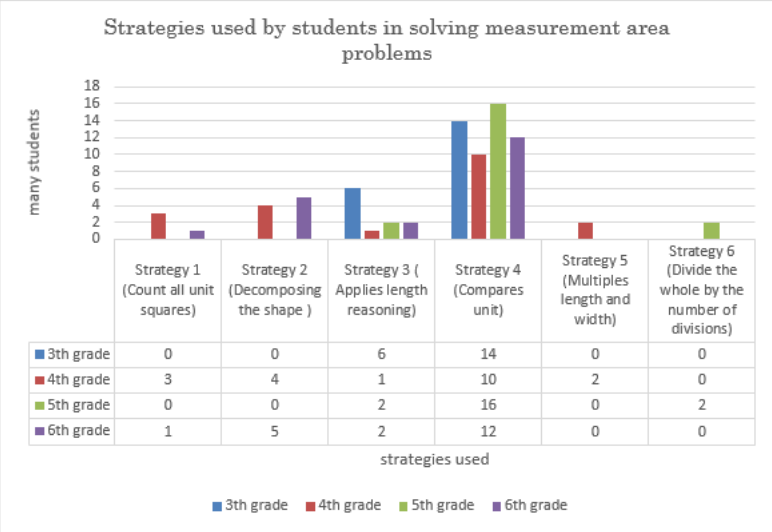

Figure 8. Strategies used by students in solving area measurement problems

The result of the findings in this study shows that in solving area measurement, elementary school students use the strategy of counting all units, where students count the number of units in each area. Students experience misconceptions related to area units by assuming that the existing point can be used as a unit to calculate the area. But in reality, a dot cannot be used as a unit of area because a dot cannot cover an area without a gap. To calculate the area, students can use an area unit that can cover the area without gaps and does not overlap (Reynolds, 1996). The results of these findings have some similarities and differences from those carried out by (Lee & Lee, 2021) and (Wickstrom et al., 2017), which can be seen in Table 3.

Table 3. Comparison of strategies

(Lee & Lee, 2021)	(Wickstrom et al., 2017)	This research
Calculating the number of square units Determining the area by counting the number of squares	Counts all unit Calculate the number of units formed to determine the number of tiles required	Count all unit squares Calculate the number of square units formed to determine the area of the area
Decomposing shapes Decompose shapes into two-dimensional figures	Addition of parts Decompose the tiling space of two-dimensional figures to determine the number of tiles	Decomposing the Shape Decompose the shape of an area into several flat shapes to determine the area of the area
	Applies length reasoning Arrange the tiles to determine the number of tiles required	Applies length reasoning Counting lines/points on the sides of the measurement area
	Compares unit Comparing units between tiles	Compares unit Think of a point as a unit of area
	Multiples length and width Multiplying of tiles required by length and width	Multiples length and width Multiplying the number of points on the horizontal and vertical lines
	Divides whole by unit Calculate the tiling area then divide by the tile area	Divide the whole by the number of divisions Calculate the measurement area then divide by the number of divisions

Three strategies are based on the findings (Lee & Lee, 2021). His research focuses on area measurement by determining the similarity of area. In the research (Wickstrom et al., 2017). There are six strategies where the research focuses on area measurement by determining the number of tiles needed to fulfill the area. This research has six strategies with a similar focus to Lee & Lee (2021).

D. Conclusion

This study found that in solving area measurement problems, students apply the strategies, 1) counting the number of square units, 2) decomposing the shape, 3) applying length reasoning, 4) counting all units, 5) multiplying length and width, and 6) dividing the whole with the number of divisions. In solving area measurement problems, students mostly apply the strategy of counting all units, where students calculate the number of points in the measurement area. Solving area measurement problems is influenced by students' experience obtaining area measurement material. There are differences in the strategies students use based on their grade level. Students tend to have misconceptions about the area unit used to measure area. The unit of area used should be able to cover the calculated area without overlapping and must be tight. However, students consider the point on the geoboard to be the unit of area. Another misconception students make is that the perimeter is the same as the area. The results of this study provide implications for future research as a guide in identifying the strategies elementary school students use in solving area measurement. The process of students' understanding of area measurement should be tiered, which can start by using concrete units, then visual, and then provide more abstract learning and tasks. Area measurement should not apply the formula directly. Instead, students are first allowed to understand the pattern and structure of the arrangement that exists in an area.

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