Development of learning trajectory of perimeter and area of squares and rectangles through various tasks

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Development of learning trajectory of perimeter and area of squares and rectangles through various tasks

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Abstract: This study aims to develop a learning trajectory through various tasks for the circumference and area of squares and rectangles that can help students construct understanding and mathematical concepts. This study uses a cognitive approach with samples taken by fourth-grade students at SDN 13 Sungai Pisang Kec. Bungus teIuk kabung, Padang City, West Sumatra, with 15 students. The methodology used is design research, which has three stages: preparing for the experiment, teaching, and retrospective analysis. This study used data collection instruments in the form of student activity sheets, observation sheets, interview guidelines, and field notes. The learning trajectory obtained is a revised learning trajectory from HLT 1 by explaining mathematical concepts and providing concrete examples that exist in everyday life, ranging from simple to more complex, constructing students' understanding of the material, and evaluating the answers given. they give to find out what is wrong and how to justify it. Learning trajectory that is developed through a variety of tasks can construct, and increase students' knowledge.

Keywords: Learning trajectory, perimeter and area, squares and rectangles, assignment variation

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INTRODUCTION

Geometry is often used to solve problems in everyday life, so it is in the most critical position in mathematics education (Cherif, Gialamas & Stamati, 2017; Özdemir, 2017; Panaoura, 2014; Rofii, Sunardi & Irvan, 2018). Geometry has a major portion in the education curriculum in Indonesia which is taught from the elementary school level to the tertiary level. Geometry has an abstract object of study than other learning fields (Prihandoko, 2005). Implicitly in learning geometry material is able to encourage students to think critically, deductive reasoning, visualization, problem-solving, intuition, logical proof, and argument (Jupri, 2017; Seah, 2015).

One of the geometry topics in elementary school mathematics is flat shapes and rectangles. A two-dimensional flat shape means a flat shape that has length and width in one flat plane, so you can find the circumference and area. Perimeter and area of squares and rectangles in flat shapes are included in subjects that elementary school students must master because they have an attachment to real life. (Winarti, Amin, Lukito & Gallen, 2012). Students who have a good understanding of the circumference material will have the initiative to use length in calculating the distance around a flat shape to get used to finding the perimeter of a flat shape by adding up each side. However, if students do not understand the circumference well, they will have difficulty determining the length of the sides if the picture is not clearly explained (Abadi & Amir, 2022). Meanwhile, if the student has spatial ability on flat shapes, he will realize that length and width are units of area. (Clements et al., 2018; Wickstrom, Hilton & Carlson., 2017). Perimeter and area of squares and rectangles are related so that students who understand the concept of calculating the circumference can certainly calculate the area of a flat shape (Fauzan, 2002).

The results of previous research revealed that students tend to only memorize formulas without knowing the concept (Chintia et al., 2021; Syahbana, 2013). If students do not construct and find their formulas and mathematical contexts, students will easily forget about the material (Gracia, Rahayu & Hakim., 2020). Elementary school students find it difficult to do minimal tasks with variations in tasks (Winarti, Amin & Lukito., 2012). In this case, students have misconceptions about the concept of perimeter and area of squares and rectangles. They think that flat shapes with the same area have the same perimeter (Clements, Sarama, Dine., 2018; Yunianto, Prahmana, Crisan., 2021). In learning the teacher explains more without explaining why and how the concept exists. Students are taught more in practice questions than exploring concepts (Fitriani et al, 2019). In addition, research in Australia explains that teachers must pay attention to student involvement (Clarke, Roche, Clarke & Chan., 2015). Therefore, the researcher focuses on eliminating these misunderstandings through various forms of assignment. So that students are expected to understand and apply the concepts they have acquired in order to form new understandings that are useful in everyday life (Rohman, Karlimah & Mulyadiprana, 2017).

Several studies noted that most students still have difficulty understanding geometric material concepts(Bustang, Zulkardi, Darmawijoyo., 2013; Fauzi, et al., 2019; MdYunus, Suraya., 2019). Flat wake is one of the materials where students make a lot of mistakes in solving problems because students lack practice working on questions, students' mistakes do not read the questions and students do not understand the concept of questions (Atiqoh, 2019). So the need for a solution using a cognitive approach in the form of assignment variations. So that it is expected to stimulate students to think critically and broadly and have broad insight. In addition, students will provide good feedback to find out to what extent they enjoy, understand, and benefit from the difficulties they get from each task type. Thus, the use of tasks allows the teacher to determine the student's learning trajectory. This will result in the active involvement of students and providing a challenging context to explore the mathematical ideas that students have (Widjaja, n.d,. 2013). Thus, to ensure the learning trajectory of school

students so that learning is measurable and the understanding of perimeter and area of squares and rectangles material is achieved. So the purpose of this research is to develop learning trajectory for elementary school students on perimeter and area of squares and rectangles material through various tasks.

METHODS

This research uses a design research method. Design research involves activities in learning and students' thinking during the learning process (Gravemeijer & Cobb., 2006). In design research, it has important aspects, namely Hypothetical Learning Trajectory (HLT) and Local Instruction Theory (LIT) (Van den Akker., 2006). Both of them lead to learning activities as a learning path taken by students in their learning activities (Prahmana, 2017). A learning trajectory is made in this study, which includes several learning activities. Design research consists of three stages: preparing for the experiment, teaching, and retrospective analysis (Prahmana, 2017; Gravemeijer & Cobb., 2006, Putri & Zulkardi, 2018). Based on these three stages, it can be stated that the HLT cycle in design research repeatedly occurs through these three stages. The HLT cycle will stop when the learning objectives are achieved and research questions can be obtained. However, if the learning objectives have not been achieved, then the three stages can be repeated. Figure 1 shows the design research cycle (Gravemeijer and Cobb, 2006).

At the stage of preparing for the experiment, the activity that contains the conjecture of students' thinking is developed by the researcher through HLT. In addition, the researchers also conducted classroom observations and interviews with teachers and students to determine students' initial state and abilities. Preparing for the experiment aims to design LIT. Before the LIT is designed, it is necessary first to conduct a literature review, such as books and journal articles about square and rectangular to design the HLT. HLT aims to provide an overview of the learning process starting from the knowledge possessed by students until the achievement of learning objectives. The stages that must be passed in HLT are designing activities that are thought to be able to help students gain knowledge and achieve learning goals. Furthermore, learning tools such as Learning Implementation Plans (RPP) and Student Activity Sheets (LAS) were designed as a reference for implementing HLT. HLT validated and declared valid can be tested in a class called cycle 1.

EMERGING LOCAL INSTRUCTIONAL THEORY

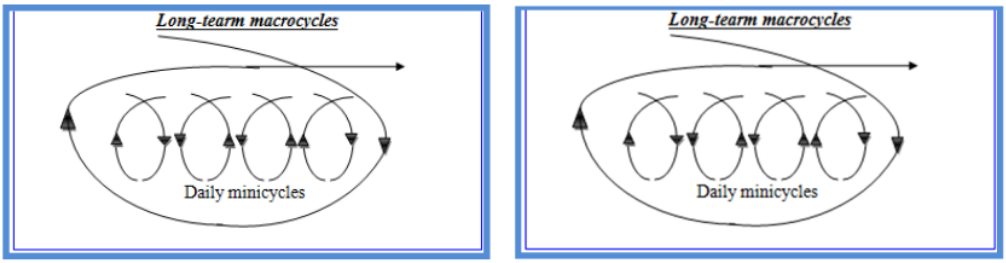


FIGURE 1. *Design Research Cycle.*

There are two cycles at the teaching experiment stage, namely the pilot experiment as cycle 1 and the teaching experiment as cycle 2. The purpose of this stage is to conduct HLT trials and improve the previously designed LIT conjecture in preparing for the experiment so as to get a better HLT. good. The trial was carried out based on the HLT made and carried out based on a reference to the validated RPP and LAS. Based on the trial, it was analyzed to what extent the activities in HLT were implemented in the learning process and their effect on students' understanding. Retrospective analysis is the final

stage in design research. All data obtained during the study were analyzed at this stage, such as student answer sheets, video recordings, field notes, and observation sheets. In addition, a retrospective analysis was also carried out by interviewing students and conducting discussions with teachers. Based on this retrospective analysis, parts of HLT are preserved and parts that are reduced. The part that is retained is the part that can positively influence student understanding. In comparison, the reduced part is the part that is considered not to have an effect on the achievement of learning objectives. Therefore, the cycle in design research occurs repeatedly. If the research objectives have been achieved, the cycle will stop.

The research instrument used a variety of tasks called The Task Mathematics Learning (TTML) adapted from (Clarke & Roche, 2017), student activity sheets, observation sheets, interview guidelines, and field notes. TTML consists of representation tasks, contextual tasks and open tasks on perimeter and area of squares and rectangles. First, the representation task aims to make students able to know the concept of finding the perimeter and area of squares and rectangles. Representation is the main focus in constructing students' knowledge and understanding of a mathematical concept. Although it is not explicitly stated in the objectives of learning mathematics in Indonesia. The importance of representation is implied in the objectives of problem solving and mathematical communication, because to solve mathematical problems. It is necessary to create mathematical models and interpret the solutions that are indicators of representation (Fatrima, 2017). Second, the form of Contextual Tasks aims to make students observe how to find the perimeter and area of squares and rectangles of flat shapes from various squares and rectangles ranging from simple to complex. Third, open Task Form The purpose of using this form of assignment is to allow students to express their opinions about the questions at hand. However, it is undeniable that broad knowledge of literacy and other sources is needed in working on this problem. From the form of this assignment, students realize that in flat shapes, squares and rectangles with different shapes can have the same area but different perimeters and so on. The form of assignment variation must be determined under agreed criteria, both from the level of student ability, context, and context (Fatimah, 2021).

The subjects in this study were fourth grade students at SDN 13 Sungai Pisang Bungus Teluk Kabung District, Padang City, West Sumatra. The students involved in this process were grade IV students, as many as 15 students, including 6 male students and 9 female students. Furthermore, in the HLT trial cycle 2, the instruments used in this study were student activity sheets, observation sheets, interview guidelines, field notes, and learning video recordings. Data analysis was carried out through retrospective analysis based on data collected according to the sequence of learning activities. Retrospective analysis using video recordings aims to see whether students are active or inactive in learning according to the designed conjecture and reduce activities that are not in accordance with learning.

RESULTS

At the stage of preparing for the experiment, the researcher designed the learning process in three sessions. Before entering into the session, the researcher first reviewed the perimeter and area of squares and rectangles material on squares and rectangles, followed by an explanation of how the stages in each type of task work were. In the first session, the work on the type of representation task aims to interpret students' initial thoughts on a problem, which is used to find a solution to the problem. The second session of working on the type of contextual task aims to invite students to interpret the content of the material they are learning by connecting it with the context of everyday life. The third session of working on the type of open task aims to construct students' understanding and find out how far the understanding has been obtained by students during learning, at this stage can be used as the final and concludes the learning results.

HLT Trial Session 1

At the stage of preparing for the experiment, the HLT that has been designed is tested on students, the activity carried out is to interpret students' initial thoughts on a problem, which is used as a tool to find a solution to the problem. The first step is to form groups with their classmates, discuss with their classmates to determine which pictures of squares and rectangles have the same area and different perimeters, or vice versa on the images in the table, this is where students can determine which squares and rectangles are. which one fits the criteria, students can determine it correctly. Calculate the perimeter and area of squares and rectangles on flat shapes that are often encountered in everyday life. Make flat shapes that have the same area but different perimeters or vice versa. The last step in the first session is to explain the relationship between the perimeter and area of squares and rectangles based on the types of shapes made. In this last step, not all students are able to explain the results of the tasks they are doing properly and correctly, this can be seen because some of them can work on and find the answer but cannot explain, lack concentration on the orders on the assignment, besides that some also only ride with a friend or not follow the discussion. The time given by the researcher was forty-five minutes starting from eight to eight forty-five minutes, the time was considered sufficient by the researcher to review a little material, explain the implementation rules and anticipate other obstacles encountered during the process of working on the task.

In the second session, the activity carried out was to interpret the content of the material he studied by connecting it to the context of everyday life. Form groups with 3 members in 1 group. Researchers gave candy. Researchers gave instructions to open the candy slowly in order to get a nice rectangular shape. Trace the candy wrapper that has been opened. (Candy wrappers can be perfectly or imperfectly shaped depending on how students tear them). In this step, students are very enthusiastic, which results in tearing the candy wrapper that does not comply with the rules or the shape becomes irregular. It is continued to calculate the perimeter and area of squares and rectangles of the candy wrapper by taking into account the conditions that have been given by the researcher on the paper that has been given. In the last step students are directed to look for objects with square or rectangular shapes in the surrounding environment, followed by calculating the perimeter and area of squares and rectangles of the objects that have been obtained. The second session was also given the same time, namely forty-five minutes to anticipate unexpected problems. So within forty-five minutes students must have completed the task.

In the third session the researchers wanted to construct students' knowledge of the extent to which students' understanding had been obtained during learning from theory to the concept of the perimeter and area of squares and rectangles itself, in this session the researcher tested it using open-ended questions, in answering the students may use each creative idea is explained in their own language. Students explain from open questions that have been presented related to the understanding that students have obtained during learning from beginning to end. An example of the question, What is the perimeter and area? Why can it be said to be a square and a rectangle? Why can the rectangular formula be obtained p x l? In the last session, students are given fifty minutes. It is hoped that from the amount of time given, students are able to give the best answers to the open questions.

HLT Trial Session 2

Based on the results of the retrospective analysis on the HLT cycle 1, there are several revisions to improve the quality of the HLT that will be used in the HLT cycle 2, such as multiplying examples of calculating perimeter and area of squares and rectangles based on the concept of a flat shape. In addition, providing simple initial examples also provides more complex examples, emphasizing the explanation of the perimeter and area of squares and rectangles that are part of 2D geometry slowly because there are various types of student abilities in one class. On the same day, the validator re-validated the

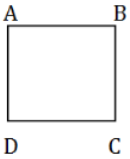
revision to prove the suitability between the learning activities provided and the achievement of learning objectives. After revision, the learning tools can be reused at the trial stage in the same class.

Learning begins at twelve o'clock in Diwali with questions and answers related to the obstacles encountered during the process of working on the previous task, giving a conceptual explanation regarding the perimeter and area of squares and rectangles, followed by giving examples of finding the perimeter and area of squares and rectangles. and rectangles ranging from simple to complex.

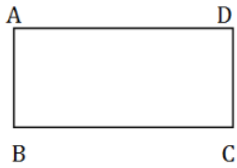
FIGURE 2. *Student activity explanation of the material*

The first session aims to interpret students' initial thoughts on a problem, which is used as a tool to find solutions to the problem. In addition to providing examples, the researcher also explains in detail the perimeter and area of squares and rectangles in real form or in pictures.

Researcher : Does the task sheet include everything in the flat?
Student : Yes mom
Researcher : What flat shapes are there?
Studen : Square and rectangle bu
Researcher : Why is it called a square and a rectangle?
Student 1 : Because if it's a square, it's a box, while a rectangle is elongated.
Student 2 : Because if the square all the sides are the same, while the rectangle is different
Student 3 : Because if a square consists of four sides that are all the same, while a rectangle consists of different lengths and widths.
Researcher : Yes, all of your friends' answers are correct, but I will give my own answer.
A square is a flat shape with four sides of the same length, namely the top, bottom, right side, left side or as in the picture on ABCD, while an example of a concrete object is the lid of the gift box that my mother brought.



While a rectangle is a flat shape with four but different sides, the sides consist of a length and a width, each of which is different. It can be seen from the picture that the sides AD and BC are called the length and the sides AB and DC are called the width, while an example of a concrete object is this book that I brought.



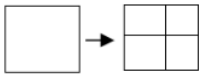
That way, you can know the formula for finding the perimeter and area of squares and rectangles. Who knows what perimeter and area are?

Student 4 : Area is the size of a flat shape

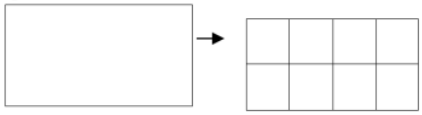
Researcher : Who else knows?

Student 5 : Perimeter is the amount that surrounds a flat shape.

Researcher : Thank you for your answer. The mother will explain that area is what covers a flat surface with one unit area



It takes 4 units of area to cover the square surface. So the area of the square is 4 units of area or 4 cm2.



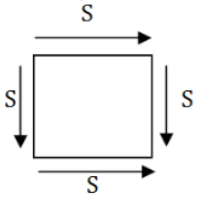
It takes 8 units of area to cover the rectangular surface. So the result is that the area of the rectangle is 8 units of area or 8 cm2.(Sandipan, 2014).

If the area is a surface cover, then the circumference is to calculate the length of the outer side of the flat shape, you can use thread or rope. Who knows the formula to find the perimeter and area from the concept above?

Student 6 : Me, Miss. Since a square has four equal sides, the formula for the perimeter of a square is (4 x the outermost side) mom and the area (side x side). Already mom.

Student 7 : Me, Miss. For a rectangle, the perimeter is 2x (p+l) while the area is p x l

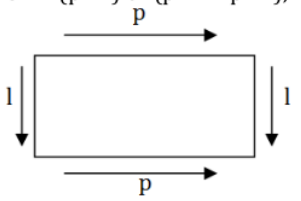
Researcher : Yes, very smart. You can see an example below.



Because squares have the same sides, to calculate the perimeter add up all the sides or calculate it using a string.

Meanwhile, to find the area, the representative of each side is multiplied so that it can cover one flat figure. So we get area of square = side x side (s x s)

As for the rectangle. This is because rectangles have different sides, namely length and width. So, the formula for the perimeter of a rectangle is 2 x (p + l) or (p + l + p + l), look at the picture below.



It can be seen in the picture besides knowing that the formula for the area of a rectangle is length x width (p x l).

To calculate the area can also be mapped as in the previous example.

After equating the perception of the perimeter and area of squares and rectangles, students can find and determine the perimeter and area of squares and rectangles of each

image. Next, students work on the tasks that have been provided on the assignment sheet given by the researcher.

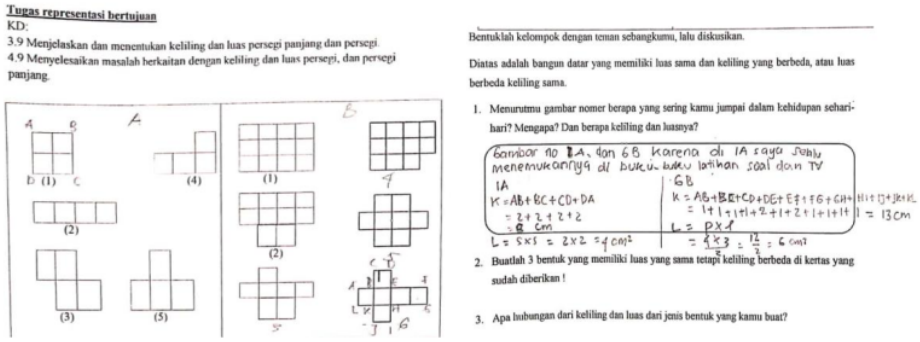


FIGURE 3. *Example of a representation task*

The second session aims to invite students to interpret the content of the material they are learning by connecting it in the context of everyday life. Students were asked to trace the torn candy wrapper as in the first cycle activity. In this second cycle, the researcher will emphasize the rules of tearing the candy wrapper so that the shape is regular and can be counted easily. In addition, students are free to choose the squares and rectangles they meet around the school to calculate the perimeter and area. In this second session, the students were able to do well.

FIGURE 4. *The researcher explains so that there is no miscommunication*

The third session aims to construct students' knowledge to find out the extent of understanding that students have obtained during learning. At this stage, to complete the task correctly and adequately, each student must listen carefully to the explanation given from beginning to end. In addition, students must read a lot of references to increase their knowledge. In the given task, all students can answer, but not all the answers are correct, but there is a development from the first cycle.

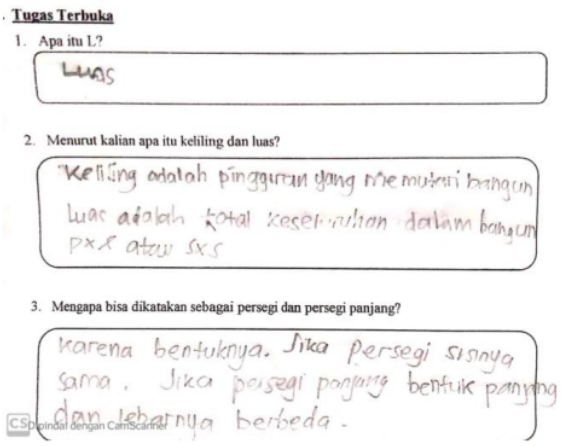


FIGURE 5. *Open task form in the third session*

Based on the results obtained by students, students have been able to find the perimeter and area of squares and rectangles in squares and rectangles through various forms of tasks, including representation tasks, contextual tasks, and open tasks. Based on the teaching experiment, it can be concluded that the activities in HLT 1, which were revised to get HLT 2 are as follows.

1. It is further deepening in explaining mathematical concepts and providing concrete examples that exist in everyday life.
2. Not only giving easy examples but also giving examples ranging from simple to more complex.
3. Allowing students to explore their environment so that they do not feel burdened in doing math tasks and learning is fun and constructs students' understanding of the material.
4. Provide an evaluation of their answers to find out which ones are wrong and how they are right.

DISCUSSION

Based on the research results using learning trajectory using a cognitive approach in this study. There were no severe obstacles, and students were able to complete the tasks given under the criteria of providing perception, assessment, reasoning, imagination, and capture of meaning related to perimeter and area of squares and rectangles materials. The learning trajectory activity developed is that students can find solutions carried out by researchers by interpreting students' initial thoughts about perimeter and area of squares and rectangles. Able to interpret the contents of the perimeter and area of squares and rectangles. It learned by connecting in the context of everyday life, constructing the understanding that students have obtained during perimeter and area of squares and rectangles learning. Students can convey what they know about this type of assignment by describing it in their own language.

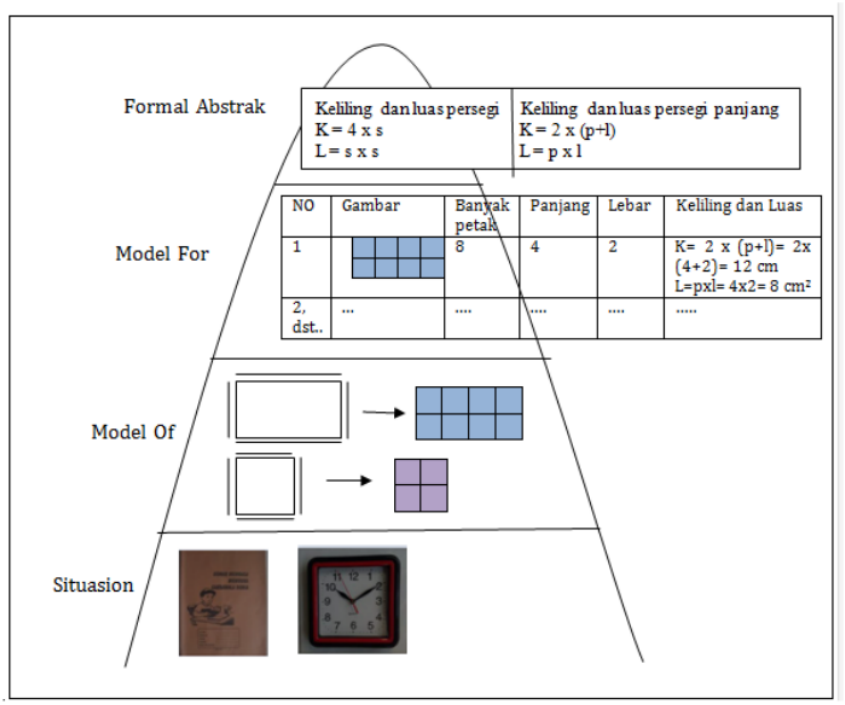


FIGURE 6. *Learning trajectory in the form of an iceberg*

Conceptual errors include students' misunderstandings in understanding questions and using formulas, theorems, or definitions that do not adjust to conditions (Ovez, 2012; Widodo, 2013). Indicators of mastery in understanding there are two aspects 1) remembering the previous material 2) being able to connect new material with previous material (Wulandari & Gusteti, 2020).

From the explanation above, it can be concluded that design research using a cognitive approach in the form of task variations is based on bloom taxonomy aspects including knowledge (C1), understanding (C2), application (C3), analysis (C4), evaluation (C5), and creating. The form of the task is designed to gradually develop students' knowledge of perimeter and area of squares and rectangles from low to more complex levels so that students discover mathematical concepts in a guided manner.

Based on the results, students' understanding of the perimeter and area of squares and rectangles can be developed from the informal to the formal stage. Students can understand the concept of perimeter and area of squares and rectangles so that students are able to work on the various types of tasks given by the researcher. In addition, the retrospective analysis obtained is then analyzed to develop the planned learning trajectory. Through the variety of tasks given, students are able and accustomed to solving mathematical problems on the perimeter and area of squares and rectangles, ranging from low-level to complex problems. In addition, this variation in tasks trains students to focus, be skilled, confident, and develop their creative ideas.

CONCLUSION

In providing understanding concepts to students, researchers provide a variety of tasks in learning that are needed to be able to improve mathematical performance in learning mathematics. The method used in this research is design research, which consists of three stages: preparing for the experiment, teaching, and retrospective analysis. The

subjects in this study were fourth-grade students at SDN 13 Sungai Pisang Kec. Bungus teluk kabung, Padang City, West Sumatra, with 15 students.

The Learning Trajectory obtained is a revised learning trajectory from HLT 1 by explaining mathematical concepts and providing concrete examples that exist in everyday life, providing examples ranging from simple to more complex, constructing students' understanding of the material, providing an evaluation of the answers given. They give to find out what is wrong and how to justify it. This research is limited in the discussion. Apart from squares and rectangles, many other flat shapes can be developed. Thus, other researchers are expected to be able to develop learning trajectories on different materials.

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