LEARNING THE CONCEPTS OF AREA AND PERIMETER BY EXPLORING THEIR RELATION

MASTER THESIS

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SURABAYA STATE UNIVERSITY

POSTGRADUATE PROGRAM

MATHEMATICS EDUCATION STUDY PROGRAM

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A Thesis Submitted to Surabaya State University Postgraduate Program

as a Partial fulfillment of the requirements for the Degree of Master of Science

in Mathematics education Program

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APPROVAL

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Allah SWT for the Blessings and Mercies in every single path of mine. My dearest Mom and Dad for your love and support, my sisters Nunuk and Desi and my brother Tiyok for always there for me anytime.

I dedicate this master thesis for those who inspiring me the most….my parents, sisters and brother.

ABSTRACT

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Keywords: *Perimeter, Area, Relation between perimeter and area, Understanding*

Learning the concept of perimeter and area is not easy for students in grade 3 of primary school. A common mistake is that students think that if the area is the same, the perimeter also has to be the same. It is difficult for them to understand that for a given area, there are many possibilities of perimeter and vice versa. When student are not aware of this relation they might confuse about the concept in their continuation of learning process. This research was conducted to study if it would support students' understanding of the concept of perimeter and area if we let them explore the relation between perimeter and area in the very first phase of the learning process.

Design research was chosen as the method to study this issue and the three basic principles in The Realistic Mathematics approach were applied in this study to support the learning process of perimeter and area. Real life context such as picture frames was choosen in developing a sequence of learning line to reach the learning goal of perimeter and area. The partipants of this research were students and mathematics teacher of grade 3 in one of the elementary school in Surabaya. Two classes were taken to involve in the first cycle and second cycle respectively.

The teaching experiment shows that the class activities such as making photo frame, measuring photo paper with sticky paper and arranging shapes with wooden matches are activities which can be used to reveal the relation of perimeter and area. From those activities students build their own understanding that in fact area and perimeter are not in one to one correspondence, they found that for the given area they might find different perimeter or vice versa. They also found the reason why they multiply length and width to count the area of rectangular or square shape from sticky paper activity. Somehow some students were found still struggle with their understanding of area and perimeter. They often simply count the area and perimeter but when it comes into comparing the area or perimeter they still struggle to differentiate between area and perimeter.

ABSTRAK

Winarti, Destina Wahyu. 2011. *Learning the concepts of area and perimeter by exploring their relation*. Tesis, Program Studi Pendidikan Matematika, Program Pascasarjana Universitas Negeri Surabaya. Pembimbing: (I) Prof. Dr. Siti Maghfirotun Amin, M.Pd, and (II) Dr. Agung Lukito, M.S.

Kata Kunci: keliling, luas, hubungan antara keliling dan luas, pemahaman

Mempelajari konsep keliling dan luas bagi siswa kelas 3 SD bukanlah hal yang mudah. Kesalahan umum yang mungkin dilakukan siswa adalah anggapan bahwa dengan luas yang sama maka keliling juga akan sama. Sulit bagi mereka untuk memahami bahwa untuk suatu luas tertentu mereka mungkin memperoleh keliling yang berbeda-beda atau sebaliknya. Jika siswa tidak menyadari hubungan antara keliling dan luas, mereka mungkin akan bingung dengan konsep tersebut dalam kelanjutan proses belajarnya. Penelitian ini dilakukan untuk mengetahui apakah dengan mengeksplorasi hubungan antara keliling dan luas dalam tahap awal pembelajaran siswa kelas 3 SD akan mendukung pemahaman mereka terhadap konsep keliling dan luas.

Design research dipilih sebagai metode untuk mempelajarai permasalahan tersebut, dan tiga prinsip dasar RME (Realistic Mathematics Education) diimplementasikan dalam penelitian ini untuk mendukung proses belajar pembelajaran keliling dan luas. Konteks dari dunia nyata seperti mengukur bingkai foto telah dipilih dalam mengembangkan urutan pembelajaran untuk mencapai tujuan pembelajaran luas dan keliling. Peserta dalam penelitian ini adalah siswa dan guru matematika kelas 3 SD di salah satu sekolah swasta di Surabaya. Dua kelas diambil untuk terlibat dalam siklus pertama dan kedua.

Hasil penelitian menunjukkan bahwa aktifitas kelas seperti membuat bingkai foto, mengukur kertas foto dengan mengunakan kertas tempel atau membentuk bangun datar dari korek api adalah aktifitas-aktifitas yang dapat digunakan sebagai alat untuk memunculkan hubungan antara keliling dan luas. Melalui aktifitas-aktifitas tersebut siswa membangun pemahaman mereka sendiri bahwa pada kenyataannya keliling dan luas itu tidak berkorespondensi satu-satu. Mereka menemukan bahwa untuk suatu luas tertentu, mereka mungkin mendapati keliling yang berbeda-beda dan atau sebaliknya. Mereka juga menemukan alasan mengapa mereka mengalikan panjang dan lebar untuk menghitung luas persegi atau persegi panjang melalui aktifitas dengan kertas tempel. Namun demikian, masih didapati siswa yang masih mengalami kesulitan untuk memahami konep keliling dan luas. Mereka hanya menghitung luas dan keliling tapi ketika merak harus membadingkan suatu luas atau keliling maka mereka mulai mengalami kesulitan untuk membedakan luas dan keliling

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Surabaya, September 2011

Writer

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CHAPTER I

INTRODUCTION

1 Introduction

1.1 Background

Perimeter and area become one of the interesting topics to be discussed since those two are very relevant to the real world. Almost in every part of our surrounding we find perimeter and area. With or without realizing, pupils use that terms in their daily conversation such as "my *plate is larger than yours*" or "I *guess I used shorter rope to fence this photo frame than what you spent*". Even though they do not literary use the words area or perimeter but the issue that they bring actually about perimeter and area. Somehow we cannot conclude yet that those who made the conversation have the same understanding about the concept of perimeter and area.

The concept of perimeter and area is not an easy thing to learn. Romberg (1997) states that a common difficulty regarding perimeter and area is to understand that for a given area, many perimeters are possible, and vice versa. In addition, it is frequently found that pupils mix the concepts of area and perimeter. They often tend to think that two figures with the same area also have the same perimeter (TAL Team, 2004). From an observation in a primary school in Indonesia, it was found that some pupils had counted the perimeters to answer the questions about areas (Fauzan, 2002).

Pupils are familiar with the concept of length since they were in grade 2 of primary school. For pupils who have a good understanding of perimeter as a

special application of length that measures the distance around a figure, they will be accustomed to finding perimeters where the length of every part of a figure is given and they just had to add all the given numbers but for those who do not have an adequate understanding of perimeter will find it difficult to deduce the length of the side when it was not stated explicitly (Kai Kow, 2006). Therefore it is important to embed a good understanding of perimeter for students on their early years of introduction in perimeter.

Different from perimeter, in fact, area is a more difficult concept for the students on their first year of introduction to area. Perimeter is in line with the concept of length which is known as linier measurement but area is not about length, it is about the whole surface that covers a shape. Understanding the attribute of area involves giving a quantitative meaning to the amount of bounded two-dimensional surface (Cross et all, 2009). Understanding of area measurement involves learning and coordinating many ideas (Clement & Stephan, 2004), such as transitivity, the relation between number and measurement, and unit iteration operating in area measurement.

Narrowing the coverage of perimeter and area for rectangles and square only then we focused on the 3rd grade students (9-10 years) that based on previous research still found some difficulties to distinguish between perimeter and area. Students in 3rd grade also show little skill or knowledge about area and perimeter (NAEP). In line with the above description, a research in implementing IRME curriculum for teaching area and perimeter for 4th grader in Indonesia was conducted by Fauzan in 2002.

One interesting finding from Fauzan's research is about the relation of area and perimeter that was thought consecutively starting with the concept of area. He described in his research that students could understand the relationship between area and perimeter after they had worked on some contextual problems in which they create geometry objects that had the same area but were different in perimeter and vice versa. Somehow the reasoning behind students thinking was just discussed briefly. Strong argumentations that underpin this is still lacking as Fauzan stated that needs further research to see the process from the development of student's mathematical thinking through their reasoning.

From one of the criticism of Fauzan to Indonesian curriculum, "Not clear why the topic 'perimeter and area' has to be separated, while they are interconnected with each other" and also the discussion of Fauzan and his colleague (see http://mathforum.org/t2t/) that it doesn't matter whether perimeter or area comes first. Based on those reasoning then this research will work on perimeter and area side by side. This research will argue that it is possible to teach the concept of perimeter and area side by side to reveal the relation of them to help the students gain understanding towards the concept of perimeter and area.

1.2 Research Questions

The research question was formulated to achieve the research aim as follows:

How can exploring the relation of perimeter and area support the student's understanding about the concepts of perimeter and area?

We formulated two sub-questions that relevant with the issue in the main research question in order to gather enough information for answering the main research question. The sub-questions are:

1. *What activities can be used to explore the relation of area and perimeter?*
2. *What kinds of understandings that students could reach from the learning process?*

1.3 Aim of the Research

In line with the background of this research and research questions, the first aim of this research is to support students' learning process in understanding the concept of perimeter and area by exploring the relation between perimeter and area through class activities. The second aim is to develop a local instruction theory on supporting students understanding in perimeter and area through the relation of perimeter and area. To achieve those aims, a hypothetical learning trajectory will be designed, tested in the teaching experiment and analyzed, redesigned to fulfill the needs of achieveing the aims.

1.4 Significance of the Research

In line with the purpose of this study there are two significances regarding this study. The first significance is to contribute in giving grounded instruction theory on the concept of perimeter and area. The second significance is to give an insight to mathematics teacher on how to develop teaching and learning process that support students' understanding about the concept of perimeter and area. This study also offeres an overview to researchers on how to design instructional activities and what considerations that should be taken into such a design.

1.5 Definition of Key terms

We will describe several key terms related to the research questions mention above.

1.5.1 Perimeter

In this research we define perimeter as the curve enclosing a region of a surface or the length of such a curve (Borowski & Borwein, 2002)

1.5.2 Area

In this research we define area as part of a two-dimensional surface enclosed within a specified boundary / geometry figure or the measure or extent of such a or part of a surface (Borowski & Borwein, 2002)

1.5.3 Relation between perimeter and area

The relation between perimeter and area in this research is about the ways in which perimeter and area are connected and how perimeter gives impact to area and vice versa.

1.5.4 Understanding

In this research we describe understanding as the ability to deduce specific rules or procedures from more general mathematics relationship, in short one knows ‘how’ and ‘why’(Skemp, 1979 in Idris, 2006).

CHAPTER II

THEORETICAL FRAMEWORK

2 Theoretical Framework

In designing a research in mathematics education, we do need a theoretical framework both mathematical and didactical to provide a foundation in order to design an instructional theory. To Design an instructional theory for the learning series of perimeter and area then we studied the literatures related to those subjects. The coverage of theoretical framework for this research is as follows

2.1 The concept of perimeter and area

Kai Kow on his article "*Teaching area and perimeter: Mathematics-Pedagogical-Content Knowledge-in-Action*" stated that most primary school pupils have good understanding of perimeter as a special application of length that measures the distance around a figure. Somehow for primary students in their early learning of perimeter and area, they might start to understand the concept of perimeter by relating it with their daily life. For instance, Ria goes around the football field from certain point and come back to her initial point then she said it as perimeter or she simply said perimeter as the boundary of the polygonal region. Early primary students understand perimeter starting from their spatial and visual idea and develop into logical measuring operation when they already have adequate conservation of length, then finally they have the concept of perimeter as the distance or length of the figure.

Douglas H. Clement (2004) in his book "*Engaging Young Children in mathematics*" described area as an amount of two-dimensional surface that is

contained within a boundary and that can be quantified in some manner. Same as the concept of perimeter for early primary students, they might start to understand the concept of area from their spatial and visual idea. They see area as the region within a boundary then along their learning process they will develop their logical measuring ability to make a sense that area is the amount of material needed to cover the whole surface that is contained within a boundary.

In this research, the concept of perimeter and area will be delivered to pupils in grade 3 of primary level in Indonesia where it is their first introduction to perimeter and area. For Indonesian curriculum, the concept of area and perimeter in grade 3 was given in the coverage of rectangular and square plane figure. It was described in the following table,

Standard Competence	Basic Competence
Counting the perimeter and area of square and rectangular plane figures and its application in problem solving.	▪ Counting the perimeter of square and rectangular plane figure ▪ Counting the area of square and rectangular plane figure ▪ Solving the problems related to perimeter and area of square and rectangular plane shape.

Figure 2.1 Area and Perimeter measurement 3rd grade elementary School in Indonesia curriculum

This research will work in the same coverage of Indonesian curriculum; somehow we convince ourselves to put some addition of the generalization for the concept of perimeter and area not only for square and rectangular plane figures only but also for any plane figures.

To be considered to have the understanding about the concept of perimeter and area, the students in grade 3 do not necessarily have to be able to state

formally the definition of perimeter and area as mentioned above. We will describe briefly about our background theory on understanding from Skemp (in Olsen, 1981 and Idris, 2006). He described the understanding as recognizing a task as one of a particular class for which one already knows a rule (Skemp, 1979 in Olsen, 1981) or the ability to deduce specific rules or procedures from more general mathematics relationship (Skemp, 1979 in Idris, 2006)

Regarding how to attempt those understanding, Skemp (in Idris, 2006) highlight the importance of getting the right direction and the connection to be made to schemata (knowledge structures) to bring about mathematics understanding. According to him teacher cannot help students to construct schemata, but can only provide good learning situation so that students can build their own schemata.

2.2 Perimeter, area and its relation

Most primary school pupils have a good understanding of perimeter as a special application of length that measures the distance around a figure (Kai Kow, 2003). Measures of length are generally regarded as the simplest measures to understand and appy because they involve only one dimension; and because of their comparative simplicity, they provide good illustration of the fundamental points of the teaching of measure generally (A.R. Bunker, 1967).

Different from perimeter, area is not an easy subject to be learned by young children. Although the steps in learning to use measures of area are very much the same as those followed in learning about length, the concept associated with area are much more difficult to grasp. In developing the concept of area, all

work should be directed towards an answer to the question, “How much surface is covered?”(A.R. Bunker, 1967). In comparing area of rectangles for instance, pupils in early elementary years tend to focus on one-dimensional length of rectangle, rather than the two-dimensional space enclosed (Jensen J.Robert, 1993). Some students develop strategies for finding area that did involve both width and height. When asked to compare the areas of two rectangles, some students compared the sums of the height and width and others compared the length of the diagonal of the rectangles. Here we can see that students seem to lack an understanding of the property of area.

It is important that students have time to explore the relationship between area and perimeter. They need to know that not all shapes with the same area have the same perimeters and vice versa (Bahr. Kathleen, et all). Relating to the concepts of area and perimeter, students try to use what they already know to make sense of new mathematical concepts (Helbert&Carpenter). When student realize that two shapes with the same perimeter might not have the same area then they will no longer believe that the same perimeter always result in the same area. Teachers should aware and make these connections explicit, determining what their students already know and helping students see how the new concept is related to that knowledge. For example students know the concept of perimeter as the length of string required surrounding the region then teacher can approach the concept of area starting from student’s understanding of the concept of perimeter. Teacher can direct student, for instance, to realize that every time they create a fence then eventually they will create a region within it.

The teacher can make this connection even stronger by using objects that students are familiar with (such as a photo frame) and by introducing the concepts as part of a problem ("Which photo frame needs the longest rope?" or "Which photo frame is the largest?"). Because it is difficult to transfer knowledge from one discipline to another, students should have experience applying mathematical knowledge to other disciplines. This will also motivate the need for learning mathematics.

2.3 Realistic Mathematics Education

Perimeter and Area are two terms that are very relevant to the real world. Everything that available in our surrounding are always consist of perimeter and area. In education curriculum in Indonesia the concept of perimeter was introduces since grade 2 in the form of introduction to length as a basic concept of perimeter then in grade 3 they start to learn the term perimeter and area. Regarding the introduction of the concept of perimeter and area, students are likely to understand concepts, such as mathematical definitions if the teacher provides them examples of those concepts (Selden. Annie et all, 1998) and indeed students try to use what they already know to make sense of new mathematical concepts (Hiebert&Carpenter). When a new concept is introduced, students need tactile and visual experiences to assist them in understanding the concept (Grouws, 1992).

Bringing the concept of perimeter and area from a real life situation to the learning activities in class somehow becomes the main consideration in this research and Realistic Mathematics Education (RME) becomes a choice to guide

the students in learning the concept of Perimeter and Area. Based on Gravemeijer (1994), there are three basic principles in the Realistic Mathematics Approach namely Guided reinvention, didactical phenomenology and self-developed models. Those three basic principles in RME are used as the underlying theory for developing the learning sequence.

In realistic mathematics Education, mathematics is primarily seen as a process, a human activity. According to the principle of *guided reinvention*, teacher should give opportunity for students by guiding/ supervising them to re-invent the mathematics by themselves. One way that teacher might do is finding the contextual problem that allow for a wide variety of solution procedures (Gravemeijer, 1994). Following the reinvention principle then we relate to the idea of didactical phenomenology. Based on the idea of *didactical phenomenology*, the teacher may find the situations that can evoke paradigmatic solution procedures that can be taken for vertical mathematization (gravemaijer,1994). The third principle is found in the role which *self-develop models* play in bridging the gap between informal knowledge and formal mathematics. Self develop model may become the model of informal mathematical activity and over time may develop into a model for more formal mathematical reasoning (Gravemeijer, 2004)

2.4 Emergent Perspective

Emergent Perspective was introduced by Cobb and Yackel (1996) as their framework for interpreting classroom discourse and communication. In this research we will also put the emergent perspective for the framework of

classroom discourse and communication to conduct the class experiment. The Framework of learning perimeter and area can be viewed as a response to the issue of attempting to understand the concept of perimeter and area as it occurs in the social context of the classroom. The social context itself was divided into Social Perspective to focus on classroom community and Psychological Perspective to focus on student's reasoning. The Social Perspective will be elaborated further as follow:

2.4.1 Social Norms

Social Norms is defined as the ways of acting and explaining as the process of mutual negotiation between teacher and students. Learning the concept of perimeter and area in reform mathematics then we expected that the classroom will have different approach than the traditional ways of learning. It is important to put the norms of reform math class in to account such as students explain and justify solution, indicate agreement and disagreement, try to make a sense the explanation given by other and question some possible alternative in such situation where a conflict in interpretation is apparent.

2.4.2 Socio-mathematics norms

Different from Socio norms, Socio-mathematics norm is the ways of explicating and acting in whole class discussions that are specific to mathematics, in this research will be particularly about the concept of perimeter and area. This norm is important to create the opportunity for the students to take over the teacher's duty as validator. Socio-mathematics norm enable students to make independent judgments. For instance, each student might have their own ways of

explaining what they understand about perimeter and area. Here the teacher and students can participate in a discussion to negotiate and redefine about, for instance, the concept of perimeter and area. Having socio-mathematic norms in the classroom will help the teacher to foster the development of the students' thinking process.

2.4.3 The mathematical practices

The description of mathematical practices in Gravemeijer and Cobb (2006) was that it can be described as the normative ways of acting, communicating and symbolizing mathematically at a given moment in time. In this learning series, there will be many mathematical practices that are more specific to particular mathematical ideas or concepts. Starting with comparing perimeter works with ropes and picture frame to evoke the ideas of perimeter and recall the knowledge of measuring length. Then making frame from ice cream sticks that will bring the students to the idea of counting perimeter with non-standard unit and also awareness that when they create any fence than there will be a region within it. Region within the fence or boundaries can be the ground idea of the concept of area. Comparing directly and indirectly with the help of tool (sticky paper) will help the students to directly experience the mathematical practices of comparing the area and perimeter then among the group they will communicate their finding. Students will also experience to use wooden matches that in fact area able to reveal many mathematical ideas such as with the same number of wooden matches students can create different shape with different area as well. At the end students will work with ropes to generalize the idea of perimeter and area not for

rectangle and square only. In the students' learning processes about the concept of perimeter and area, their interpretation and their mathematical practices are related so that their mathematical development occurs as they contribute to the constitution of mathematical practices.

2.5 Hypothetical Learning Trajectory

Simon (1995) in Gravemeijer (2006, page 133) described Hypothetical Learning Trajectory as the consideration of the learning goals, the learning activities and the thinking and learning that students might engage. This chapter will elaborate those considerations that will be presented as a learning line or learning trajectory of perimeter and area subjects.

The learning line will be designed for 3 weeks teaching experiment and divided into 6 activities. In line with the purpose of this research described in chapters 1 and 2 the design of learning will put perimeter and area as the subject to be learned side by side. The scheme of HLT refinement can be seen in the following diagram.

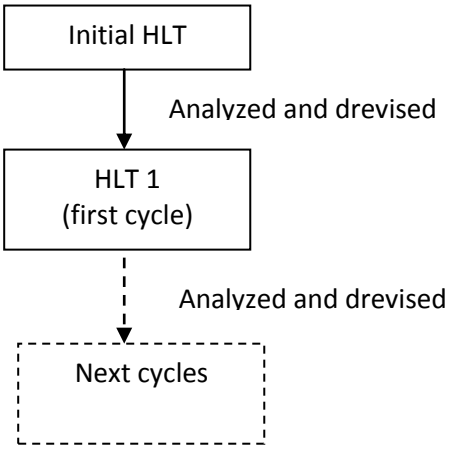


Figure 2.2 Scheme of HLT changing

Below we will describe the detail of the learning lines that consist of goals, description of activities and conjectures of students' thinking.

2.5.1 Perimeter of a shape

The meaning of perimeter as we described in chapter 1 is curve enclosing a region of a surface or the length of such a curve. Based on Indonesian curriculum, pupils are introduced with the concept of length in grade 1 and started learning to use of measurement unit for length in grade 2. Since pupils in grade 3 are already familiar with the concept of length and how to measure it from their previous years then the concept of perimeter itself will not be a very complicated matter for them. The purpose of this learning is to understand the literary concept of perimeter as the whole outer edge or boundary of a shape and the concept of perimeter as the length of the whole outer edge or boundary. In this learning step of perimeter there will be an activity which directs the students to the introduction to what is meant by perimeter and how to measure it. The researcher chooses the activity of fencing a photo frame as a class activity.

2.5.1.1 Frame fencing activity

-*Goals*:-Students are able to compare the length of the fence they have created

-Students are able to define with their own words the meaning of perimeter.

-*Description of activity*

Teacher brings the context of purchasing the fencing for photo frame to the photo frame makers. Teacher will share her or his problem that the price of fencing a photo frame depends on the size of fence. The shortest the size of the fence it means the cheaper the price of the frame fencing. Teacher will bring the

different shapes and size of photo frame and asks the student to help her or him to decide which photo frame will cost the least amount of money.

Students start the activity with group work of measuring the fence of the photo frame. For instance 30 students in class then there will be 6 groups of 5. Teacher will provides each group with different shapes of photo frames such as rectangles, squares, triangles, quadrilateral and circle with the bunch of rope as their tools to measure the length of the fence. Scissors also provided to cut the rope as much as students need. At the end of the class activity, teacher will conduct a discussion. Teacher will post some questions such as: “What shape will cost the most for fencing? Why do you think so?” and “What shapes will cost the least for fencing? Why do you think so”, “Describe how you compare the fence”. At the end of class discussion, teacher will direct the students to the exploration of the definition of perimeter based on student’s thinking after doing the activity.

-*Conjectures on students’ thinking*

-When students start comparing the fence of the photo frame, they might start estimating the frame among them such as ‘I think my frame is bigger than yours” or “I think my frame will need longer fence than yours”.

-Some student might span the rope around the edges of the frame to see the total length they need then they just simply span the rope along the ruler to see the length of it or they might not use ruler, instead they just compare among the rope to see which one is the shortest or longest.

-There might be some students who will not use rope but directly measure each edge with rulers than adding it up altogether to get the total length.

-Discussion

It was expected that students will use the rope as their tools to measure the length of the outer edges of the frame. By using rope, students will just simply span it and compare it to see which one is the longest or the shortest. Introducing the use of rope in the first activity also intended that students will be familiar with it because they will use it again for the following activities at the end of the lesson series.

Since students in grade 3 already know ruler as the tools to measure length starting from grade 2 so there might be some possibilities that students will come with the idea of using it instead of rope or measure the rope with ruler. React to this possibilities teacher can just let student work with ruler. For those who work with ruler, it might take more time than direct comparison of ropes. Students might argue among themselves that using ropes will be more efficient than ruler since they just need to compare without having known the measurement. Then teacher can emphasis that they need to figure out which frame that needs more or less fence and they are not coming into measurement of perimeter. Teacher can also post questions to those who measure the circle frame whether they get difficulties when they use ruler to compare its length.

Students might come with vary ideas about the way they compare the fence of the frame. Through these differences then teacher can bring it into class discussion. On the class discussion, besides the vary ideas in comparing the fence, students might come up with different ideas about perimeter as well, some might say perimeter is the length of the rope, others might say the total length of the

outer part of the photo frame or the total addition of each edge of the frame. Teacher is the main actor to direct the class to the final conclusion about what is the meaning of perimeter and also encourage students to be able to reasoning when the frame will cost the most or the least.

2.5.2 Area of shapes

Stepping from the concept of perimeter to the concept of area was not an easy step to take moreover for young children in 3rd grade who just in their beginning of knowing the term perimeter and area. Even though perimeter and area are interconnected but perimeter has a different concept from area, perimeter is merely as linier measurement which connects to length but area concern with the whole surface that cover the shape. So the concept of area seems more complicated than perimeter.

Compare to perimeter, the concepts associated with area are much more difficult to grasp. Part of this difficulty is due to the fact that the child's every day experience which involve area can be described quite satisfactory in general terms, with the result that it is harder to establish the need for specific measures. In developing the concept of area, all work should be directed towards an answer to the question, "How much surface is covered?"(A.R. Bunker, 1967). The purpose of this learning is to understand the literary concept of area as the whole surface that cover a shape and the concept of area as the total amount of material needed to cover a surface.

2.5.2.1 Making photo frame

-*Goals*: -Students will aware that every time they create any fence then there will be a region within it.

- Students are able to describe with their own words, the meaning of area.

- Students will aware that the same perimeter can have different area and vice versa.

-*Description of activity*:

To start with, teacher will use the activity in learning perimeter to introduce the concept of area. The photo frame context in learning perimeter will be modified by using ice cream stick. If previous activity was comparing the fence of the photo frame but now students create the photo frame by themselves as a present for their Mother. Student will form a frame from the ice cream stick. Each group will consist of 4 or 5 students; each student will get 20 ice cream sticks. Teacher will ask the students to make a different shape for each student in the group. They can use less than 20 sticks for the frame or spend it all. Students will arrange the stick with any shapes they want then stick it together on a paper to form a photo frame. Teacher will give examples to avoid misconception about the task given. After each group completing their work then the teacher can bring them into class discussion and post a question such as " can anyone of you explain what do you found different from this activity compare to fencing frame activity?", or "did you find any interesting fact about the frame when you create it? Explain it".

-*Conjectures on students thinking*:

-The rectangular and squares are the most common shape for the frame so it might happen that the whole class will only make the frame with the shape of rectangles and squares

-With the same number of sticks and freedom to choose the shape, student might come to the possibilities that they can form the different shapes and different area with the same number of stick which means the same perimeter.

-Some students might use less than 20 sticks, in this case they might come to the possibilities that they can form the same area with the different number of sticks.

-Answering the question post by the teacher they might only think about the different procedures between the first activity previously in comparing the fence of the frame and the present activity in creating the fence by themselves. But some other might realize that in this present activity they create a fence which eventually creates a space within it.

-*Discussion*

By using the activities that quite similar context with frame fencing activities, it was expected that pupils will be able to relate the perimeter with the concept of area. They will realize that every time they create a fence then eventually they will have a region within it. Here teacher can encourage the student to use that fact to reasoning themselves about the meaning of area.

Rectangles and squares are the most common shapes for frame so that most of students might choose these shapes. React to these choices, teacher can use students choices in rectangles and squares to post a question such as “Can you form a shape like this with 19 sticks?17?15?”. Student will think or even try to make it, then eventually they will able to explain that it is impossible to make it, we have to take one more or add more in the opposite side. Even though in this discussion teacher will not go into the concept of length x width but it will worthwhile for students to have knowledge that in rectangle and square the opposite side have the same length.

It was expected also by giving the same number of sticks and freedom to choose any shape, students will start to realize that with the same perimeter they can have different area or vice versa. As each student will have their own design of the frame so it might be possible that some of them unintentionally have different shape but they spent the same amount of sticks or they spent the different amount of sticks but seems to have the same area. Indeed in this activity students are not yet in the steps of measuring area but it was expected that at least they can estimate it and make a presumption that with different number of sticks they can have the same area or vice versa.

2.5.2.2 Comparing the photo papers

-*Goal*: - Students are able to compare the area directly and order it

-*Description of activity*:

In this activity teacher will bring the context of printing photos. Students are asked to help the teacher to find the cheapest price of the photos. Teacher will

share her or his problem that the price of the photo printing depends on the area of the photo paper, the bigger the photo paper the more expensive the price and vice versa. Teacher will bring the different shapes and size of photo paper and asks the student to help her or him to decide which photo paper will cost the least amount of money to print the photos.

Students started the activity with group work of comparing the area of the photo paper. For instance 30 students in class then there will be 6 groups of 5. For the class activity, teacher will only use paper so that it easy for student if they might need to folded or cut the paper. Teacher will provide each group with different size of rectangular and squares paper with the same size as the real photo paper that the teachers has. The paper were arrange as such so that there are some paper that can be compared directly with the other paper such as the bigger paper can cover the whole part of smaller paper. At the end of the class activity, teacher will conduct a discussion. Teacher will post some questions such as: "Which photo paper will cost the most for photo printing? Why do you think so?" and "Which photo paper will cost the least for photo printing? Why do you think so", "Describe how you compare the area of the frame". From students' answer that might be vary then teacher can lead it to discussion about measuring area.

- *Conjectures on student thinking*:

  -Comparing the paper then some students might only use their sight to compare the area of the paper. They will use their visual sense to make an approximation of ordering the paper from the smallest to the biggest or vice versa.

-Some others might use the length of the side to decide the area. As we know that students in grade 3 have learned about the concept of length and how to measure it in grade 2. There is possibility that students were still influenced with what they've learned previously. They might think that the longer side will remain bigger perimeter.

-Some student might arrange the paper as a stack or put it side by side to see any leftover part of the paper that covers the other paper. They might conclude that the shape which has the most left over part then it will be the biggest area.

- *Discussion*

Comparing photo paper is the activity that intended to develop students' knowledge about area through comparing and ordering. With the material that was arranged as such then it is possible for them to compare the paper directly. Direct comparison is an important early stage in measuring. In this level students still do not have to relate their work with numbers or unit. They can simply use their sense to make the comparison. Such as using their visual sense to decide that one is bigger than the other or arrange it in a row or put it as stack to see which shape has the most leftover part. Somehow their initial knowledge can also influence the way they work in this activity. For those who understand about measuring length, for instance, they might relate it with the way they compare the area. We, as the educator, must be aware that the students' initial knowledge might lead them to the wrong understanding. Comparing the area, for instance, they will say the

longest the side the largest the area. They still consider that measuring length and area are two things that similar.

2.5.2.3 Measuring photo paper with sticky paper

-*Goal*: - Students are able to measure the area by using another object as unit measurement

- Students are aware that different area will create different perimeter and vice versa.

-*Description of activity*:

This activity is the continuation of the previous activity. When pupils find that there are some photo paper that are difficult to be compared directly since it just slightly different size to each other then they are urged to find other ways to compare it. In this activity teacher will again bring the context of printing photos. Students are asked to help the teacher to find the cheapest price of the photos. Teacher will bring up the previous discussion about comparing the area of photo paper. Teacher will post a question "How if you find that two photo papers have almost the same size?" how you compare it? Students might come up with the idea of using other material as a tools to measure the area of the photo paper but if no one has the idea of using others tools then teacher can direct the students to do so. The teacher will bring the issue of n using sticky paper, "In other class they use the help of sticky paper to measure the photo paper, what do you think if we try to practice it in class now?". Teacher will bring the different shapes and size of photo paper and asks the student to help her or him to decide which photo paper

will cost the least amount of money to print the photos with the help of sticky paper.

Students start the activity with group work of measuring the area of the photo paper. For instance 30 students in class then there will be 6 groups of 5. Teacher will provides each group with different size of rectangular and squares photo paper and a box of square color sticky papers as a tool to measure the area of the photo paper. The frames were arrange as such so that when the sticky paper was attached then there will be no space left and it will be arranged so that different size of frames might have the same number of sticky paper on it. At the end of the class activity, teacher will conduct a discussion. Teacher will post some questions such as: "Which photo paper will cost the most for photo printing? Why do you think so?" and "Which photo paper will cost the least for photo printing? Why do you think so", "Describe how you compare the area of the frame". Is there any group which has the same perimeter but different area?" can you share to the class, how is it possible?"From students' answer that might be vary then teacher can lead it to discussion about measuring area.

-*Conjectures on students thinking*

-To measure the area of photo paper, students might count the number of sticky papers one by one. For others who aware about the number of column and rows of the sticky paper that they arrange, they will just count the paper in one column then times with how many rows or vice versa.

-Student might only see the photo paper and make estimation about the number of the sticky paper.

-React to the question about different area but the same perimeter then students will realize that they have different number of sides of sticky paper but in fact they spent the same numbers of sticky paper or oppositely they spent different numbers of sticky paper even though they have the same number of sides of sticky paper.

-Discussion

The use of sticky paper as the tool of unit measurement is under the consideration that square is the simplest shape to adjust with. Sticky paper which has colorful paper is expected to help students to make arrangement in counting or in coloring the photo paper is even easier. By doing this activity, students were expected to be able to reasoning about the different ways of arranging the sticky paper to measure the area of the frame. The question about the perimeter direct to the idea that students will see the number of sides of the sticky paper in the outer parts as the perimeter of the photo paper. From two different fact about the number of sides of sticky paper and the numbers of sticky papers that represent perimeter and area respectively then students can bring it into conclusion that with the same number of sides of sticky paper they might need different number of sticky paper or vice versa. This fact will lead to the understanding that indeed perimeter and area related but those two has its own concept that different to each other, perimeter does not depend on area and vice versa.

2.5.3 Perimeter and area

From the previous activity we can see that even though the main activity has direct students to the meaning of area and perimeter but students also start to

do the activity that bring them briefly to the relation of perimeter and area. For the following teacher can use the relation of perimeter and area to deepen students understanding about the concept of perimeter and area itself.

2.5.3.1 Arranging different shapes on grid paper by using wooden matches

-*Goal* : - Students able to arrange different kind of shapes by using wooden matches on the grid paper.

- Student able to reasoning that an area can have different possibilities of perimeter and vice versa

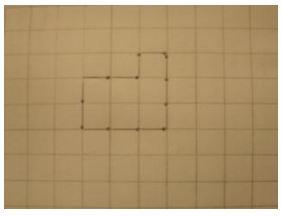
-*Description of activity*:

The activity is a game activity where the task is arranging the different kind of shape with certain amount of wooden matches on the grid paper. Students were given a worksheet to fill in along the game:

Rules of the game:

1. Students play in a group of 3 or 4 students.
2. There are 50 wooden matches ready in each team
3. There will be a series of card which has different pictures of grid design

e.g :



The picture on the card was arrange as such so that there will always more than 1 shape that has the same perimeter but different area or vice versa.

4. Each person will get 5 cards in random and they will play in turn. They have to form the shape based on the card form the matches provided.
5. The matches have to follow the grid in grid paper.
6. Students are requested to take a note in every shape they form for:

   -the number of matches they use (in matches unit)

   -the area of the shape (in square grid unit)

At the end of the game, Teacher will conduct a class discussion about what students learn from the game. Student must be able bring their reasoning to the discussion about their finding during the game such as how come different area might have the same perimeter or vice versa.

-*Conjectures on student's thinking*

-Students which have many activities in perimeter and area previously might find this game is really interesting and do not find any difficulties to play it.

-During the play students might notice already that they form the different shapes but it might have the same area or perimeter, different area with the same perimeter or vice versa.

-*Discussion*

This game is rich with the concept about the relation of perimeter and area. Through this game, students are familiar with arranging different kind of shape with the same amount of matches or vice versa. With playing this game where different arrangement of matches will create different area or perimeter then

students will able to reasoning that with the same perimeter they can create different shapes with different area or vice versa.

2.5.4 Exploring the shape other than rectangle and square

In our daily life, in fact we are not just dealing with rectangular and square shapes only. By exploring the shape other than rectangle and square it was expected that students will able to generalize the concept of perimeter and area for the shape other than rectangle and square.

2.5.4.1 Playing with rope

-*Goal* : - Students are able to generalize that an area of any shapes can have different possibilities of perimeter and vice versa.

-*Description of activity:*

As the final activity, teacher will bring the activity that was expected to be able to generalize student's insight that an area of any shapes can have different possibilities of perimeter and vice versa. The rope will be given to the students as the main tools in this activity. Students will sit in a group of 4 or 5 then each group will be given 2 ropes with the same length. Teacher will ask students to make any shapes from those ropes, in different shapes respectively. Then teacher will post questions: "Do you think both ropes form different area?, can you explain?" or "Do you think both rope form the same area?"can you explain. After posting a question to the groups then teacher can bring it into class discussion. Teacher will choose the answers from those that able to direct the class into the final conclusion.

-*Conjectures on students thinking*

-While forming the shape from the rope most of students might tend to make the form of rectangles and squares only since most of the previous activities were dealing with rectangle and square but some of them might be so creative to make any irregular shapes.

-Answering the questions from the teacher, some student might answer that both rope forms the same area since they have the same perimeter but some other might say it will be different by reasoning that area does not depend on its perimeter or vice versa.

-Discussion

Through this activity it was expected that students will be able to make generalization about the relation of perimeter and area. In the previous activities students works mostly in the shape of rectangle and square then in this activity students will use rope as the media to form any shapes. It was expected that by giving freedom for students to form any shapes then they will have idea to form irregular shape or any shapes other than rectangles and squares. Giving a tricky question such as" Do you think both ropes have the same area? Was expected to evaluate students understanding about the relation of area and perimeter in terms of irregular shapes, it was presumed that when students already understand the relation of area and perimeter in activity 6 then obviously they will able to answer correctly the question given in this activity

CHAPTER III

RESEARCH METHODS

3 Methodology

There are some elements will be discussed in this chapter regarding the methodology used in this research. We will describe about design research methodology and the content within it such as the preparation and design of this research, the teaching experiment and the retrospective analysis. We will also talk about how we collect our data and how to work on it, also about Validity and Reliability of this research.

3.1 Research Design

Theoretically, the aim of this research is to develop the instructional theory to support students understanding in perimeter and area by exploring the relation of perimeter and area. Practically, the aim of this research is to see how children relate perimeter and area, also to figure out whether they aware with the different of those and use it to support their understanding about the concept of perimeter and area. In designing the research methodology, the researcher use the three phases of conducting a design experiment from Gravemeijer & Cobb (2006), namely:

3.1.1 Preparation and design

Preparation and design is the preliminary work to be conducted in this research. It was started from collecting the sources such as articles, journals and books which are related to perimeter, area and its relation. While working with the sources, researcher also starts designing the learning process. Interviews were also

conducted with some mathematicians and educators to gain more insight in the related matter.

3.1.2 Teaching Experiment

The teaching experiment will be run to implement the result of the learning process design. First cycle will be conducted as the pilot experiment, taking 6 students to participate in the teaching experiment. The aim of the pilot experiment is mainly to adjust with the initial learning process design. We expect to develop the design better to implement it in the next cycle of the teaching experiment. The content of the teaching experiment of first cycle and next cycles will be the same under the consideration that next cycle is the revision of the previous cycle. There will be preliminary discussion among researcher and teacher before conducting the class with the design proposed to adjust and make agreement about how the class will run based on teacher and researcher point of view. This is to avoid or minimize any error that possible happen on the field.

3.1.3 Retrospective analysis

The goal of retrospective analyses will, of course depend on the theoretical intent of the design experiment. However, one of the primary aims is typically to contribute to the development of a local instruction theory (Akker et al, 2006). In this retrospective analysis, researcher will make an analysis from the result of the teaching experiments. All the data from video, interview and field notes will be collected for being analyzed.

3.2 Data Collection

For collecting the data of the research experiment, researcher will use video recording, interview, students' work and also field note.

3.2.1 Video Recording

At most two videos will be placed in class during the teaching experiment to avoid too many data to be observed deeply. Those two videos will have its own part, one for static video that will capture all happening during the class experiment and the other one is the dynamic video that will be operated around the class to capture certain moments that was considered important.

3.2.2 Interview

There will be several interviews before and after the teaching experiment. Before the teaching experiment, researcher will conduct the interview with the class teacher to gain information about the class situation including students, class environment and norm and also subject material. Researcher will also make an interview to some student in order to gain the data about students' ability or condition before the teaching experiment. After the teaching experiment then researcher will also conduct another interview to do further observation and gain more detail information about students' achievement after the class experiment.

3.2.3 Students' work

Students' work were designed as one of the instruments in the teaching experiment to assess how far students' understanding toward a certain lesson given. The students' work will also include pre-test and post test which aimed to

assess students' pre-knowledge and students' development in understanding the intended concept respectively.

3.2.4 Field Note

Field note is one of the important data collections. Field note is still needed even though we have recorder the whole class session since there might be a certain moment that we consider important but it might not be catch properly by the camera.

3.3 Validity and Reliability

The nature of this research can be characterized as design research which also known as developmental research. It consists of designing instructional activity which results in a Hypothetical Learning Trajectory to understand the students' learning process. The validity and the reliability from the result of the research to strengthen the quality of the research are described as follows,

3.3.1 Validity

Validity is seen as the strength of the research, which are used to suggest determining whether the findings are accurate from the standpoint of the researcher, the participant, or the reader of an account (Creswell&Miller, 2000). In this research the validity will be seen from internal and external sides. Internal sides including the ways of collecting the data collection, the method of analysis and triangulation. External side will consist of the generalization from the result of the research and the theory whether it useful in other contexts.

This research has purpose to see how the relation of perimeter and area will help students to deepen their insight towards the concept of perimeter and

area itself. In order to validate the research internally then it was expected that during this research, the sufficient data to see how students reasoning about their understanding of the concept of area and perimeter will be gain. It will include video recording of the whole lesson series, students' works, record of the interview and also field note. Externally, the validation will be seen from the generalization of the research whether it will appropriate to implement research for the population where the samples were taken.

3.3.2 Reliability

Reliability in this research will be seen from three ways, namely:

3.3.2.1 Data registration

To convince ourselves that we work in a reliable way, trustworthy and also not misleading then we try to make the detail of data collection. We collect the data from different resources. Those data are described and categorized to get the conclusion. The method triangulation will be done by checking the data from different methods such as the data from video recording, audio, students' work field note.

3.3.2.2 Track ability

We do realize that we need to give a clear description on how we work on this research so that people will easily see how it run. We will describe how the teaching experiment was happening, how we interpret it and give conclusion. We name it as Retrospective analysis.

3.3.2.3 Inter subjectivity

Every researcher definitely has their own point of view or subjectivity toward the research that they conduct. Somehow sharing the ideas might bring into a better understanding. For that reason, we will cross-interpret the data that we have in this research with colleagues and supervisors. We can come into common discussion on the data collection and make a better understanding.

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CHAPTER IV

RETROSPECTIVE ANALYSIS

4 Retrospective Analysis

From the whole data of the teaching experiment that we have collected, we will analyze both the pilot experiment and the teaching experiment. We will relate the analysis with the initial HLT in chapter 2 whether it was supported or not supported that lead into the explanation how and why this design support the students' understanding of perimeter and area. We will describe both the analysis in on the first and second cycle of HLT implementation.

4.1 The Timeline of the Research

	Date	**Description**
Preparing for the Experiment		
Preparation	October –December 2010	Studying literatures and designing HLT 1
Preliminary research to school (communicating with school and teacher)	3 of February 2011	Communicating the plan of the research including HLT and research method
Teaching Experiment for the First Cycle		
1st meeting	18th of February 2011	Pre-test, activity.1: Frame fencing
2nd meeting	21st of February 2011	Acitivity.2: Making photo frame Activity.3: Comparing the photo paper
3rd meeting	22nd of February 2011	Activity.4: Measuring photo paper with sticky

	Date	Description
		paper
4th meeting	23rd of February 2011	Activity.5: Arranging shapes with wooden matches
5th meeting	24th of February 2011	Revising activity.5
6th meeting	28th of February 2011	Working with odd number of wooden matches.
7th meeting	4th of March 2011	Post-test
Teaching Experiment for the Second Cycle		
1st meeting	24th of february 2011	Pre-test
2nd meeting	16th of March 2011	Activity.1: frame fencing
3rd meeting	17th of March 2011	Activity.2: making photo frame
4th meeting	21st of March 2011	Activity.3: comparing the photo paper
5th meeting	22nd of february 2011	Acitvity.4: Measuring photo paper with sticky paper
6th meeting	23rd of March 2011	Activity.5: Arranging shapes with wooden matches
7th meeting	25th of March 2011	Activity6: revision activity.5
8th meeting	28th of March 2011	Activity.6: Arranging the shapes from ropes

Figure 4.1 Timeline of the research

4.2 Analysis on First cycle of HLT implementation

The research was conducted in 3rd grade of At -Taqwa elementary school Surabaya. It was planned to have at least 2 cycles of HLT implementation. The first cycle will consist of 6 random students from grade 3 of two different classes. Those 6 students are Andre, Dilla, Dio, Farel, Ryan, and Salma. Those students are the representation of different types of students starting from Andre who has good realistic interpretation, Dilla as a quite student but very diligent, Dio who has a very good logical reasoning but still has problem in his counting ability, Farel who has a good arithmetical ability but quite weak on his reasoning, Ryan who always does a very good practical work and last Salma who has a very fast response but sometimes also very careless. The HLT was divided into 6 different activities that the first activity was aimed to support the second activity and so on.

4.2.1 Pre-test

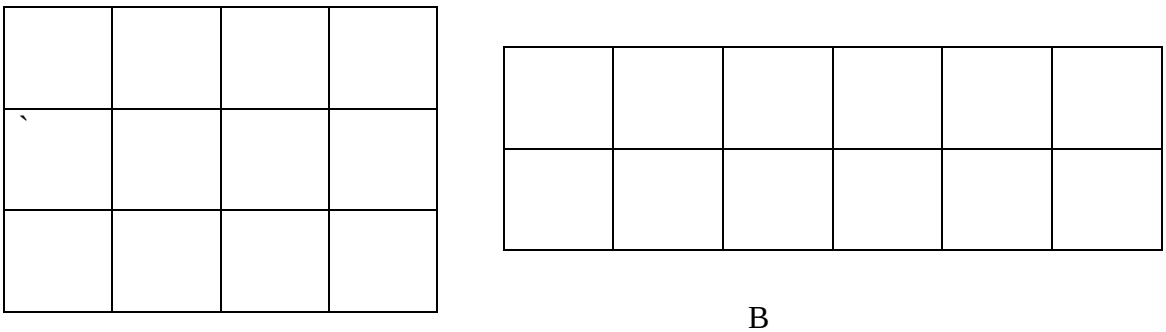
Pre-test was conducted to know the students understanding towards the subject that will be given. It was started by giving the worksheet that consist of five pages that quite surprising for the students. They said it was quite a lot of works to do. The Pre-test has essay types of questions. The question set mainly divide into 2 activities, each of which was used to answer the questions given. In the first activity, students were given two ropes to be compared,

Figure 4.2 An example of the ropes

Here the aim of using ropes was to recall students' knowledge in measuring length as basic knowledge to go further into perimeter later on. Besides on the learning series they will also use ropes so we thought it good to make them familiar with it. Most of the students found no problem to compare those two ropes including finding the differences and similarities. At first we predict that some of them will use ruler to compare but in fact none of them come up with the idea of using ruler to compare. Somehow when the teacher asked the tools to measure the length they can mention ruler as the tools.

For the 2nd questions students were asked to create any shape from the ropes given. Students were able to form the shapes from the ropes even though the ropes were not quite handy to be formed as shapes. For describing the differences of the shapes they have created, students tend to compare the visual appearances only such as they made different shapes of circle or oval, one shape is bigger or smaller than the other. We thought some students might come with the idea of perimeter and area when they were asked about the difference of the shapes but for the beginning of learning perimeter and area, it makes sense that at the first time they still did not have the idea about it yet.

On the 2nd activity they worked with grid paper. In this activity 2 tables were given in different form but with the same number of grids.



A B

Figure 4.3 Examples of tables with the same number of square grids but different form.

Students were asked to find the similarities and differences from both tables. They noticed that the number of grids from both tables is same but the shapes are different. Somehow it's interesting that they count the number of grids but to decide the type of shapes they ignore the number of grids in each side but just see the pictures

For the next questions, students were asked how they compare the perimeter and the area of the shape. Some of them said "by seeing the grids" with no further elaboration about the meaning of seeing the grids but some of them even have no idea how to do it.

The last question was about rearranging the tables in the different forms of squares or rectangles but with the same number of grids. Most of the students just change the shapes from vertical to horizontal. They can notice that the similarities of the previous tables and the new tables they arrange that the number of the grids were still the same. For the differences some of them could explain that the number of rows and columns were changed.

-Discussion

The questions given in pre-test are quite open actually; somehow since the number of students is quite small then each student has more opportunities to ask question to the teacher concerning the pre-test. The use of ribbon for pre-test did not give much help, at the contrary students thought that it was hard to form any shape by using that ribbon. The questions that mostly exploring student's reasoning was making them confused. Students in grade 3 seem not yet familiar of giving argument or reasoning. They mostly know how or what to do but to describe it in the sentences are not easy, as on the worksheet paper they tend to write very short sentences.

On this test most of the students are familiar with the term length and how to deal with it, somehow the term perimeter sounds quite new even though they know it was related to length but area for most of them are totally new.

4.2.2 Frame fencing activity

Frame fencing activity was the first activity to engage the students with the knowledge of perimeter. Teacher used the context of purchasing the fencing for photo frame. Teacher brought the different shapes and sizes of photo frame and asked the students to help her to decide which photo frame will cost the least amount of money. Teacher posed some questions such as: "What shape will cost the most for fencing? Why do you think so?" and "What shapes will cost the least for fencing? Why do you think so", "Describe how you compare the fences"

Before starting the activity teacher brought some real examples of picture frames (3 different sizes of picture frame) to the class and made small discussion with students,

Teacher : does anyone has it at home?
Students : yeeesssssss
Teacher : does anyone know what these are?
Students : place for picture
Teacher : Do you know any other shape of frame other than what I have now? (*teacher only has rectangular and square shapes*)
Salma : yeah..love...:)
Andre : i know circle
Teacher : So for this frame, if all of them made from the same material, do you think which one is the most expensive?
Students : that one (*all pointing to the biggest frame*)
Teacher : Why this one?
Dio : because that one is the biggest
Teacher : heemm..so the biggest is the most expensive??
Students : yeeess
Teacher : Why biggest is the most expensive?
Dio : because for the biggest we put the most difficult effort
Salma : Because for the biggest you spent the most material on it.
Teacher : Ok then how if i want to decorate the edges of the frame by giving a fence from ribbon? Do you think which one that needs the most material?
Andre : the one that bigger
Teacher : so now let's try to work on this frame. Pretend that you have picture frame factory. For fencing the frame which frame will cost the most expensive? Work in group of three.
(*Teacher gave them four different shapes and sizes of carton paper made as if they are picture frame*).

Students started the activity with group work of measuring the fence of the photo frame (carton paper). Teacher provided each group with different shapes of photo frames (rectangles, squares, triangles, and circle) with the bunch of ribbons as their tools to measure the length of the fence. Scissors also provided to cut the ribbon as much as students need. Students span the ribbon around the edges of the shapes respectively and cut the ribbon when it arrived in the end of the side.

Figure 4.4 Measuring the frames' fence by using ropes

In fact the idea of measuring the frame by using ribbon is not always start from one of the end of the ribbon, some students just take any part of the ribbon then attached it to the frame, and apparently they realize themselves that it takes more work than start it from one of the end. One person in group A noticed this situation:

Ryan : *(Ryan tried to measure the edge by taking the middle part of the ribbon…but he got mix up)*
Andre : you have to start from one of the end
Ryan : *(repeat his work again and he made it)*

After cutting the ribbon as long as the total edges of the shape then student compare the length of those ribbons to find the shortest and the longest one. They span the ropes together. Some of them do it altogether at one and compare it but some of them do it two by two.

Figure 4.5 Comparing the ropes

Somehow the idea of ruler appeared after the teacher asking whether students have some other ways to measure the length of the outer part of the picture frame. Student came up with the idea to use ruler or "meteran".

Teacher : Is using ribbon the only way to find the cheapest price of the frame?
Students : no
Teacher : So what can you use other than ribbon?
Students : we can use ruler, or meteran

Since student did not provide themselves with ruler or 'meteran' then they just use ribbon to work so the last conjecture of working with ruler did not appear at all.

At the end of the class activity, students write the answer for the question posed by the teacher.

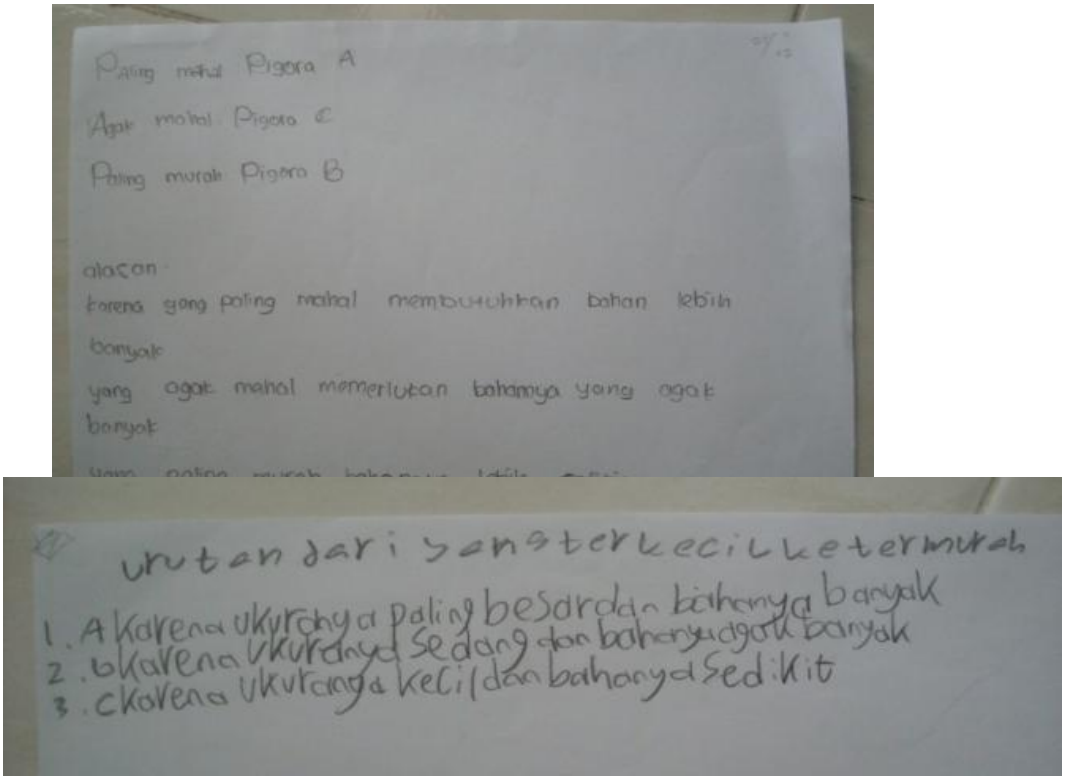


Figure 4.6 Example of students' work on comparing and ordering the frame fence.

At the end of the session indeed teacher can direct the student that the perimeter is the outer part of the shape. Somehow it's still difficult for children to describe it in their own words; they like to show what is called perimeter instead.

-Discussion

Frame fencing activity is a good start of the learning series of perimeter and area because it relates with the idea of measuring length and the concept of perimeter. Indeed we will work on both perimeter and area but since the students of grade 3 have learned about measuring length which also the basic knowledge of perimeter then it seems students will be easier to accept the idea when it start with something that they already knew or experience.

Even though 3rd grader already familiar with ruler to measure the length somehow in this activity we hardly find the students who came up with the idea of using ruler. It might happen because the teacher already started with ribbon to deal with. Children in this level tend to follow what is told as it shows to them at the first place. Somehow we can see that they have the knowledge about standard measurement when they can mention ruler as another tools that they can use to measure the perimeter.

From this activity students start to experience themselves how to compare the fence of the frame. They might not yet really know how to describe what perimeter is but we can see from their work that they have the idea of perimeter when they surround the outer part of the shapes with ribbon. For comparing the ropes indeed students found no problem at all. They put all the ropes together to see and then order it from the longest to the shortest or vice versa. They can

intuitively notice which one is longer without using any standard measurement tools.

4.2.3 Making Photo Frame

Making photo frame is the continuation of the frame fencing activity. If previous activity was comparing the fence of the photo frame but now students create the photo frame by themselves. The objective of this activity is mainly as the bridge from perimeter as the outer part of the shape in the first activity to the introduction of area in the next activity. Making photo frame activity is intended to build students' awareness that during the making of photo frame, while making a fence then eventually they also create a region within it.

Student formed a frame from the ice cream sticks. Each group consist of two students, each students will get 20 ice cream sticks. They can use less than 20 sticks for the frame or use it all. Students arranged the stick with any shapes they want then stick it together on a paper to form a photo frame. Teacher gave examples in advance to avoid misconception about the task given.

During the group work, teacher posed several questions to the students:

Teacher : compare to our 1st activity yesterday, what is the difference you found from today's activity?
Andre : yesterday was hard and today is easy
Teacher : so you choose this form (*he made square frame*), if i use these sticks to measure the perimeter, what is the perimeter of your frame?
Andre : 4 ice cream sticks
Teacher : if i use scissors instead of ice cream sticks with the same length, what is the perimeter?
Andre : 4 scissors
Teacher : wait..you made another shape? What shape is it?
Farel : this is triangle
Teacher : so what is the perimeter of this frame?
Farel : 3 sticks
(*After each group completing their work then the teacher asked all students to gather for class*)

Teacher : Everyone let see the frame of Dio and Ryan. For this frame if I use ice cream sticks to measure the perimeter of this frame. What is the perimeter of this frame?
Dio : (*counting each stick one by one*) 14 (*fourteen*)
Teacher : what 14?
Dio : 14 ice cream sticks.
Teacher : so the perimeter is 14 sticks then (*pointing to the inner part of the frame*) what about this part? What do you call this part?, well you know already that this part (*pointing around the outer part of the frame*) is?
Students : perimeter
Teacher : so how about this one? (*Pointing to the inner part of the frame*), what do you call this?
Salma : that is field
Teacher : field? Ya..it's possible..when you make a fence then you have your field inside it. For this photo frame, what do you call this part?
Students : (*no answer*)
Teacher : well actually what is the use of this part? (*still pointing for the inner part of the frame*)
Student : to put the picture
Teacher : ok..for picture, so how do you measure this part?
Andre : we can multiply it
Teacher : multiply? Which one that you should multiply?
Andre : this (*pointing on length*) times this (*pointing on width*)
Teacher : why multiplication, can you explain?
Andre : just silent
Teacher : ok then it's as homework for tomorrow, how you measure the inner part of the fence

-Discussion

The activity of making photo frame stimulates the student to have more interest in learning perimeter and area. First of all, students really enjoy making the frame. It's a good starting point for them to be engaged more in the learning series. From making the frame student in fact also practices to form 2 dimensional shapes. They made the shapes of rectangle, square and triangle since those shapes are quite familiar for them since they learned it already in grade.2. Most of students just used some of the sticks so researcher didn't find any student who uses the same number of sticks. So apparently the conjecture that students will be

aware that with the same number of sticks they can have different shapes was not coming.

As we can see on the conversation, the teacher started to introduce the measurement unit of ice cream stick to count the perimeter of the frame. Then the teacher tried to provoke the students to think when they made the frame from ice cream sticks, there was an area in it. Students start to think when they know how to measure the outer part which they know as perimeter from the previous learning then how about the area inside of the fence? How to measure it? One of the students answers with multiplication but he failed to explain. For this moment teacher stops the activity and leaves the question for students about how to measure the area.

4.2.4 Comparing the photo paper

Comparing the photo paper is the activity that supports the students to learn about area. In this activity teacher will share her or his problem that the price of the photo printing depends on the area of the photo paper, the bigger the photo paper the more expensive the price and vice versa. Teacher asked the students to help her or him to decide which photo paper will cost the least amount of money to print the photos.

In the activity, teacher used carton paper as the representation of photo paper with the different sizes of rectangular and square papers. The paper were arranged as such so that they can compare directly with the other papers such as the bigger paper can cover the whole part of a smaller paper. The class discussion was run as follows.

Teacher : So now I want you guys to make an order of the cheapest to the most expensive photo paper. Before you start let me ask you, if you want to find the cheapest to the most expensive what will you do with the photo paper.
Students : distinguish the paper
Teacher : ok..so you distinguish it, you compare it. You can put sign on the photo paper so it's easier for you for to make the order. (*Students start to work with the photo paper*)

In comparing the photo paper, 1st thing that both the team did was put the photos in one row and see it.

Figure 4.7 Arrange the plane figures side by side to compare them

But then they also put the paper on the other paper so it were seen as a stack of paper.

Figure 4.8 Put the plane figures as a stack to compare them

At the end of the class activity, teacher conducted a discussion as follow,

Teacher : Ok now, let's start' from Dio's team; according to your group which photo paper will cost the cheapest price?
Dio's team : Paper C (*they show the smallest paper*)
Teacher : Why C costs the cheapest price?
Andre : because it's the smallest paper

Teacher	:	which part of the paper do you mean with small? the outer part?
Ryan	:	all part, perimeter and area
Teacher	:	perimeter and area? What do you mean with area?
Andre	:	(*show the outer edges of the paper*)
Teacher	:	(*pointing to the outer edges of the paper*) so this is area??
Students	:	no
Teacher	:	so what is it then?
Student	:	perimeter
Student	:	so if this part (*pointing to the outer edges of the paper*) is perimeter, then which one is area?
Ryan	:	pointing to the outer edges of the paper
Farel	:	No, that one is perimeter
Teacher	:	so then perimeter and area are the same?
Student	:	no, different
Teacher	:	what is the different?
Student	:	perimeter is taking around the city
Farel	:	area is big
Teacher	:	so still the question, what is area is, let it keep first. Now continue to the discussion. Now the next group, which paper is the cheapest?
Salma	:	paper C (*choose the smallest paper*)
Teacher	:	why paper C is the cheapest?
Dilla and Salma	:	because it needs less material
Teacher	:	how did you figure out which one is the cheapest and most expensive
Andre	:	made the stack of it (*he put the biggest at the bottom then the smallest at the top*)
Teacher	:	how about the other team
Dilla	:	we also made a stack
Teacher	:	so, which one from the stack that is the cheapest?
Andre	:	the smallest one
Teacher	:	so it means the paper at the top? The one where we can see the whole part?
Student	:	yes

-Discussion

In this activity children did not found any difficulty to decide which photo paper will cost the most or the least. It happens because 3 of the photo paper have different sizes and similar in shapes so that student can directly compare the sizes of the photo paper. First they arrange the photo in a row and then they put those photo papers in a stack then compare it.

Somehow when the teacher tried to connect the perimeter and area apparently students were still confused to differ both of them. They clearly know

that perimeter is the outer edges of the shapes but they found difficulties to describe area instead they also pointing the outer part as the area.

For helping the students to figure out the meaning of area then the teacher tried to provoke some situation that has relation with area as in this conversation:

Teacher : Do you think this room is big?
Student : yes
Teacher : compare to medical room? Which one is narrower?
Students : medical room is narrower than this room

So from the short conversation above, actually they have the concept of large and small, wide and narrow but apparently needs some more effort to direct the students to the description of area.

4.2.5 Measuring photo paper with sticky paper

This activity is the continuation of the previous activity. When pupils find that there are some photo paper that are difficult to be compared directly since it just slightly different size to each other then they are urged to find other ways to compare it. In this activity teacher brought the context of printing photos that they have discussed previously in the third activity

(*Teacher brought two different sizes and shapes of photo paper, square and rectangle respectively*)
Teacher : if I have these 2 photo papers? Then how can I compare it?
(*Students try to fit the first paper to the other, the first thing they did was trying to fit the edges of the shape but in fact not all parts are fit nor one shape covers the whole part of the other one*).

Figure 4.9 Put two different shapes in stack

Teacher: then after that, how do you know one is bigger or smaller than the other?
Farel : we cut it
Teacher: How? Can you explain (*ask Farel to show and explain it*)

Figure 4.10 Farel's work in comparing the shapes

(*Farel is one of the students that is quite difficult to give explanation so he just show that he cut the part that left over than paste it to the other part left*)
Teacher: do you have any other ways to compare other than cut the paper?
Dio : we can put cover on it
Teacher: put cover? Listen everyone…it is interesting, Dio said to cover the shape
So how do you cover it, with what?
Dio : black paper?
Teacher: why black paper ?
Dio : so it won't be seen

Since one of the students already has idea about covering the whole part of the surface then the teacher brings to the example from another school about the use of sticky paper to cover the surface. (Teacher ask the students to try it for next meeting because the time was over)

Before starting the activity with sticky papers, teacher tried to recall about perimeter and area. Teacher asked the students to point the part of the book that called as perimeter of the book then students said that the outer edges were the perimeter. Step to the area, teacher also ask the students to show her part of the book called as area.

Teacher : so which part that called as area?

Salma : all
Dio : inside (*pointing to the book*)
Teacher : so can I say that this whole part is the area? (*Covering her hand to the whole part of the book*)
Students : yeesss

After recalling about perimeter and area and the teacher at least convinced from students' answer that they can distinguish area and perimeter then she started with measuring with sticky papers. The instruction and examples were given to avoid students' misconception.

After arranging the papers then students count the number of sticky papers they used for each photo paper. In fact students came up with many different ways of counting. Salma counted all the sticky papers one by one and Farel saw every

Figure 4.11 Counting the area with sticky paper

row of 3, he repeated every 3 for 6 times because he has 6 columns then Andre simply said that he just do 4 times 5 to get 20. The variety of the ways to count the squares did not really matter so teacher did not discuss any further about it.

Teacher : Now let us compare these two photo papers, which one is bigger?
Students : Photo paper A
Teacher : why A?
Dio : Photo paper A needs more sticky papers than photo paper B
Teacher : others? Do you agree?
Students : yes
Teacher : so now after we know the area of the photo paper, let us check the perimeter of the paper. If I used the side of sticky paper to measure then how many sides of sticky paper is the perimeter of this photo paper?

(To count the number of side indeed students look at the outer rows of squares only but the way they count the sides was influenced by their previous activity of counting the number of sticky paper)

Figure 4.12 Counting the perimeter of the rectangle

(*For the photo paper with 18 sticky papers they get 16 sides instead of 18 sides. It happens because students count the sides as one square so when they arrive in the corner, they only count one whereas corner has 2 sides*)

Teacher : If you want to count the perimeter, which part that you count?

Students : the outer part

(*The teacher guides the students to count the sides of the photo paper. The teacher tried to stimulate the students by using the mistakes of counting made by Salma*)

Teacher : So when Salma count each square instead of the sides, when we use that method?

Dilla : to find area

Continue the activity by working on their worksheet (worksheet attached below), students were asked to count the number of sticky papers to cover the whole paper and also to count the number of sides that represent the perimeter of the paper. The pictures that new for them since the grid only available in 2 sides of the rectangle it seems confusing them at first. Somehow they can figure out by themselves how to cope with it. Some of them put lines as a help but some of them only imagine then count it.

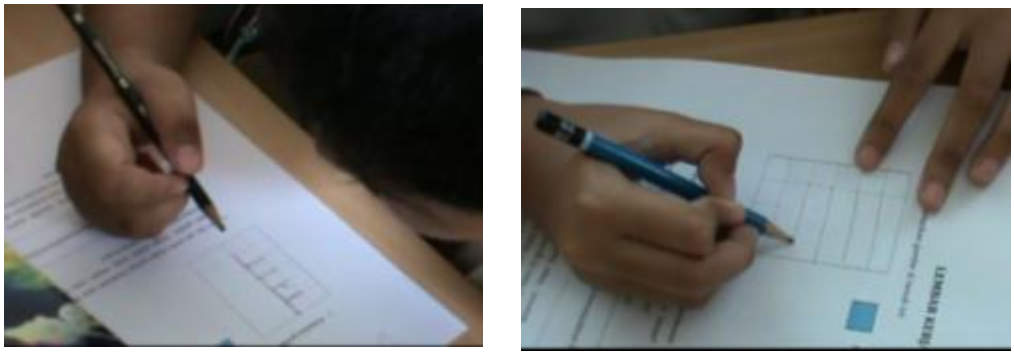


Figure 4.13 Students work on the worksheet

The next question was rearranging the squares to form another shapes. At first they still confuse with the question given but after teacher explain it than they can understand it. Some of them can answer correctly for the question about the new perimeter whether it still the same or change and what is the reason. Farel, Andre and Rian can answer correctly that the new perimeter was different from the previous one but their reasoning are different Farel write that because the number of sides was different but Andre write that the shape was different.

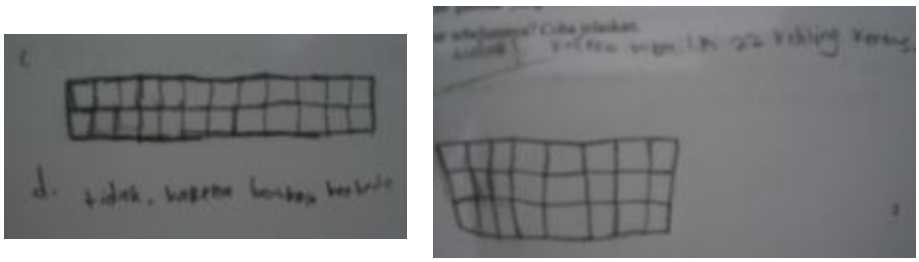


Figure 4.14 Students' answer

Somehow Salma and Dilla give asnwer that the previous and the new form have the same periemeter because the form are also the same. In this case they just change the picture from vertical into horizontal.

-Discussion

In this activity we found that students did lots of work to develop their understanding about perimeter and area. Starting from comparing the photo paper with sticky paper, they struggling to arrange the sticky papers to cover the whole surface of the paper then they think how to count it. Some of them do it one by one but some of them did more handy ways like counting by column vice or multiply the two sides.

Children were struggling to distinguish whether they count area or perimeter. When they count the number of squares, they notice that they measure the area of the paper but they also did similar way to measure the perimeter of the shape. As what Salma did, counting the squares when the question was about perimeter. Somehow teacher can use this mistake to direct the student to be able to distinguish the way of measuring perimeter and area.

The worksheet helps the student to move from the *model for* perimeter and area into *model of* perimeter and area. The use of grid paper instead of sticky papers was expected to help student to develop their thinking in measuring perimeter and area.

4.2.6 Arranging shapes with wooden matches

From the previous activity it can be seen that students start to understand the meaning of perimeter and area and also they can distinguish which one is area and which one is perimeter and how to measure it. Somehow we need to emphasize more on the relation of perimeter and area. The present activity is arranging the different kinds of shapes with certain amount of wooden matches on the grid paper. Students were given 3 different questions; picture of shapes, the

number of wooden matches, the number of squares that has to be formed from wooden matches.

First of all the teacher gives an example of how student works with the grid paper and wooden matches. Again teacher recalled students understanding in perimeter and area.

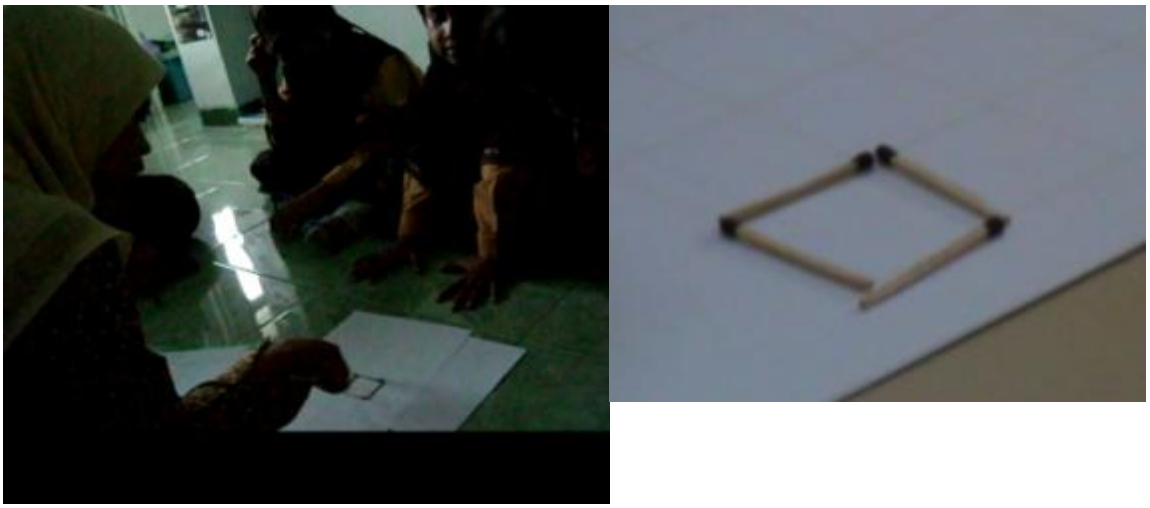


Figure 4.15 Working with wooden matches

Teacher : For making this squares how many wooden matches I need?
Students : 4 wooden matches
Teacher : so 4 in this square use to represent?
Andre : the side
Teacher : side?.. I have side 1, side 2, side 3 and side 4 (*pointing to every side on the square*)
Then what is 4 representing?
Yesterday we learned the outer part of the squares known as ?
Students : perimeter
Teacher : if I use this wooden matches as a tool to measure the perimeter then what is the perimeter of the square?
Student : 4 wooden matches
Teacher : then if I use one square in this grid paper to measure the area of the shape then what is the area of this shape?
Farel : 1 square
Teacher : how if I change it a little bit (*put more wooden matches*)
Now, what is the area?
Andre : 2 squares
Teacher : how about the perimeter?
Students : 6 wooden matches

After made small discussion while demonstrating how to arrange the matches then teacher asked the student to start working in a group. Students works two by two and with the different questions given. The teachers has arrange the questions as such so that later on when the students work on the matches in a certain result it will come up that with the same number of wooden matches they will create shapes with different number of squares or vice versa.

As we predicted that students enjoy doing this activity and they did not find any hard time to make the shapes at all. They completed the work in a quite short time including filling the table about the perimeter and area for each shape. Teacher started the class discussion after all students completed their works; teacher asked all the class to help recheck each other works. One student made wrong interpretation about the question. He was asked to make any shape with area of 6 squares but in fact he made the shapes with perimeter of 6 wooden matches.

There are two possibilities, Firstly he didn't not read the question carefully, secondly indeed he still mix up with squares for area and wooden matches for perimeter.

Figure 4.16 Example of shape formed from wooden matches

Teacher tried to find the answer as follow:

Teacher : can you repeat the question, Andre?
Andre : create a shape with the area of 6 squares
Teacher : So for this shape what is the area?
Andre : (*reading the paper again*) oh wait …aha squares
Teacher : So if the matches are 6 then we can count 1,2,3,4,5,6 (*pointing on each side of the shape*).
Teacher : so for this shape what is the area?
Andre : 2 squares
Teacher : and the perimeter?
Andre : 6 wooden matches.

During the checking then it was found that Ryan can create two shapes with the same area but different perimeters.

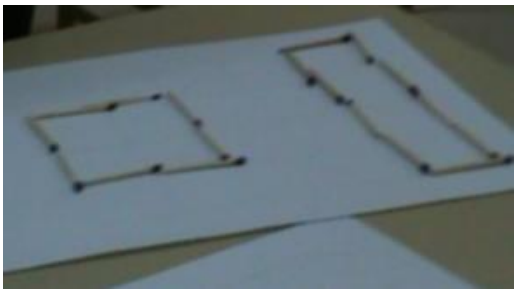


Figure 4.17 Examples of two shapes with the same number of square grids but different number of wooden matches

After asking each student to make conclusion with their own words about the picture above then the teacher tried to emphasize it:

Teacher : so from two shapes made by Ryan we can conclude that those shapes have the same number of squares. Number of squares represents?
Students : the area
Teacher : and different number of wooden matches which represent the perimeter
Teacher : how if two shapes with the same area and same perimeter, is it possible?
Students : yes
Teacher : how about two shapes with the same perimeter but different areas, is it possible?
Some Students : No
Some students : yes

The teacher then asked the students to check all shapes that they made whether they find two shapes with the same perimeter but different areas. Fortunately there are shapes with that requirement. Here teacher stated both different conditions.

Teacher	:	Pay attention carefully, from Ryan's work, he creates two shapes with the same number of squares but with different number of wooden matches. From Farel's work he creates two shapes with the same number of wooden matches but different number of squares. What can you conclude from these two different conditions?
Ryan	:	from Ryan's work; same areas but different perimeters, from Andre's work; same perimeter but different areas.
Teacher	:	yes right

After the class activity then teacher gave a worksheet to do (worksheet attached below). A grids table was given and students were asked to draw the possibilities of different shapes that can be created from a certain amount of matches. Drawing the matches representation on grid paper were not a difficult task for students somehow they just draw several drawing with limited variety of shapes. It made the conjectures that they can find different numbers of grids for the same number of matches was not coming out.

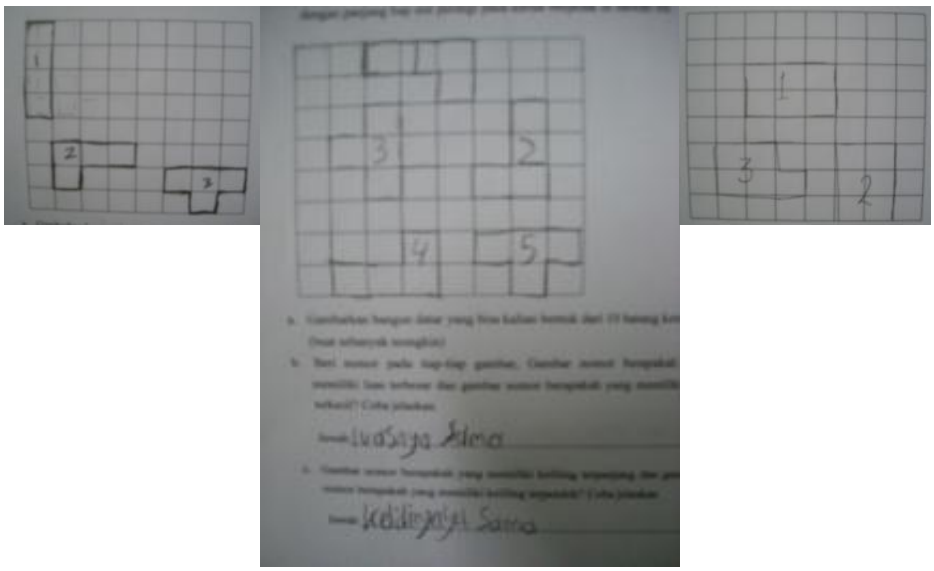


Figure 4.18 Examples of students' work

-Discussion

The result of the students' work on arranging wooden matches was really help the teacher to direct the student to build their own understanding about the relation between area and perimeter. Somehow the result on worksheet did not come out as smooth as class activity. The conjecture of different area for the same number of matches in fact did not come out. Actually even though each student made similar shapes on their own worksheet but among them has difference in design, teacher should bring this result into class discussion so that students can make conclusion from it.

4.2.7 Working with odd number of wooden matches

From the previous work, students were working with all even numbers of wooden matches. The teacher tried to give a problem to the students "how if the numbers of wooden matches are odd and they have to create square or rectangular shapes?"

All students were so eager to solve it, they do it very quick since they already has lots of experiences of creating shapes from the previous activities. But in the middle of their work they started to realize that it is impossible to create a square or rectangle with odd numbers of wooden matches. Arranging with odd numbers then they will end up with "need one more matches" or "one matches was left over"

Salma : I need one more, it will work if I have 6 matches (Salma has 5 matches)
Ryan : it is too many matches
(*Then the teacher started interviewing the students about the problem they have with odd number of wooden matches*)
Teacher : Seems none of you can create the square or rectangle?
Students : yaaa….it doesn't work

Teacher : do you still remember the number of wooden matches I gave you the day before?
Students : 8, 10, 12, and 14
Teacher : how about today? What number of matches you have?
Students : 5, 7, 9, 11, 13 and 15
Teacher : can you notice the differences?
Student : even and odd
Teacher : so to create any square or rectangle is it possible to use wooden matches with odd numbers?
Students : no, we can't form it with odd numbers
Teacher : let see Dilla's work; how many matches you have Dilla?
Dilla : I have 7 matches
Teacher : in this design, how many matches you need?
Dilla : 8 matches
Teacher : but let see her design; here is one side that still uncompleted, it needs one more matches. So when we create any square or rectangle, the sides opposite to each other has to be…??
Teacher : this side has 2 and the opposite side also 2, so the opposite sides have to be the same right?
Teacher : let see the uncompleted side, one side has two matches and the opposite side has only one matches, is it possible?
Students : NO
Teacher : Let see Farel's work; this side has 4 matches and the opposite side also has 4 matches, so what is the condition for the opposite sides?
Students : The opposite sides should have the same number of matches.
Teacher : so if this side has 1 match, so the opposite side needs?
Students : 1 match as well

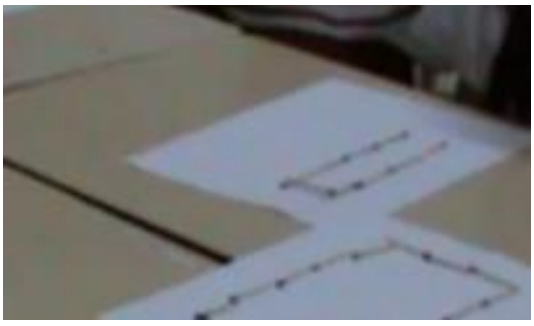


Figure 4.19 Example of the shape formed with odd number of wooden matches

-Discussion

The activity above is good starting to come into more formal level of measuring the area of squares or rectangles as length x width and the perimeter of it as (2 x length)+(2 x width). By bringing up the different condition of arranging

even and odd number of matches then students can build their own understanding through the fact that with odd number they can't formed any square or rectangle, they found that the opposite sides should have the same number of matches.

Teacher did not lead the students to more formal level of finding the formula for perimeter and area but indeed this can be good basic knowledge for students to continue into more formal learning of perimeter and area in the next level.

4.2.8 Playing with rope

Coming into generalization then teacher brought the activity that was expected to be able to generalize student's insight that an area of any shape can have different possibilities of perimeter and vice versa. This activity was given directly after odd wooden activities. Teacher urges the students to think how if their wooden matches were changed into rope. Teacher asked students to make

Figure 4.20 Students work with the ropes to form any plane figure

any shape from those ropes. Since students worked with grid paper then they continue to use it for rope activities. We found that students created different shapes those not just rectangles but also any curves.

With the help of grid paper they count the area of the shapes they made and in fact most of them have different results of area. Meanwhile they work with ropes with the same length for all shapes. This situation was used by the teacher to direct the students to make their conclusion that with the same length of ropes they can create different forms of shape and also different areas.

Teacher : So let see how many grids that cover each shape; dilla 21, Salma 24, Rian 30, Dio 30, Andre 27 and Farel 16. Meanwhile all of you have the same length of ropes.
Teacher : So we here we can say that, even though the length of ropes area the same but the area.....???
Students : not always the same

The worksheet was given after the class activity. There are only 3 questions given. Most of the students give an answer that still not as what we expected. When they were asked the possibilities of 2 ropes with the same length to form different areas, they said "yes it's possible", but their reasoning is more to the shape only. "Because the shapes are different then they also have different areas". Also when they were asked whether they need to know the perimeter before they measure the area, they said yes. Some of them give reasoning that they need to know the shape first, they need to form perimeter or they just simply said that they need it.

-Discussion

Counting the number of grid that covers the shapes was not a big problem for the students. When it comes into the relation of perimeter and area, somehow, students get confused. Here we can see the dangerous of introducing the term with double meaning. As we can track back from the very first activity, the teacher introduce perimeter as the outer edges of the shapes and at same time also

introduce perimeter as the length of the outer edges of the shapes. The same happening for area, first the teacher brought the discussion about area into the inner part of the shape but then also introduce the area as the number of material needed to cover the whole surface.

Children seems to take both meaning at a time where on their beginning of learning perimeter and area it will be a very hard work for them to understand both at a time. It should be clear from the very first time that they learn perimeter and area in the field of measurement of perimeter and area only in the matter of their visualization.

4.2.9 Post-test

Post test were given after the students completing their lesson series. This test was aimed to see the students understanding and reasoning about the whole series of the learning (relation between area and perimeter).

First activity was given similar with the activity in pre-test but the ropes given have different length. In this activity students did it very well, they can describe how they compare the ropes and they notice that the ropes have different lengths. In the next activity students were requested to create any shape from the ropes and measure their areas. In this activity, on purpose teacher did not provide any tool to measure the areas. Teacher expected the students to come with the idea of grid paper then as what we predicted, they asked about grid paper during the test.

Salma : Area? ehm..so?
Teacher: for example you have created the shape then you can measure the area, you can make estimation perhaps.
Salma : Oh ya..so I make some kind of grid to estimate how many squares needed for the shape?

The students can make their own grid paper, even though they could not make the very neat one but it is clearly seen that they have the knowledge about measuring area with the help of grid paper from the previous lesson. So when there's a question about area then their thought directly went to grid paper.

For describing the meaning of area, the expectation from the researcher was that students are able to explain that area is the total materials needed to cover the whole surface. In fact most of the students described area as the inner part since from the starting point they learned the outer part of the shape as perimeter and the inner part is area.

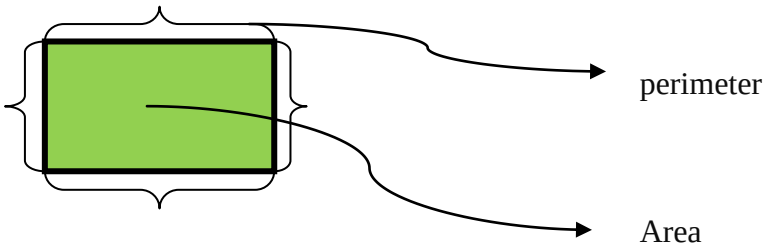


Figure 4.21 Students' description about perimeter and area

The second activity was working with grid paper. In this activity 2 grid tables were given in different form but with the same number of grids. Students were asked to find the similarities and differences from both tables. Some students noticed both table as rectangular shape with the same area but different perimeter but there is student that mix up perimeter as area and area as perimeter. For the next questions, students were asked how they compare the perimeter and the area of the shapes. Here they can clearly state that they measured the area by counting the grid and measured the perimeter by counting the total outer side of the grids.

The last question was about rearranging the tables in the different forms of squares or rectangles but with the same number of grids. Most of the students still do as the pre-test; just change the shapes from vertical to horizontal. They can notice that the similarities of the previous tables and the new tables they arrange that the number of the grids were still the same.

4.2.10 Conclusion from first cycle implementation of HLT

From the whole learning series we can conclude that introducing perimeter and area at the same time for grade 3 was actually not a problem. They might find some confusion at the beginning and made certain mistakes about those two terms but through the mistakes, we can direct them to the difference between perimeter and area and how they are related.

Starting from Activity 1-frame fencing where children were directed to recall their knowledge about length to connect it with the term of perimeter. When they span the ropes along the edges of the frame then they build their own understanding that perimeter is the length of the outer parts of the shapes. Continuing to the next activities of making photo frame then student experienced themselves to create many kinds of shapes. The use of ice cream sticks also helps them to start using the tools to find the perimeter of the shapes. As the teacher asked them about the perimeter of the frame then they can simply answer that the perimeter is the total ice cream sticks that they use to make the frame. The teachers' questions during the class discussion about the inner part of the frame actually made them think about that region. Even though they have a hard time to describe what the region within the frame is but they have the idea that when they

create a fence on the paper with ice cream sticks, indeed there was a region within it.

Starting with the idea of region within the frame then the activity was continued to comparing the size of the photo paper. From the class discussion it was seen that Dio has the idea of covering the whole part of the surface to figure out the size of photo paper, and from the question about which room is bigger or smaller where they can describe very well certain room is bigger or smaller than the other. It means that even though students cannot describe yet the meaning of area but naturally they already have the sense of area.

Direct comparison was aimed as the scaffolding to go to the situation when students cannot compare things directly then what can they do. In direct comparison, when the shape of the paper are similar, students can compare it easily just by seeing or put all the paper together in stack somehow students has problem when the shapes are not similar and they cannot just simply look at it or put it on stack. The idea of cutting the left over part was a good idea that arose from Farel. Somehow teacher needed to direct the students into the idea of covering the whole surface with sticky papers to finally come into the measurement of region.

Covering the whole surface with sticky papers was very stimulating, colorful papers also help students to enjoy this activity more. In this activity Dio was quite struggling to arrange the sticky papers and counting the number of sticky papers, somehow with the help from his friend and the teacher then he can support himself and be confident to speak up his works. Some students were still

using counting one by one to get the total number of sticky paper that covered the surface of photo paper, somehow Farel counts it by row wise and Andre simply use row times column. Indeed Andre is the only one that is quite moving fast to the formal level compared with his other friends.

An interesting finding was when teacher asked the number of sticky papers they use to cover the whole surface. All students gave the right answer for the number of sticky papers but when they come into counting the perimeter by using the side of the sticky papers as the unit, and then they got mix up. They count the sides as they count the squares, somehow teacher can use these mistakes to direct the students to realize themselves that at the same time with the same shapes they can distinguish between perimeter and area. And through sticky paper it's clearly seen that area is the total sticky papers used to cover the whole surface. Perimeter is the total outer sides of sticky papers that cover the edges and they count it by adding up all the outer sides of sticky papers that cover the edge.

Moving into more formal level, the teacher used wooden matches and grid paper to come into more detailed relation between perimeter and area. During this activity students finally figure out by themselves that with the same number of wooden matches they can create different shapes with different numbers of squares and vice versa. Somehow the students still find difficulties to find the greatest area that they can create from the same number of wooden matches. They tend to make one model and just change it vertically or horizontally.

The additional activity of creating squares or rectangular shapes with odd number of wooden matches was also interesting. At the first place students were

so eager to work on it, somehow they were struggling to figure out why they cannot form any square or rectangle with odd number of wooden matches. Last activity was the generalization of the relation between perimeter and area where in this activity students will figure out that for any shapes with the same perimeter it can have different area and vice versa.

4.2.11 HLT-revised

There are some revisions that will be taken into account for preparing the 2nd cycles. As we can see from the whole series that teacher has double meaning for perimeter and area. First the teacher introduce perimeter as the outer edges of the shapes but then also introduce it as the length of the outer part of the shapes. Same happening for area, the teacher introduce area as the inner part of the shape but then also introduce area as the total material spent to cover the whole surface of the shape. Whereas the goal of this lesson series is the understanding of perimeter and area in the field of measurement. So for the 2nd cycle we will direct the students to have the understanding or perimeter and area in the field of measurement.

For the pre test and post test, we will change the material for the ropes since previous one was not quite handy according to students. We will reformulate the questions in pre and post-test as well. The result of Post-test in cycle 1 showed that the questions given did not assess the whole learning series. We can say briefly that the question given was still quite general, need to be more specific and more elaboration for every lesson given.

In the wooden matches activity, after the activity of creating shapes with wooden matches we plan to bring it into semi-formal activities where the students no longer needs wooden matches to create the shape but they can directly draw it in grid paper instead. Indeed they work with drawing on grid paper while they do their worksheet but we consider that worksheet is not sufficient enough it has t0 be conducted in class activity so it can come into class discussion as well.

We consider adding one more activity after the wooden matches' activity. The activity is finding the possibilities of creating the squares or rectangle shapes with odd number of wooden matches. The idea is that measuring perimeter and area in the formal level will be in the form of $(2 \times length) + (2 \times width)$ and $(length \times width)$ respectively. Even though the final goal of this learning series was not yet reaching the formal level mention above but since students already work with wooden matches and arranging it so giving this additional activity will be worthwhile for as their knowledge to go to the formal level.

Considering the different number of student from 1st cycle compare to 2nd cycle, where the 2nd cycle will consist of 28 students then we consider re-arranging the group activity as such so that at least all the group member will involve. We also consider not conducting class presentation for every session but class discussion instead.

4.3 Analysis on second cycle of HLT implementation

The second cycle of HLT implementation was the revision of first cycle of HLT implementation. The retrospective analysis was conducted based on the data collection namely, students' work, video of class experiment, and also interview.

We have chosen to make further elaboration of the data that were in line with the HLT whether in giving support or even not supporting the HLT. The aim of this analysis is to figure out how was the implementation of HLT compared to the design of the HLT itself and then to propose the better approach for the implementation of HLT in the future.

The participants for this second cycle consist of the whole class of 3B, At-Taqwa elementary school Surabaya. The class consists of 28 students, 10 girls and 18 boys. The class that was dominated by boys more or less affects the class environment that seems quite crowded and noisy. Somehow the students in this class, mainly boys, are very active. They were very fond of doing class activities, give good response on class discussion, and answer the questions given. The class itself has two class teachers. Both of them are in charge for the class management but they teach certain subject respectively. We work with one of the teacher who in charge in mathematics subject. The teacher is a new comer in the school; she has been working as a teacher for one year. Indeed she is quite new as a teacher somehow we can see that she is willing to learn and cooperate very well along this research.

During the teaching experiment, we thoroughly observed the learning process of students in learning perimeter and area and its relation. Somehow we also paid attention on teacher's role during the class experiment. Some finding related to the elements in perimeter and area and its relation need to be analyzed further and clarified so it can come into the generalization of the learning process of perimeter and area. In this analysis we will briefly review each of the cycle and

the teaching experiment in particular based on the findings and mathematical ideas.

4.3.1 Pre-test

Pre-test was conducted to know the students understanding towards the subject that will be given. From the whole series of questions given in pre-test, most of students have no problem in comparing the lengths of the ropes. It means that students already have the pre-knowledge about measuring lengths and how to compare them. In this test, most of the students are familiar with the term 'length' and how to deal with it, somehow the term perimeter sounds quite new even though they know it was related to length. They also still have misconception about counting perimeter. When they were asked about the perimeter of the shapes most of them will pay attention on the physical appearance of the shapes and ignoring the unit measurement. Seeing two shapes below, for instance,

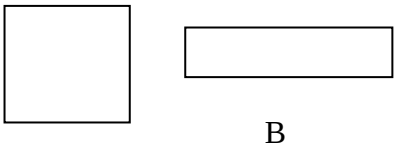


Figure 4.22 Plane Figures

they will say that picture B has longer perimeter compared to A because picture B as a whole seems longer than A.

And for area, it indeed is totally new for them. When they have to compare two shapes with grid paper in it, the first thing they check is the number of square grids in each shape somehow they do not have in their mind yet that area is the

total material needed to cover the whole surface (see appendix C). Many students leave their page blank for the question about describing the word ‘area’.

When it comes into comparing two shapes with the same number of square grids but different shape, only some students notice that the number of square grids is same. They did not yet come into their sense of the relation of perimeter and area on those both shapes. None of them put their reasoning on perimeter. To compare those shapes they also use their intuitive that one is big or small, long or short.

-Discussion

From the result of pre-test we can see how far the knowledge of students about perimeter and area. It is very acceptable that students in grade 3 do not have the understanding about the term ‘perimeter’ and ‘area’ yet because indeed it is new for them. The result of this pre-test also help us to redesign our HLT so it will as much as possible be in line with the needs to support the students in their learning process of understanding perimeter, area and its relation.

4.3.2 Introducing the term Perimeter

Perimeter in Indonesian word, ‘keliling’, is not a new term for students in grade.3. They use it in their daily base such as ‘berkeliling kota’, ‘mengelilingi lapangan’. Somehow as a single word ‘keliling’ which we describe in chapter 1 as the curve inclosing a region of a surface or the length of such a curve, it is a new term for the students. As we can see in this following conversation:

Teacher : today we will learn about perimeter (*keliling)*
Rizky : Berkeliling ke mana? (*where to go around*?)
Haikal : to Singapore

It showed that the first impression that students might get when the teacher said about perimeter is about goes to taking around on a certain place.

When it comes into measuring the perimeter then it will be easier for them to understand what the length of the path is than to understand what the perimeter of the path is. It happens because they have learned the concept of measuring length in grade 2 but not the length of the whole outer sides of certain shape known as perimeter of the shape.

Fencing activity was the first activity to engage the students with the knowledge of perimeter. Since students in grade 3 have learned about measuring length then it was expected that through fencing activity students will be able to recall their knowledge in measuring length as basic knowledge of perimeter. The teacher used the context of purchasing the fencing for photo frame. Teacher brought the different shapes and sizes of photo frame and asked the students to help her to decide which photo frame will cost the least amount of money.

In the first session, teacher brought three different sizes of photo frame; she asked the students how to count the perimeter of the frame. Surprisingly students came with lots of ideas of counting the perimeter starting from the standard tools and non standard. They mention ruler, path, pencil, rope, meteran (some kind of ruler but very long), and pencil box. From the students' respond we can see that they already understand about the concept of measuring length, they know that they can measure the length with different kind of units. During the class activity, we did not sure whether students familiar or understand about the word perimeter but since the teacher shows by surround her finger along the outer

side of the frame then it help to form the students idea about what they will measure.

Figure 4.23 Measuring the perimeter with the ropes

In the second session, a group work, each group were given four different shapes namely rectangle, square, triangle and circle. Those shapes were chosen because students already familiar with them. Circle was chosen as the reasoning that using ropes as the tools to measure the perimeter is quite making sense because ruler or other straight tools are not always worked. Students span the rope and surround it along the edge of the shapes. They cut the ropes then compare it.

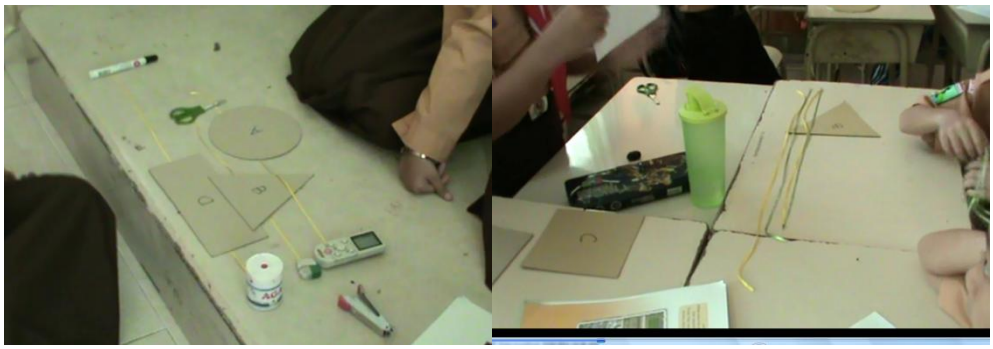


Figure 4.24 Comparing the length of the ropes

During this activity of measuring the perimeter of the shape, students start to build their understanding that for counting the perimeter they need to surround the outer part of the shapes. Most of the students can show which part of the shape known as perimeter; somehow it is still difficult for them to put it in words, as the class discussion below:

Teacher : So from the activity we've already done, what is perimeter according to you?
Mizar : the sides of the shape
Hani : the area of the shape (*but her hand seems to surround the shapes*)
Haiqal : the angles of the shapes

From the students' answer above we can see that each student has their own interpretation about perimeter even though they did the same activity of surrounding the outer part of the shapes by using the ropes to find the shortest ropes. As we make an interview with one of the students, Diva, she can explain to us that she studied about perimeter, she can explain how to measure the perimeter, somehow, when it comes into the description of perimeter in her own words she said about area but she can show that perimeter is the length of the outer part of the shape. It seems that Diva still struggle to find her own words about perimeter, but she can describe what perimeter is actually.

-Discussion

The idea of choosing the fencing frame activity as the first activity along the series was under the consideration that grade 3 students have learned the length measurement in grade 2. It was expected that by starting the learning series with something that already accustom for the student then it will give good stimulation to go further on the learning series. Fencing activity indeed helps students to come into the terms perimeter as the outer part of the shape and how to

count it. We found that it was not an easy task for students in grade 3 to describe perimeter in the words. Somehow from the class activity and class discussion we can see that students are able to build their own understanding about perimeter. They can show how they compare the perimeters of the frames. They can show which part of the shape known as perimeter. We can conclude here that students in grade 3 do not have to be really able to describe the meaning of perimeter in certain words. Their understanding can be seen from how they work on counting and comparing perimeter and their reasoning.

4.3.3 Counting perimeter with non-standard unit and introducing the term 'area'

From the fencing frame activity, students have their understanding about perimeter as the outer part of the shape. They use the ropes to surround the outer part of the shapes then compare the ropes and stated that one rope is longer or shorter than the other without considering the length of each rope. In this present activity students start using nonstandard measurement unit to count the perimeter of the shape. It was expected that student will have deeper understanding about perimeter when they work with discrete tools which are more real for them comparing to the ropes.

Making photo frame is the context used to learn about counting perimeter with non standard measurement unit. If previous activity was comparing the fence of the photo frame but now students create the photo frame by themselves by using ice cream sticks. The objective of this activity is mainly as the bridge from perimeter as the outer part of the shape in the first activity to the introduction of

area in the next activity. Somehow it was also a media to recall students' knowledge about perimeter. By making photo frame it was expected that students will be aware that while making a fence then eventually they also create a space within it. And by using ice cream sticks as the measurement unit then they can count the perimeter of the frame.

Student formed a frame from the ice cream sticks. Students arranged the sticks with any shapes they want then stick it together on a paper to form a photo frame. Teacher gave examples in advance to avoid misconception about the task given. Students seem really enthusiastic in making the frame especially in deciding what shape they will make considering the limited number of sticks they

Figure 4.25 Discussion about perimeter and area

have. During the group work teacher assists them and posed some questions that lead them to the awareness of space within the perimeter and counting the perimeter as well.

Teacher : Aang,what is this (*pointing to the outer sides of the shape that students made from the ice cream sticks*)
Aang : Rectangle
Teacher : This (*pointing to the ice creams sticks while counting one, two, three,….)*
Aang : sides

Teacher : if this (*pointing to one side of the rectangle*)…this (*pointing to another side*), these area sides. If all from here (*surround the outer sides of the ice cream frame*) to here..?
Students : perimeter
Teacher : Then what is inside perimeter?
Students : area
Teacher : can you count the perimeter of this shape?
Students : (*count the sticks*)

From the discussion above we can see that the teacher try to recall the understanding about perimeter and then also try to build students' awareness that when they create a fence then there is an area within it. From the activity teacher also bring students into counting perimeter with nonstandard unit, namely, ice cream sticks. Counting with sticks seems easier for students than using ropes because sticks are discrete quantity so it will be easier for students to count when the unit is the sticks. It will be helpful for students when they just need to consider that perimeter is the outer part of the shape and how to count it is just simply count the number of ice cream sticks surrounding the shape.

-Discussion

In this activity we start seeing that perimeter was learned together with area. When the students arranged the ice cream sticks to form a certain shape then teacher directs them to be aware that there is a region within the shape that they've created. Somehow the sense of perimeter seems to be stronger than area in this activity. Students seem busy in arranging the sticks and come into how many sticks they've spent for each shape somehow they do not really pay attention on the region within the shape unless the teacher asked them about. Teacher's question related with counting perimeter become a good support for students understanding especially for them who still have less understanding of perimeter

from the previous activity which using ropes as the context. To build students awareness on area then teacher also post question about the region within the shape. Indeed some students seem struggled in this activity because they pay more attention on working with sticks and put aside on the counting perimeter and awareness on region within the shape. This students need to be supported so that they will have the same understanding as their other friends.

4.3.4 Comparing the area

The study of area involves two steps based on Simon and Blume (1994) in Zacharoz (2006); namely, considering the area as a quantity and evaluating that quantity. Physical quantity can be seen while the experiences offer the students to compare area of objects (Heuvel-Panhuizen, 2005). In this way, intuitive awareness of measuring emerges in many students. Comparing the area of photo paper is the activity that supports the students to learn about area. The context given was that the price of the photo printing depends on the area of the photo paper. The bigger the photo papers it means the more expensive the price and vice versa. Teacher asked the students to help her or him to decide which photo paper will cost the least amount of money to print the photos. By comparing the photo paper it was expected that students will start using their intuition to compare the papers by using, for instance, the term ‘bigger’ or ‘smaller’. The papers were arranged as such so that students will be able to compare it by using their intuition, they can compare directly with the other papers such as the bigger paper can cover the whole part of a smaller paper. At this stage students might not be able to describe the quantity of the area in numbers yet but they have made the

first steps of learning area already by describing the comparison of certain areas with the terms ‘bigger’ and ‘smaller’.

Before starting the class activity with comparing the photo papers, teacher again tries to recall students’ knowledge about what perimeter and area are.

Teacher : Do you still remember what we’ve learned yesterday?
Students : Keliling (*perimeter*)
Teacher : So what is perimeter?
Aang : perimeter is side to side
Meizar : Perimeter is the length of the outer boundaries (*panjang batas terluar*)
Teacher : (*repeating Meizar’s answer*) the length of the outer boundaries.
So what is area?
Students : region inside the sides
Students : inner part

Then teacher come to the white board, draw a rectangle and re-explain about area and perimeter. Teacher repeated Meizar’s answer about perimeter as the length of the outer boundaries by surrounding the outer sides of the rectangles then she shaded the inner part and poses a question for students:

Teacher : so what is this shaded part?
Student : area
Student : region
Teacher : the region inside the boundaries
So do you think the region inside the perimeter can be measured? it has quantity?
Students : yes
Teacher : so area has a quantity

On the discussion above, the teacher tried to direct the students into the early idea of what they are going to do on the activity. Teacher expected the students to understand that area is not just the region inside the boundaries but it also can be quantified and they will learn how to count it.

It’s shown during the class experiments that from the very first place students actually have the sense of area already. By seeing three different shapes, for instance, they can directly differentiate them by saying one is smaller or bigger

than the other. Somehow it does still not yet come into their mind about how to count the area. Indeed one or two students already know about counting the area in the formal level of $length \times width$ but he failed to explain why it comes into length times width; they just simply use it.

The conflict then arises when the teacher gave two different photo papers which are slightly different for students to compare.

Figure 4.26 Comparing two different shapes

With these two shapes they cannot directly conclude which shape is smaller or bigger than the other just by seeing it or put it in stack. They need to quantify the areas to make sure which one is bigger or smaller than the other shape. And they will ask and try to find the answer how to count the area of those shapes. To raise the conflict in area then the teacher brought the context of printing photos that they have discussed previously in the third activity. Teacher brought two different sizes and shapes of photo paper, square and rectangle respectively.

In this activity, the teacher urged the students to think and figure out the idea that they need a tool to quantify the area of the photo paper. From the HLT, it

was planned that teacher explores the possibilities to count the area from the students' idea. Somehow during the class experiment teacher directly offered the students to cut the paper. Teacher also questions how if comparing two shapes which cannot be cut, for instance, comparing the area of one board to the other board. Unfortunately teacher did not explore further and directly propose to use paper to cover the surface. What teacher did might not give enough support on students' development process. Somehow we will not discuss further in this analysis. We will more focus on students' development process.

Coming into comparing the areas of two shapes by using square paper to cover the whole surface, it was expected that from this activity students will build their understanding for area as the total number of materials (square papers) that cover the whole surface. The teacher started with class discussion on counting the perimeter and area of class locker, as follow:

Teacher : Do this locker has perimeter?
Students : yes
Teacher : so count the perimeter

Figure 4.27 Class discussion on perimeter and area by using the lockers at the context

From the previous activities of making photo frame where they used each of ice cream sticks as the measurement unit of perimeter, teacher expected when they count the perimeter of the locker, students will use each outer side of the square box as the unit measurement. Somehow when the teacher asked them to count its perimeter they answer it as 8 x 4 = 32 which as its area with the square box as its measurement unit. It seems that students cannot relate ice cream sticks with the sides of the square to be something similar to count the perimeter. Also when the teacher comes with rectangular paper with square grid on it, some students said that its perimeter is 4.

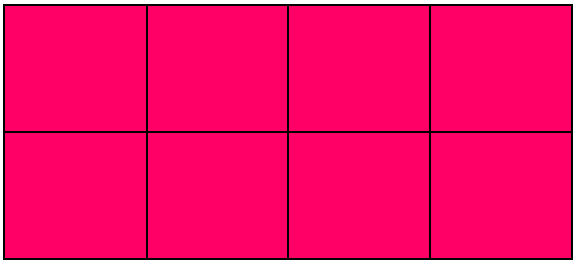


Figure 4.28 Grid paper

Those students do not have the idea of using each side of square grid as the measurement unit as when they used ice cream sticks previously. They just think that rectangle has 4 sides so for the perimeter as the length of all outer part then it must be 4. Indeed some students count the perimeter as 12 square sides. Teacher uses this answer as the class conclusion on how they count the perimeter.

Having the discussion above, student seems struggled at the first place to differentiate which one for counting area and which one for counting perimeter. We can see here that students' understanding about counting area and perimeter is still not deep enough. Indeed, they already have the idea that perimeter as the

outer part and for them area is the inner part of the perimeter. Somehow the context of locker seems quite abstract for them to represent area and perimeter.

Coming into the main activity of comparing two photo papers, teacher asked the students to find which photo paper is smaller than the other. The goal of this activity is to develop students' understanding of area as the number of materials used to cover the surface. Somehow the idea of perimeter will also be recalled by counting its perimeter by using the sides of square paper as the measurement unit.

Using sticky papers to cover the whole surface of the photo paper seems not a problem at all for all students. It might be supported from the previous discussion of locker and rectangular paper with square grid in it. Somehow, again, some of them still get mixed up between counting perimeter and area. Ardan, for example, when the teacher asked him to count the perimeter of the photo paper he counted the number of square paper. Even after the teacher explained to him that perimeter is the outer part and area the inner part, still he counts the squares for perimeter. It seems that counting the sides of squares doesn't make a sense for him to count the perimeter. It seems that square is the one that real for him, the sides of the squares seem to be one unit of the square so when it comes into counting perimeter he also counted the squares.

Even though we found many students still mix up between area and perimeter but some other students in fact do not have any problem with this activity. They can differentiate very well which one for counting area and which

one for perimeter. This student seems to have good spatial ability as well. Taking the side of square paper to count the perimeter seems reliable for them.

-Discussion

Area comparison of some shapes which can be compared directly seems to be good starting point. This type of comparison is the simplest one for students. Pupils have no problems in comparing these kinds of shapes only by seeing them or put them as stacks. The idea of area was in fact already embedded in students mind as well. They can compare the areas by saying one is bigger or smaller than the other even though they do not have the idea of counting the area yet. Stepping into indirect comparison where the students use sticky paper as measurement unit then students starts to learn how to count the area. They start to have the sense of area as the number of sticky papers they use to cover the whole surface of photo paper. Somehow when it comes into counting perimeter by using the sides of sticky paper as measurement unit then some confusion were there. For some students, the side of sticky paper used as measurement unit of perimeter is still quite abstract. First they use sticky papers to count the area but then they use its side to count the perimeter. These students still need further support on their understanding about perimeter and area.

4.3.5 Two plane figures with the same area can have different perimeter or vice versa.

The common difficulty about perimeter and area is to understand that for a given area, there are many possibilities of perimeter and vice versa. Pupils often think that for the same area they will get the same perimeter as well. When

students lack awareness to this relation of perimeter and area then on their continuation of learning process they might get confused about this concept. It is important that students have time to explore the relationship between area and perimeter. They need to know that not all shapes with the same area have the same perimeter and vice versa (Bahr. Kathleen, et all).

Teacher has started to bring up the idea that for a given area, there are many possibilities of perimeter and vice versa when they use sticky papers on the previous activity. Students count the area by counting the number of sticky papers and count the perimeter by counting the outer side of sticky papers. Somehow we figured out that not all students can accept the idea of counting area and perimeter by using sticky papers. Some of them can distinguish very well between area and perimeter but some of them get mixed-up between counting area and perimeter. For them using the side of sticky papers to count the perimeter seems quite abstract.

Indeed the understanding that for a given area there are many possibilities of perimeter and vice versa is still new for the students. Even though in the previous activities it was already introduced, somehow the use of sticky paper as the context for both counting area and perimeter seems still made some students confused. At the contrary with sticky papers, the use of wooden matches and grid paper as the context to learn the relation of perimeter and area seems to be a rich material to use. Starting with forming as many shapes as possible from the same number of wooden matches on the grid paper, teacher encouraged the students to develop their own understanding about the relation of perimeter and area. For

instance, with 10 wooden matches in fact different students have different ideas of arranging the shapes that result in different areas as well.

Figure 4.29 Examples of different plane figures with the same number of wooden matches

From the pictures above we can see that, with the same number of wooden matches, 10, the shapes have different number of square grids. It leads to the understanding that for the given perimeter the areas can be different.

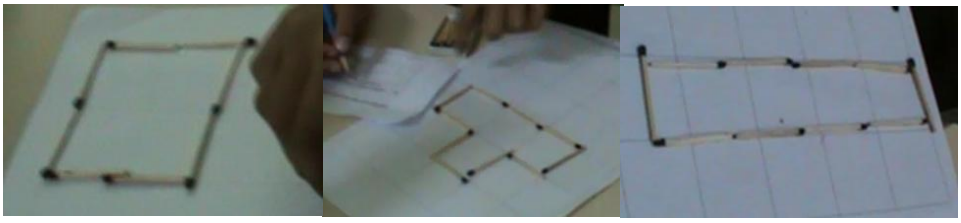


Figure 4.30 Examples of different plane with the same number of square grids but different wooden matches

Conversely, for making any shapes with 4 squares grid area, each students may need different number of wooden matches. It leads to the understanding that for the given area, the perimeters can be different.

The use of wooden matches and square grids as a context was in fact very reliable for students. They used to count the area with square grid as its measurement unit and wooden matches as the boundary of the shapes seem real for them. The fragment below shows how the use of wooden matches and grid paper help students in counting the perimeter and area.

Teacher : what is the perimeter? let's count
Doni : (tagging each wooden matches and whispering 1,2,3,…12) twelve
Teacher : ok..12, now what is the area?
Doni : (tagging on each square grid inside the wooden matches and whispering 1,2,…6) six

We can see that it seems Doni doesn't have any problem to differentiate which one is perimeter and which one is area. The perimeter represented by wooden matches and area represented by square grids seem to be to different things that are real different for students.

For some students who already have a good understanding, with some support, they even can figure out how to count the perimeter in a handy way instead of counting it one by one. Mizar, for instance, he can notice that the opposite sides have the same length so he came into the idea of $(2 \times p) + (2xl)$ for counting perimeter.

Moving from the context of wooden matches which is very real to students then teacher comes into worksheet where students try to draw a shape on the grid paper. It was expected that students no longer need wooden matches to form a certain shape; instead they will draw on a grid paper. Same as forming wooden matches, students have no problem in interpreting wooden matches on grid paper. Even though most of them just play in the rectangular form vertically or horizontally but they can stick with 10 wooden matches.

Coming into finding the biggest area that possible to be formed from 10 wooden matches then there are different levels of understanding towards this problem. Some students can directly describe their reasoning very clear that the biggest area is the one that has the most number of square grids. Somehow there

are some students who can write the area and perimeter correctly but did not explain which one is the smallest or biggest. There are some possibilities, they might understand already but are not able to describe their reasoning, and other possibility they do not really understand the question given. Students with lower ability somehow still struggle in understanding about counting area, for comparing the area they just see the physical appearance and ignoring the number of square grids.

Finding the longest perimeter has the similarities with area. Even though they know from the first place that as if they only have 10 wooden matches to be drawn on the grid paper, somehow they still answer that one of the drawing has the longest or the shortest perimeter. They mostly pay attention on the physical appearance of the shape and ignore the number of wooden matches on the drawing. Indeed there are one or two students who can answer correctly that all perimeters remain the same because all those shapes spent the same number of wooden matches; namely, 10. Still it becomes a great concern of the teacher that some students still struggle with perimeter and area.

Repeating the discussion on perimeter and area seems to be one of the supports from the teacher to help the students to build their understanding about perimeter and area. Teacher decides to repeat the discussion on area and perimeter especially emphasizing on counting perimeter. Class discussion seems to be the right choices, first because students have learned in the previous day, second because all the class will be involved in the discussion. Teacher puts big grid paper on the white board and represents wooden matches with ice cream steaks.

Posing several questions about perimeter and area, teacher expected the students to recall their previous knowledge about how to count perimeter and area

-Discussion

The use of wooden matches and grid paper was really good support for students learning after some confusion in the previous learning with sticky paper. First of all wooden matches are something separated from the grid paper. Students will notice it as 2 separate things. Grid paper to represent the area counting and wooden matches along the side of the grid paper to represent the perimeter counting.

By using wooden matches and grid paper teacher tries to build awareness that for the given area it might have different perimeters and vice versa. As the example mentioned above that for 10 wooden matches, for instance, students can create different shapes with different areas as well.

The wooden matches and grid paper are real and make sense for students, so they do not find it difficult to come into more formal level where they no longer use wooden matches but draw it on grid paper. Drawing the shape on a grid paper was quite similar with arranging wooden matches so students are still able to recognize this pattern of work.

4.3.6 Form the shape with odd number of wooden matches

From the previous activity, students were working with all even numbers of wooden matches. The teacher tried to give a problem to the students “how if the numbers of wooden matches are odd and they have to create square or rectangular shapes?” Through this activity, it was expected that student realize,

they need even number of wooden matches to form rectangle and square. It was also expected that they will realize that the opposite side of rectangle have the same length. Indeed we will not go further into formal form of counting perimeter and area but in the long run, based on their knowledge, they will be able to come into more formal level of counting perimeter in the form $(2 \times l) + (2 \times p)$ or $2 \times (l + p)$.

Teacher let some representation to come forward and demonstrate how to make square or rectangle with odd number of sticks. They were so eager to solve it, they do it very quick since they already has lots of experiences of creating shapes from the previous activities. But in the middle of their work they started to realize that it is impossible to create a square or rectangle with odd numbers of wooden matches. Arranging with odd numbers then they will end up with "need one more matches" or "one matches was left over".

Teacher also posed the next problem, is that enough with even number of matches to create a square? Teacher made some kind of class discussion and chooses some representative to come forward and demonstrate how to make the square. Arranging square with even number of sticks then they realize that they need more than just even number but also divisible by four.

-Discussion

Exploring the ideas of arranging the shapes from wooden matches in fact can be very broadening. After working with the same number of matches or the same number of square grids but different number of matches then the teacher try to explore to the possibilities of forming rectangles or square from odd number of

wooden matches. In this activity all students involve with their design respectively and indeed they have the idea that it was impossible to form the rectangles and square with odd number of matches in the contrary it have to be even number. Somehow the students did not come into the awareness yet that the opposite side has the same number of matches. They have those ideas after the teacher direct the students to see the sides of the shapes. To come into the idea of formal calculation also still a long run. It seems that students need more time to explore the idea of odd wooden matches.

4.3.7 Exploring the perimeter and area of the shapes other than rectangle and square

The concept of perimeter and area actually is not limited in the form of rectangle and square only. Every plane shape has the concept of perimeter and area including irregular shapes. In our everyday life we figure out irregular shapes also, other than regular shape. Realizing that students needs to be able to generalize the concept of perimeter and area not for rectangle and square only then it's important to give sometime for student to explore the shapes other than rectangle and square.

The aim of this activity is to develop students' awareness that 2 shapes with the same perimeter can have different area and vice versa. Another reason is that we avoid students to come directly into rope activity that seems quite abstract compare to recall wooden matches' activity. Before directly step into irregular shapes then we bring the students to parallelogram and rhombus. Parallelogram and rhombus was chosen because we want to stick into the concept of the relation

between area and perimeter. By using 4 ice cream sticks for each shape for instance, then we can get different area when one shape is square and the other one is rhombus.

Arranging plane figures with ice cream sticks again can be used to explore the perimeter and area of parallelogram and rhombus. Looking back to the previous activities of arranging wooden matches for rectangle and square, teacher tried to bring the conflict among the students. How if her rectangle was moved a little bit to the right or to the left, will it still have the same area with the previous one (i.e rectangle)?. It was interesting because the class was divided in two groups, half believed that the area will remain the same but some said it will change. By questioning about the area of the shape then students will start to explore it by measuring it.

Teacher started the discussion about perimeter and area of parallelogram and rhombus by asking the students to form any rhombus with four ice cream sticks.

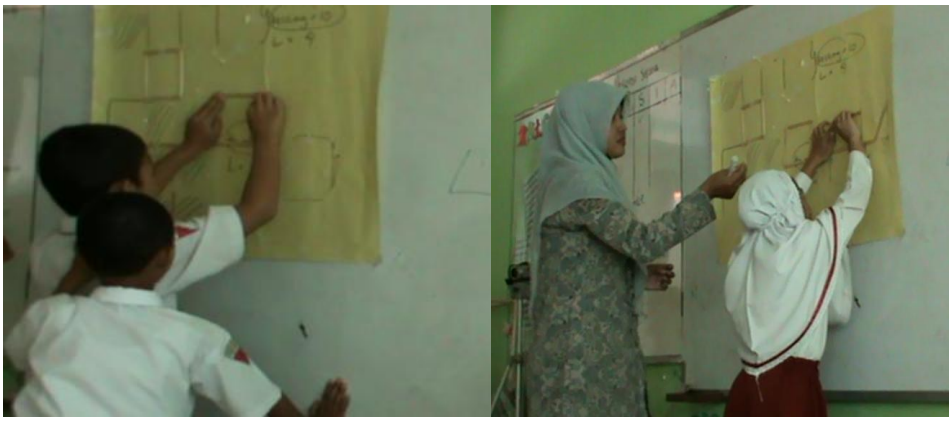


Figure 4.31 Forming the shape with ice cream sticks

The form of rhombus made by the students seems did not help much to reveal the fact that the rhombus and square which formed from the same number of ice cream sticks have different area. It happen because students formed the ice cream sticks just slightly different from the squares. Most of the students see it as one square area, same as the square shape previously. Teacher then asked other students to form another parallelogram, this time with six ice cream sticks.

Counting the area of the parallelogram and rhombus is something new for students. First, the shape is slightly different with squares and rectangle. Here two opposite side are a little bit slant compare to rectangle or square. Since the students have experienced to use square shapes to count the area then it might make them confuse a little bit about how to count the area of rhombus or parallelogram. There are some left over parts which are not covering the whole one square grid.

Teacher introduced the concept of counting area with approximation. Teacher introduce the term, for instance, greater than 2, smaller than 1. Somehow, introducing approximation was not an easy approach for the teacher. It might happen because students start to learn counting perimeter and area by using the fix whole number of measurement unit and using certain shape like rectangle and square.

Moving from parallelogram and rhombus into irregular shapes then teacher use the ropes and grid paper as the tools to reveal the idea of irregular shapes. Teacher asked the students to form any shapes from the rope on the grid paper.

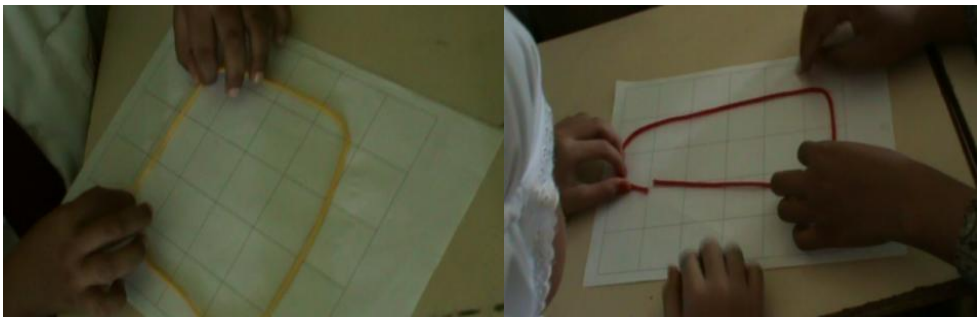


Figure 4.32 Forming the shape with the ropes

The idea of giving the task to form any shape is that, ropes are flexible to be formed in any way; it's quite different with ice cream sticks or wooden matches which have straight shape. By using ropes we expected that students will come with non rectangular or square form but more to irregular shapes. We expect that students will aware that with the same length of ropes they can make different shapes and remains in different area as well. And they won't restrict their idea with rectangle and square only but to any shapes.

Somehow what happen during the class experiment did not really as the conjecture given. Most of the students tend to form rectangle and squares form. Even though the teacher asked them to form any shapes but still from the first idea that come into their mind was making rectangle and square form. Indeed they can form square or rectangle in a perfect shape because it's quite difficult to make a right angle; somehow their basic idea was rectangle and squares. The benefit of using ropes is that students can't force themselves to make the ropes in line with the grid paper, sometimes the lines lays between the squares grid. This condition will urge the students to make an estimation to count the area of the shapes.

Since forming the shape from the ropes was not really handy so it take quite some times for students to make the shape itself. They really focus on how to form the shapes from the ropes given. When it comes into counting the area then students seems still struggle to make estimation. It's shown from their worksheet that they did after this activity. For counting the area of the plane figure given below

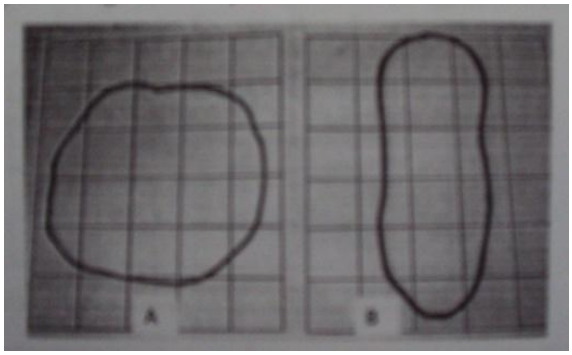


Figure 4.33 The shape formed from the ropes, arrange on the grid paper

then they still write it in the whole number of squares unit. It seems students still confuse to decide, for instance when the shape only cover some part of the square grid, then it still difficult for them to decide what value they can give, such as a half of the square, more than a half or even less than a half. It seems the whole number is the only real number for them so most of them still answer with the whole number.

-Discussion

The perimeter and area exploration of the shape other than rectangle and square was important for grade 3 students. In their daily life they do not just face rectangular shape only but also other shapes including irregular one. By giving a chance for the students to explore the shape other than rectangle and square than

we help the student to build their awareness about the concept of perimeter and area for any shapes.

Indeed the student's understanding about the concept of perimeter and area might be more in rectangle and square form somehow we already gave a preliminary knowledge about different shapes that available and need to be consider by them as well.

Starting with parallelogram with ice cream sticks and grid paper seems to be good choices before come into irregular shape with grid paper. In fact ice cream sticks were less abstract compare to ropes to be form as the shapes. With the parallelogram and rhombus we can lead the students to the shape other than rectangle and squares but also still in the coverage of the relation between area and perimeter where in the same area it might be some possibilities of perimeter.

The use of ropes as the tools to form any irregular shapes seemed does not really help to come into the idea of the relation between perimeter and area. It happen because the ropes it selves were not quite handy tools to be formed as the shape. Students more focus in deciding what shape to be formed and how to form it rather than realize that each of them use the same length of ropes to form different shapes and different area. Indeed teacher also bring the discussion about it to the class, somehow we figure out that the students still struggle with it.

4.3.8 Post-test

The post test was conducted after we complete the whole series of teaching experiment. This test was aimed to assess students' understanding about the lesson given along the whole lesson series. Based on the result along the

process of teaching experiments then we decided to make several revisions on the post test of cycle one. Some addition activities and students' works were given during this cycle which is not given in the first cycle, so we consider to also assessing the addition material given.

All the questions given in post test were about what student have learned during the teaching experiment. Starting from comparing two different shapes then we see that most of the students came into the idea of perimeter and area, they differentiate the shape based on their perimeter and area. They are also able to describe how they count the perimeter and area.

Working with incomplete grid paper, they are able to use their spatial ability to see the grids as a whole coverage of the surface. And for those who did work well with their spatial sense then put the line to continue the pattern of the grid. It seems that the students understand very well about the concept of area as the total square grids to cover the surface. Somehow we also found some student who still struggle with incomplete grid. They cannot imagine the grid as the whole surface, they area only pay attention on the grids that was drawn on the paper.

Working with the wooden matches, in this test, student no longer working with wooden matches in real but they only imagine as if they have certain number of wooden matches to be drawn on the grid paper. Most of the students find no problem in drawing the matches. Most of them work in the shape of rectangle and square. It is quite understandable since they work most of the time with these two shapes. We also still found some students who struggle to draw the matches, they might find problem to imagine the matches and put it in the drawing.

Counting the area seems does not become a problem for most of the students. They understand very well that area is the inner part of the shape then they count the number of square grids to get the area. Somehow for perimeter in fact did not result the same way. Many students still struggle with the idea of perimeter. Indeed they understand that they need to count the outer side to get the perimeter but when it comes into comparison then they get mix up. They still consider that the shape which looks longer than the other shape no matter the calculation is, it will be consider having longer perimeter as well.

From the result of post test we divide the students into three different group, first those who made some improvement from their previous knowledge, second those who still struggle with the concept of perimeter and area and third those who did not join pre-test. From 28 students, 14 of them make a very well improvement, 11 of them still struggle with perimeter and area and 3 of them did not join pre-test. For those who did not join pre-test, we hardly find prove about their initial knowledge about perimeter and area but Diva made a good work on her post test, even though her other 2 friends seem still struggle as their other 11 friends.

-Discussion

The result of this post-test more or less can give description about students' progress from their initial knowledge. Statistically comparing the result of pre-test and post-test indeed we see some improvement for some students but some other also still struggle with the concept of perimeter and area.

For instance the different acceptance about the concept of area and perimeter, most of the student can count and compare the area of two different shapes; somehow many students still struggle to compare the perimeter of two different shapes. It might be happen because the idea of area in this learning series seems more real for students to be put in their logic. Even though perimeter seems to be a very simple measurement but when we put together with area, student might get it more abstract compare to area.

Even thought the main consideration in this paper is about the process of students learning but at least from this post-test we also can briefly conclude that indeed those representations of numbers (see appendix) can support the argumentation previously about the development of students' learning process.

4.3.9 General Discussion

The relation of perimeter and area become the means in this research to support students' understanding about the concept of perimeter and area. Based on the aim of this research, the learning series was arranged as such so that perimeter and area were studied side by side along the learning series. The key principles of RME serve as a basis for the whole learning series in this research. We will elaborate how that key principles underlay the activities in this research.

4.3.9.1 Guided Reinvention or Mathematizing

The first key principle of RME is guided reinvention or mathematizing. Based on this principle, teacher should give opportunity for students by guiding/ supervising them to re-invent the concept of perimeter and area by themselves. Teacher's role is very important to help the students to re-invent their own

mathematics. The following are the elaboration of teacher's role in guided reinvention or mathematizing.

1. Providing students an opportunity to present their idea

   During the group or class discussion teacher should stimulate student to present their ideas to start the class discussion. Teacher can start it by posing question to the students. During the teaching experiment we figure out that teacher posed the questions below in order to provoke students to present their idea.

   - "What is perimeter according to you?"
   - "What did you use to measure perimeter?"

2. Stimulating social Interaction

   Teacher should be able to stimulate social interaction among students. Teacher can provoke this interaction through pair work, group work or class discussion. It was proven in the observation that those students who rare to share their ideas in the class discussion were able to share it in the pair or group work. Another strategy to stimulate social interaction was posing appropriate question, as one of the question posed by the teacher during the teaching experiment below,

   "Kiki said we can use hand span to count the perimeter, how about the others?"

   Along the lesson series teacher also arranged group activities where students work in their group to cooperate in solving the problem and sharing ideas. It is important for the students to interact among their friends and also with the teacher because their learning process was not only when they study themselves but more when they share it with people and get justification from

them. As the discussion in one of the group during the teaching experiment below when one student try to respond to their friends answer.

Teacher	:	(*talking to the group*) So how you count this perimeter?
Rizky	:	(*tagging each side of sticky paper*) one, two,…seventeen
Aang	:	(*knowing that Rizky's tagging was not synchronic with his counting*) you wrong!
Teacher	:	this is how you suppose to count (*tagging each side of sticky paper*) one, two, so now you try
Arya	:	(*tagging each side of sticky paper*) one, two,… (*he did skip counting*)
Aang	:	you wrong, you missed one line. (*he showed to the group how to count the perimeter correctly*)

3. Connecting activities

To support student's learning, teacher needs to help the students in communicating and developing their ideas by elaborating upon what they already know. During the teaching experiment we figured out a discussion where teacher try to relate the previous activities with the next activities, as the conversation below.

Teacher	:	"what tools can you use to measure perimeter?"(*students mention ruler, hand span, ropes, pencil case etc*)
Teacher	:	(*show a circular shape*) "what tools can be used to measure this shape?"
Meizar	:	ribbon
Teacher	:	how about this (show rectangular shape)
Rizky	:	ruler
Teacher	:	(repeated again for circular shape) so can we use ruler to measure the perimeter of this shape?
Students	:	no..

From the conversation we can see that teacher try to relate the knowledge of students about length measuring tools with counting perimeter. Teacher tried to bring the students to their awareness that not every shape can be counted with the same tools. Teacher also wanted to make ropes as a tool that make a sense for students in the next activities that will be conducted.

4. Eliciting the mathematical concept

Cooke & Buchholz (2005) and Kolb in de Freites & oliver (2006), in Ariyadi (2009) mention that the most important objective of a class discussion is transforming students' concrete experiences into mathematical concepts. One of the examples of transforming a concrete experience into mathematical concept during the class experiment was when the teacher tried to bring the idea of region within the boundaries into measuring area.

" Do you think the region within the boundary has quantity?"

By posing a question about quantity, teacher try to direct the students to the idea that if the region has quantity then it can be measured, the next question for students will be "How can I measure the quantity of this region?" Other finding during the teaching experiment that shows how teacher tried to elicit the mathematical concept was when students use sticky paper to count the area of the photo paper below

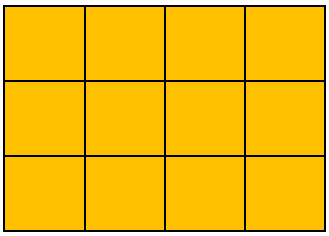


Figure 4.34 Ilustration of photopaper covered with sticky papers

Teacher : what is the area of the shape?
Aang : (counting the square one by one) twelve
Teacher : do you have any other way than count it one by one
Aang : this is 4 right (pointing to the first row), then this three (pointing to the last coloumn) so four × three equal to twelve.

5. Asking for clarification

In the learning process we need to figure out the student's thinking through their reasoning. From students' reasoning we can see their idea or strategies that can picture either their achievement or the difficulties that they face during the learning process.

During the observation of teaching experiment we found several discussions when teacher tried to clarify students' answer.

Teacher : which one has the cheapest price s? (*show 3 different rectangular shapes and stated that the smallest its area the cheapest its price will be*)
Students : B (*the biggest one*)
Teacher : how can you decide B?
Students : It's the smallest
Teacher : How can you know B is the smallest? Aang, come here, show how you get B.

In the discussion above teacher try to get the clarification from students about their answer. This becomes one of the ways for the teacher to see students' ability in expressing their idea as the benchmark of their understanding. As have been stated by Romberg, et all (2005) that expressing ideas involves communication of knowledge, either verbally, in writing or through such means as pictures, diagrams, or models.

4.3.9.2 Didactical Phenomenology

Based on the idea of *didactical phenomenology*, the teacher may find the situations that can evoke paradigmatic solution procedures that can be taken for vertical mathematization (Gravemaijer, 1994). One of the ways that teacher can do is by finding the contextual problem that allows for a wide variety of solution procedures (Gravemeijer, 1994). In this research we helped the teacher to design

the series of activities that reveal a contextual problem in which students might come with a wide variety of solutions.

A situation that is experientially real for students is used as the base for mathematical activity along the learning series. Some activities were chosen to fit the concepts of perimeter and area and are also experientially real for students; for instance, arranging shapes with wooden matches. From 10 wooden matches students can come with different shapes but often with rectangular and square form. For rectangular and square forms, to count the perimeter of the shapes, students might also come with different strategies. From the observation during the teaching experiment some students choose to count the number of wooden matches one by one, others choose to see only two sides, they add it up then multiply it by two since they know that the opposite sides has the same number of wooden mathches.

4.3.9.3 Self-developed model

A self-developed model was the last principle of RME that serves as the basic idea in this research. The whole series of activities were intended to be able to support students in making their self-developed model to understand the concept of area and perimeter. Creating picture frame from ice cream sticks, in fact, help students make a very simple preliminary description about perimeter and area. The inner part is area and the outer part (i.e ice cream sticks) is the perimeter. With their own simple description they use to memorize in their mind what area and perimeter are.

Starting to count the number of square grids to count the area and also arranging wooden matches in square grid paper then students accustom with the square grid unit in counting area. As they have to count the area of shape made from ropes, the first idea they have is to put it on the grid paper so that they can count its area. Students are also familiar with counting perimeter with wooden sticks unit or use one side of the square grid. They accustom with certain model that they use in counting perimeter and area and use it in solving problem.

Learning perimeter and area side by side along the lesson series makes them accustomed to see both aspects of perimeter and area in any shapes. When they were asked about the different between two shapes, their answers mostly go into the similarities or the difference of its perimeter and area even though some of them also pay attention to the different form of the shapes. The fact that two shapes with the same area might have different perimeters and vice versa seems help the students to be aware that area is not depending on its perimeter and vice versa.

CHAPTER VI

CONCLUSION

5 Conclusion

5.1 Answer to the research questions

This chapter will consist of the conclusion that was drawn from the whole learning series to answer the main research questions. The main research question was formulated as ”*How can exploring the relation of perimeter and area support the students' understanding about the concepts of perimeter and area”.* For answering the main research question, we have two relevant questions that make the main research question more practical and concrete. Those are:

1. *What activities can be used to explore the relation of area and perimeter?*
2. *What kinds of understanding that students could reach from the learning process?*

5.1.1 Answer to the first sub question

There are two main ideas relating to the relation of perimeter and area. Those are the idea that every time we create a fence then eventually there is a region within it, and the idea that for two different shapes with the same area then there are many possibilities of perimeter or vice versa. In this research, we designed the learning trajectory that consists of the series of activities that was expected to explore the relation of perimeter and area. We will describe briefly how an activity can be used as the tool to explore the relation of perimeter from each activity.

- Making Photo Frame

The objective of this activity is mainly as the bridge from perimeter as the outer part of the shape in the first activity to the introduction of area in the next activity. In this activity students arrange the ice cream sticks on the paper to create a photo paper. From this activity indeed we can't see much what is reveal from students mind. The only obvious happening is that there were busy to decide what shape they will create.

Somehow during the group work teacher support the students by posing some questions that lead them to their awareness of space within the perimeter and counting the perimeter as well. From the discussion in the class (see 4.2.3) we can see that Aang, for example, with the support from the teacher can answer which part of the shape that was called as perimeter and area. He notices the outer part of the shape (i.e. ice cream sticks) is perimeter and he also knows the word area already and describes it as the inner part of the perimeter. He with his understanding that define perimeter and area physically without relate it with the quantity yet.

- Measuring photo paper with sticky paper

The goal of this activity is to develop students' understanding of area as the number of materials used to cover the surface. Somehow the idea of perimeter will also be recalled by counting its perimeter by using the sides of square paper as the measurement unit.

From this activity student will both working with sticky paper for counting perimeter and area. For perimeter, they will count the number of the sides of

sticky paper and for counting the area, they will count the number of sticky paper. It was arranged as such so that with the same number of sticky paper it will result different number of the sides and vice versa. Here students figure out themselves that from 2 different shapes with the same number of sticky paper they can get different number of sides (see 4.2.4).

- Arranging shapes with wooden matches

The use of wooden matches and grid paper as the context to learn the relation of perimeter and area seems to be a rich material to use. Starting with forming as many shapes as possible from the same number of wooden matches on the grid paper then teacher encouraged the students to develop their own understanding about the relation of perimeter and area. For instance with 10 wooden matches, in fact different students have different ideas of arranging the shapes that result in different area as well.

Conversely for making any shapes with 4 squares grid area, each students may need different number of wooden matches. It leads to the understanding that for the given area, the perimeter can be different. By using wooden matches and grid paper teacher try to build awareness that for the given area it might have different perimeter and vice versa. As the example mention above that for 10 wooden matches, for instance, students can create different shapes with different area as well (see 4.2.5).

Conclusion for the first sub question

Making photo frame, measuring photo paper with sticky paper and arranging shapes with wooden matches are activities which can be used to reveal

the relation of perimeter and area. From doing those activities, students experience themselves how perimeter and area are related. By making photo frame from ice cream sticks they realize that counting the perimeter means counting the number of ice cream sticks, somehow they also wondering that there is a region within the ice cream frame. It comes into their awareness that every time they create a fence then there will be a region within it. This is the preliminary step of knowing the term ‘area’.

Comparing the area of photo paper with sticky papers then students figure out that two photo papers with the same number of sticky papers to cover its surface do not always remains with the same perimeter which in this case they use the side of sticky paper as measurement unit of perimeter. In addition wooden matches’ activity also gives rich possibilities of revealing the relation of perimeter and area. Student can arrange different shapes with the same number of matches. With 10 wooden matches for instance, each students might form different shapes which also result in different area. They realize themselves that forming two shapes with the same number of wooden matches, they might found those shapes have different area. Reversely, forming 2 shapes with four squares unit area then they might use different number of wooden matches to form it.

5.1.2 Answer to the second sub question

The goal of this design of learning series is that by exploring the relation of perimeter and area, student will gain an understanding about the concept of area and perimeter along their learning process. During the class experiment students experienced a learning series that was designed as such so that it was

expected to occupy the need of students to support their understanding about the concept of perimeter and area. As we described in chapter 2, Skemp described the understanding as recognizing a task as one of a particular class for which one already knows a rule (Skemp, 1979 in Olsen, 1981) or the ability to deduce specific rules or procedures from more general mathematics relationship, in short one knows 'how' and 'why'.

Grade 3 students have learned how to measure the length with standard and non-standard tools. Here we conclude that they already have understanding about length measurement. It was shown also when the students were able to mention the tools that can be used to measure the length of the fence for the photo frame (see 4.2.2). Perimeter itself also related to the concept of measuring length. This becomes one of the considerations that even though the learning of perimeter and area will come side by side but the introduction to the term of perimeter come in the first learning series.

From the frame fencing activity students start to experience themselves how to compare the fence of the frame by using ropes. They might not yet really know how to describe what perimeter is but we can see from their work that they have the idea of perimeter when they surround the outer part of the shapes with ribbon. They aware that to know the total ropes needed to fence the frame, they need to surround the frame with the ropes.

We found that it was not an easy task for students in grade 3 to describe perimeter in words. Somehow from the class activity and class discussion we can see that students were able to build their own understanding about perimeter. They

can show how they compare the perimeters of the frames. They can show which part of the shape known as perimeter (see 4.2.2). We can conclude here that students in grade 3 do not have to be really able to describe the meaning of perimeter in certain words. Their understanding can be seen from how they work on counting and comparing perimeter and their reasoning.

Exploring the relation of perimeter and area become the means in this research to support students' understanding in the concept of perimeter and area. Making the frame from ice cream stick was aimed to lead the students into counting perimeter with non-standard form. After making the frame from ice cream sticks then they count the perimeter with each stick as its unit measurement. The stimulation from the teacher (see 4.2.3) helps the students to be aware that when they create the frame then there is a region within it. Even though they have different word to describe it such as space, or area but we can see that students start having the idea of area.

Having the idea of area as the region within the frame then it was continued into the quantity of the region itself. When the students compare 2 different shapes which they can not just use their intuition to decide which one is bigger or smaller then they need another tools to quantify it. The use of square paper as the tools to quantify the area of shape seems really help to make the students understand about the concept of area as the total material needed to cover the whole surface. Through this activity student are able to demonstrate how to count the area with square paper unit. They can compare two different shape by

differentiate the number of square papers that cover the surface of the shapes (see 4.2.4).

In the relation of area and perimeter the fact is that two shapes with the same area might have different perimeter and vice versa. Students need to explore those relation so that they have good understanding and able to differentiate very well between area and perimeter. Working with sticky paper and wooden matches, students start to explore that relation. With sticky paper they experienced themselves that with the same number of sticky paper, two shapes can have different perimeter with the sides of the sticky paper as the measurement unit (see 4.2.4). Also when students work with wooden matches, they experience themselves that with certain number of wooden matches they were able to form several different shapes with different area. Conversely to result the shapes with certain number of square grids they can spend different number of wooden matches (see 4.2.5). From this activity, students will aware that not every shape with the same perimeter will result the same area and vice versa.

Conclusion of second sub-question

We grouped the kinds of understanding that students gained along the learning process into two different kinds. First is when students can recognize a task as one of a particular class for which they already know a rule. Second is when students can deduce specific rules or procedure from more general mathematics relationship, simply we can say they can explain how and why.

5.1.3 Local Instruction Theory of learning perimeter and area in grade 3 of elementary school

We have described in chapter 1 that the aim of this research was to develop a local instructional theory on supporting students understanding in perimeter and area through the relation of perimeter and area. Below we formulate a table to summary the local instruction theory that consist the sequence of activities and the concept for the teaching and learning perimeter and area.

Activity	Tools	Practice	Concept
Measuring the fence of the photo frame by using ribbon	Ribbon	Measuring the fence and comparing the length of the fence	Perimeter is the curve enclosing a region of a surface or the length of such a curve..
Making photo frame from ice cream sticks	Ice cream sticks	Creating frame from ice cream sticks (any shapes)	Area is a part of a two-dimensional surface enclosed within a specified boundary or geometry figure
Comparing the area of photo paper	Photo paper	Direct comparison	Area is the measure or extent of such a or part of a surface
Comparing the area of photo paper by using sticky paper	-Photo paper -Sticky paper	Indirect comparison	Area is the number of material needed to cover the whole surface
Arranging the shapes from wooden matches	Wooden matches	Arranging different shapes by using wooden matches on a grid paper	Two shapes with the same area can have different perimeter and vice versa
Arranging the shapes from ropes	Ropes	Arranging different shapes by using ropes on a grid paper	Two shapes with the same perimeter can have different area and vice versa.

Figure 5.1 Local Instruction Theory

5.2 Weakness of the research

We designed the Local Instruction Theory with the key principles of Realistic Mathematics Education as the underlying theory (see 5.2). The cyclic character in design research allowed us to adapt the experimental settings and the learning trajectory, and instructional activities are used to elicit our purpose in this study.

Somehow, the high expectation from the researcher made the design of instructional activities become very compact within a certain period of time. Each phase of instructional activity was designed in one day meeting. Most of the phases consist of group work activity, class discussion and individual work on worksheet related to the respective activity. For grade 3 students, indeed those series of activities seems too much to be achieved at once. The concepts of perimeter and area are new for students in grade 3. They need more time to perceive their own learning process. From the interview with the teacher, we got a very valuable input that the students in grade 3 feel a burden to have the learning series that consist of group work, class discussion and individual work all at once. During the teaching experiment we also figure out that students' respond was decreasing when it passed a half period of the learning duration.

Another consideration is about students' learning styles. In this study, researcher did not make any further elaboration on how students' learning styles in fact gave contribution to the process of their learning. As an example, some students found that the use of tools such as wooden matches or sticky paper really helpful for them to understand how to find area or perimeter. At the contrary some

others do not need any practical experience, they simply reading about and studying them.

It will give beneficial when we study further on students learning style so we can put appropriate approach for a particular conditions for the students which can give a better result of the study it self.

As we describe in chapter one that one of the aim of this research was supporting student's learning process to understand the concept of perimeter and area. Somehow the description and boundaries on what is so called 'support' was not being elaborated. It needs some more detail description to clarify how far we can say that some action called as support for students on their learning process.

5.3 Recommendation

Through the whole process of implementing the HLT on the teaching experiment, we have several considerations that can be recommended for further research or for educator who is interested in this particular course. We will start with the classroom organization. The class size in fact also affected the implementation of this leaning series. Students in grade 3 are children who love to play and very active. The more space for students to explore themselves will be beneficial for the learning process. We recommend putting two class teachers who in charge for the implementation of this learning series so that they can well manage the class.

The duration of the teaching experiment should become the main consideration from the very first time of designing the experiment. We recommend for the future researcher to pay attention to the duration of teaching

experiment. The time which is too short or too long will give huge effect to the result of the research itself. We also recommend a preliminary research to the intended school, first because we need to know earlier about the place where we will conduct the experiment; second we can interact and make discussion with the teacher so we can share more and get more information to eliminate any possible error/obstacles.

Concerning with the learning process itself, the choices of square sticky paper to count the area of the photo paper and also the perimeter of the photo paper seems confusing for students. Square papers to cover the whole surface of photo paper seem to make a sense for students but using the edge of the square paper to count the perimeter of the photo paper seems confusing for them. We recommend to the teacher to be critical in choosing the context as the means to help students re-invent the mathematics. Instead of using square papers we can use wooden matches and grid papers or keep the square paper context but leave it for the concept of area only.

The use of ropes to explore the perimeter and area for the shape other than square and rectangle seems to be a good idea. Somehow we have to be aware with the previous learning series we already have. If along the series students used to work with rectangle and square only and not familiar with estimation then when it comes with any shape (irregular shape) formed from ropes they will struggle a lot in making the estimation of its area and neglect the fact about the relation of perimeter and area itself.

5.4 Reflection

Looking back into this study, we can see that the domain instruction theory of Realistic Mathematics Education helped understand the significance of realistic problem situation for students. Learning the concept of perimeter and area of plane figures for Indonesian students is more to learning to memorize the formula without knowing why it works that way. They start to learn from something which is quite abstract for them because it was introduced through the means which are not connected to their real world.

In this research, we tried to bring the realistic problem situation as the starting point to learn the concept of perimeter and area. As what we have designed in the learning experiment, for instance, perimeter and area will be more real when students surrounded the edge of grid paper with wooden matches and covered a rectangular photo paper with squares respectively.

We designed the Local Instruction Theory with the key principles of Realistic Mathematics Education as the underlying theory (see 5.2). The design research paradigm used in this research is also appropriate for the purpose of this study. The cyclic character in design research allowed us to adapt the experimental settings and the learning trajectory, and instructional activities are used to elicit our purpose in this study.

Somehow, the high expectation from the researcher made the design of instructional activities become very compact within a certain period of time. Each phase of instructional activity was designed in one day meeting. Most of the phases consist of group work activity, class discussion and individual work on

worksheet related to the respective activity. For grade 3 students, indeed those series of activities seems too much to be achieved at once. The concepts of perimeter and area are new for students in grade 3. They need more time to perceive their own learning process. From the interview with the teacher, we got a very valuable input that the students in grade 3 feel a burden to have the learning series that consist of group work, class discussion and individual work all at once. During the teaching experiment we also figure out that students' respond was decreasing when it passed a half period of the learning duration.

CHAPTER VII

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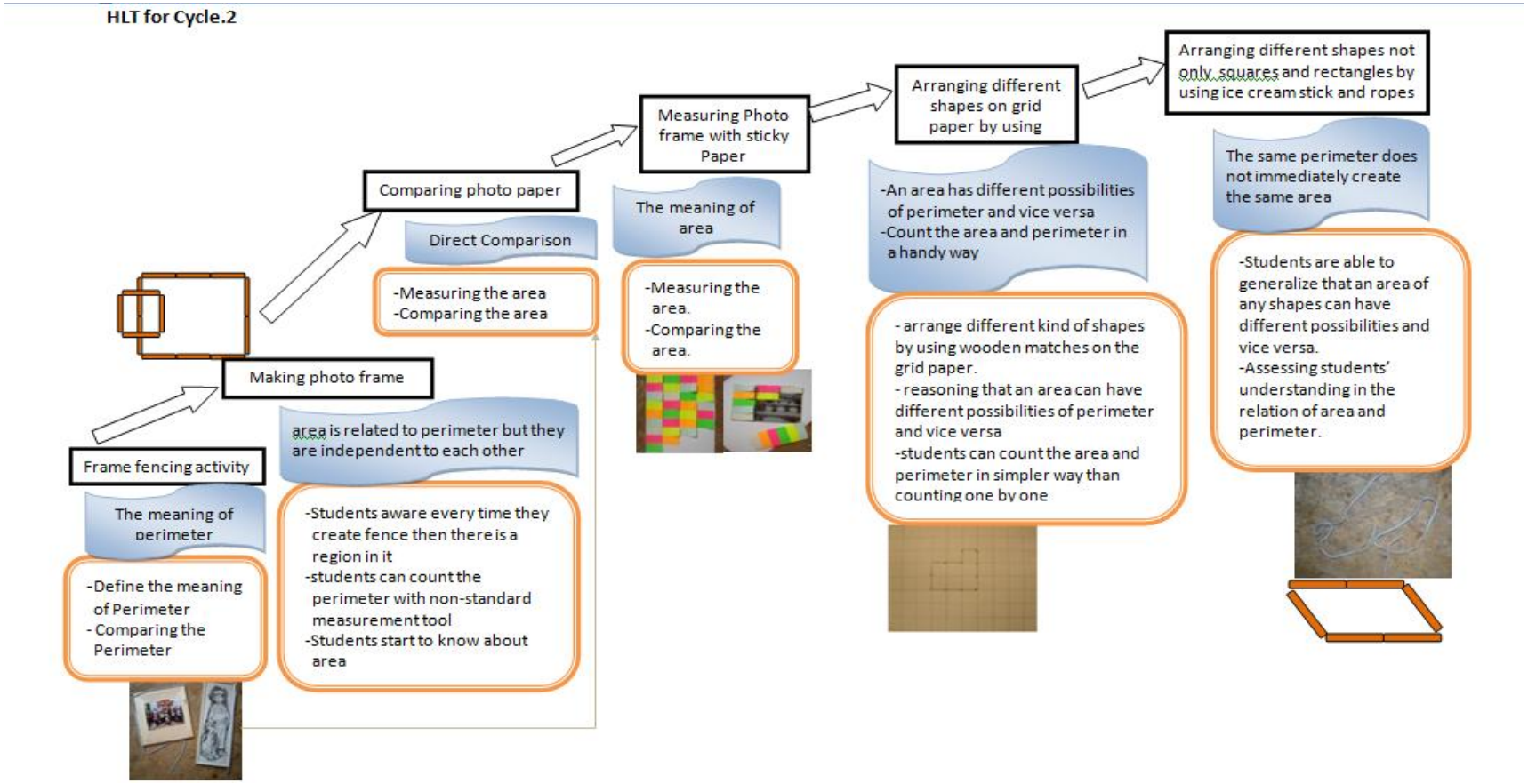
Appendix A HLT visualization



Appendix B **Lesson Plan**

Rencana Pelaksanaan Pembelajaran

Satuan Pendidikan: SDIT AT TAQWA Surabaya
Mata Pelajaran : Matematika
Kelas/ Semester : III / 2
Pertemuan Ke- : 1
Alokasi Waktu : 2 x 30 menit

Standar Kompetensi : Menghitung keliling, luas persegi dan persegi panjang, serta penggunaannya dalam pemecahan masalah.
Kompetensi Dasar : Menghitung keliling persegi dan persegi panjang.
Indikator :

- Menghitung keliling bingkai foto (persegi, persegi panjang, segitiga, lingkaran)
- Menjelaskan keliling sebagai panjang batas terluar dari bangun datar.
- Membandingkan keliling bingkai foto (persegi, persegi panjang, segitiga, lingkaran)

I. Tujuan Pembelajaran

a. Siswa mampu menghitung dan membandingkan ukuran keliling bangundatar.
b. Siswa dapat mendefinisikan dengan kalimat mereka sendiri tentang arti keliling.

II. Materi Pembelajaran

- Keliling bangun datar adalah panjang garis yang menglilingi atau membatasi suatu bangun datar.
- Keliling ditentukan dengan total panjang bahan yang diperlukan untuk mengelilingi batas terluar bangun datar.

III. Metode Pembelajaran

Tanya jawab, diskusi, tugas kelompok

IV. Langkah-langkah Kegiatan

Pendahuluan :
Apersepsi :

- Mengingat kembali materi sebelumnya tentang pengukuran panjang, pengenalan bangun datar.

Kegiatan Inti :

1. Guru akan membawa konteks memesan bingkai foto. Guru akan menceritakan permasalahan beliau bahwa harga bingkai foto bergantung pada ukuran keliling bingkai foto tersebut. Semakin panjang ukuran keliling bingkai foto maka harganya semakin mahal dan sebaliknya. Guru akan membawa beberapa bingkai foto dengan ukuran dan bentuk yang berbeda-beda dan meminta siswa untuk membantu beliau memutuskan bingkai foto yang mana yang harus dipesan agar beliau membayar dengan harga termurah.
2. Siswa akan bekerja secara berkelompok (4-5 orang). Guru akan membagikan beberapa bingkai foto dengan bentuk dan ukuran yang berbeda pada tiap kelompok. Mereka akan menghitung keliling bingkai foto dan membandingkannya, guru memantau siswa dan mengarahkan siswa yang mengalami kesulitan.
3. Guru memandu diskusi dan mengarahkan siswa agar mampu merumuskan arti keliling dengan kalimat mereka sendiri.

Penutup :

Membimbing siswa untuk merangkum materi yang telah disajikan

V. Alat/ Bahan/ Sumber

Bingkai foto (kertas karton)

Pita/tali, gunting

VI. Penilaian :

- Proses dalam kerja kelompok mencakup keaktifan siswa berpartisipasi.
- Presentasi hasil kerja kelompok

Surabaya, 14
Februari 2011

Kepala Sekolah
Kelas

Guru

Rencana Pelaksanaan Pembelajaran

Satuan Pendidikan: SDIT AT TAQWA Surabaya
Mata Pelajaran : Matematika
Kelas/ Semester : III / 2
Pertemuan Ke- : 2
Alokasi Waktu : 2 x 30 menit

Standar Kompetensi : Menghitung keliling, luas persegi dan persegi panjang, serta penggunaannya dalam pemecahan masalah
Kompetensi Dasar : Menghitung keliling persegi dan persegi panjang

Indikator :

- Membuat bingkai foto

I. Tujuan Pembelajaran

a. Siswa tahu bahwa setiap kali mereka membentuk suatu pagar maka mereka juga membentuk suatu daerah di dalamnya.
b. Siswa dapat menjelaskan dengan bahasa mereka sendiri arti luas.
c. Siswa tahu bahwa dua bangun datar dengan keliling yang sama dapat memiliki luas yang berbeda-beda.

II. Materi Pembelajaran

- Setiap pagar yang dibentuk juga akan membentuk daerah di dalamnya
- Luas bangun datar adalah suatu ukuran daerah yang dibatasi oleh garis yang mengelilingi atau membatasinya.
- Dua bangun datar yang memiliki keliling yang sama dapat memiliki luas yang berbeda-beda dan juga sebaliknya.
- Keliling berhubungan dengan luas namun tidak bergantung satu sama lain.

III. Metode Pembelajaran

Tanya jawab, diskusi, tugas kelompok

IV. Langkah-langkah Kegiatan

Pendahuluan :

Apersepsi :

- Mengingat kembali materi sebelumnya tentang menghitung dan membandingkan keliling bingkai foto.

Kegiatan Inti :

1. Guru akan membawa konteks membuat bingkai foto dari stick ice cream. Setiap kelompok siswa akan mendapat 50 stick ice cream. Guru akan meminta siswa untuk membuat 2-3 bingkai foto yang berbeda ukuran dan / atau bentuknya. Guru akan memberi contoh untuk menghindari kesalahan pemahaman tugas.
2. Siswa akan bekerja secara berkelompok (4-5 orang). Mereka bisa menggunakan semua stick atau kurang. Stick disusun sedemikian rupa dengan bentuk bebas, dilekatkan pada kertas sehingga membentuk bingkai foto.
3. Guru memandu diskusi dan mengarahkan siswa dengan memberikan pertanyaan:

" siapa yang bisa menjelaskan apa yang berbeda dari kegiatan kita hari ini dibandingkan dengan kegiatan kemarin (pertemuan-1)?"

"Apakah kalian menemukan sesuatu yang menarik dari bingkai foto yang kalian buat? Jelaskan".

Penutup

Membimbing siswa untuk merangkum materi yang baru saja disajikan

V. Alat/ Bahan/ Sumber

Stick Ice cream, kertas linen, gunting

Kertas Poster, Spidol

VI. Penilaian :

- Proses dalam kerja kelompok mencakup keaktifan siswa berpartisipasi.
- Diskusi kelas

Surabaya, 14 Februari 2011

Kepala Sekolah Guru Kelas

Rencana Pelaksanaan Pembelajaran

Satuan Pendidikan: SDIT AT TAQWA Surabaya
Mata Pelajaran : Matematika
Kelas/ Semester : III / 2
Pertemuan Ke- : 3
Alokasi Waktu : 2 x 30 menit

Standar Kompetensi : Menghitung keliling, luas persegi dan persegi panjang, serta penggunaannya dalam pemecahan masalah
Kompetensi Dasar : Menghitung luas persegi dan persegi panjang

Indikator :

- Menghitung, membandingkan dan mengurutkan luas kertas foto

I. Tujuan Pembelajaran

Siswa mampu membandingkan langsung dan mengurutkan luas kertas foto

II. Materi Pembelajaran

- Luas bangun datar adalah ukuran daerah yang dibatasi oleh garis yang mengelilingi atau membatasinya.
- Membandingkan luas antar bangun datar secara langsung tanpa menggunakan alat bantu lain.

III. Metode Pembelajaran

Tanya jawab, diskusi, tugas kelompok

IV. Langkah-langkah Kegiatan

Pendahuluan :

Apersepsi :

• Mengingat kembali materi sebelumnya tentang pengenalan luas

Kegiatan Inti :

1. Guru akan membawa konteks tentang cetak foto. Siswa diminta membantu guru untuk mencari harga cetak foto termurah. Guru akan menceritakan permasalahan beliau bahwa harga cetak foto bergantung pada luas kertas foto tersebut. Semakin luas kertas foto maka harganya semakin mahal dan sebaliknya. Guru akan membawa beberapa kertas foto dengan ukuran yang berbeda-beda dan meminta siswa untuk

membantu beliau memutuskan kertas foto yang mana yang harus dipesan agar beliau membayar dengan harga termurah.

2. Siswa akan bekerja secara berkelompok (4-5 orang). Guru akan membagikan beberapa kertas foto dengan bentuk dan ukuran yang berbeda pada tiap kelompok. Kertas disusun sedemikian rupa sehingga kertas-kertas foto tersebut dapat dibandingkan secara langsung. Namun ada juga kertas foto yang berbeda tipis antara satu dan lainnya sehingga akan memerlukan lebih banyak usaha bagi siswa untuk membandingkan. Untuk kondisi kertas foto yang sulit untuk dibandingkan secara langsung, guru tidak akan mengarahkan siswa untuk menyelesaikan pada saat itu juga, namun menggunakannya untuk bahan materi perteuan selanjutnya.
3. Guru memandu diskusi dan mengarahkan siswa agar mampu untuk membandingkan luas

Penutup :

Membimbing siswa untuk merangkum materi yang baru saja disajikan.

V. Alat/ Bahan/ Sumber

Kertas foto (kertas linen)

Kertas Poster, Spidol

VI. Penilaian :

Proses dalam kerja kelompok mencakup keaktifan siswa berpartisipasi

Presentasi hasil kerja kelompok

Surabaya, 14 Februari 2011

Kepala Sekolah

Kelas

Guru

Rencana Pelaksanaan Pembelajaran

Satuan Pendidikan: SDIT AT TAQWA Surabaya
Mata Pelajaran : Matematika
Kelas/ Semester : III / 2
Pertemuan Ke- : 4
Alokasi Waktu : 2x 30 menit
Standar Kompetensi : Menghitung keliling, luas persegi dan persegi panjang, serta penggunaannya dalam pemecahan masalah
Kompetensi Dasar : Menghitung luas persegi dan persegi panjang
Indikator :

- Menghitung luas bangun yang berbentuk persegi dan persegi panjang dengan bantuan objek lain sebagai unit pengukuran.

I. Tujuan Pembelajaran

a. Siswa dapat menghitung luas dengan objek lain sebagai satuan pengukuran.

II. Materi Pembelajaran

- Ukuran luas ditentukan dengan jumlah bahan yang diperlukan untuk menutup seluruh permukaan bangun datar.
- Menghitung dan membandingkan luas antar bangun datar dengan menggunakan alat bantu obyek lain sebagai satuan pengukuran.

III. Metode Pembelajaran

Tanya jawab, diskusi, tugas kelompok

IV. Langkah-langkah Kegiatan

Pendahuluan :

Apersepsi :

- Mengingat kembali materi sebelumnya bahwa ada beberapa kertas foto yang tidak dapat dibandingkan secara langsung.

Kegiatan Inti :

1. Guru mereview pertemuan sebelumnya bahwa ada beberapa kertas foto yang tidak dapat dibandingkan secara langsung. Kemudian guru memberikan pertanyaan:”bagaimana kalau kalian mendapati dua kertas foto yang memiliki ukuran hampir sama? Bagaimana kalian membandingkannya? Jika tidak ada siswa yang merespon, guru dapat mengarahkan dengan “ Di kelas lain, mereka menggunakan bantuan

kertas tempel untuk menghitung luas kertas foto, bagaimana kalau kita coba?"

2. Secara berkelompok (4-5 orang) siswa menghitung luas kertas foto dengan bantuan kertas tempel, guru memantau siswa dan mengarahkan siswa yang mengalami kesulitan.
3. guru memandu diskusi dan mengarahkan siswa untuk mendapatkan kesimpulan.

Penutup :
Membimbing siswa untuk merangkum materi yang baru saja disajikan

V. Alat/ Bahan/ Sumber
Kertas foto (i.e kertas linen)
Kertas temple (post it)
Kertas Poster, Spidol

VI. Penilaian :
Proses dalam kerja kelompok mencakup keaktifan siswa berpartisipasi

Presentasi hasil kerja kelompok

Surabaya, 14
Februari 2011

Kepala Sekolah Guru
Kelas

Rencana Pelaksanaan Pembelajaran

Satuan Pendidikan: SDIT AT TAQWA Surabaya
Mata Pelajaran : Matematika
Kelas/ Semester : III / 2
Pertemuan Ke- : 5
Alokasi Waktu : 2x 30 menit
Standar Kompetensi : Menghitung keliling, luas persegi dan persegi panjang, serta penggunaannya dalam pemecahan masalah
Kompetensi Dasar : Menyelesaikan masalah yang berkaitan dengan keliling, luas persegi dan persegi panjang

Indikator :

- Menyusun berbagai bentuk bangun datar

I. Tujuan Pembelajaran

-Siswa dapat menyusun berbagai bentuk bangun datar dengan menggunakan korek api pada kertas berpetak.

-Siswa dapat memberikan alasan bahwa dua bangun datar dengan luas yang sama bisa memiliki keliling yang berbeda dan / atau sebaliknya.

II. Materi Pembelajaran

- Dengan bantuan kertas berpetak dapat disusun berbagai bentuk bangun datar dengan luas yang berbeda-beda untuk keliling sama dan juga sebaliknya.

III. Metode Pembelajaran

Permainan, tugas kelompok, diskusi

IV. Langkah-langkah Kegiatan

Pendahuluan :

Apersepsi :

- Mengingat kembali materi sebelumnya bahwa keliling tidak bergantung pada luas dan sebaliknya.

Kegiatan Inti :

1. Dalam aktivitas ini, siswa melakukan permainan berkelompok menyusun berbagai bentuk bangun datar dengan sejumlah korek api yang telah ditentukan pada kertas berpetak.

2. Lembar kerja akan dibagikan kepada siswa untuk diisi sesuai dengan hasil permainan yang mereka jalankan.
3. Guru memandu diskusi dan mengarahkan siswa untuk mendapatkan kesimpulan.

Penutup :
Membimbing siswa untuk merangkum materi yang disajikan.

V. Alat/ Bahan/ Sumber
Kertas perpetak
Korek api

VI. Penilaian :
Lembar Kerja Siswa

Keaktifan siswa dalam diskusi kelas

Surabaya, 14
Februari 2011

Kepala Sekolah Guru
Kelas

Rencana Pelaksanaan Pembelajaran

Satuan Pendidikan: SDIT AT TAQWA Surabaya
Mata Pelajaran : Matematika
Kelas/ Semester : III / 2
Pertemuan Ke- : 6
Alokasi Waktu : 2x 30 menit
Standar Kompetensi : Menghitung keliling, luas persegi dan persegi panjang, serta penggunaannya dalam pemecahan masalah
Kompetensi Dasar : Keliling dan Luas bangun datar
Indikator :

- Menghitung keliling dan luas bangun datar.

I. Tujuan Pembelajaran

Siswa dapat mengeneralisasi bahwa dua bangun dengan luas yang sama dapat memiliki keliling yang berbeda-beda dan juga sebaliknya.

II. Materi Pembelajaran

- Mengeneralisasi pemahaman tentang keliling dan luas bangun datar bahwa untuk semua bangun datar berlaku hubungan antar luas dan keliling yang tidak saling bergantung satu sama lain.

III. Metode Pembelajaran

Tanya jawab, diskusi, tugas kelompok

IV. Langkah-langkah Kegiatan

Pendahuluan :

Apersepsi :

- Mengingat kembali materi sebelumnya bahwa persegi atau persegi panjang yang memiliki luas yang sama dapat memiliki keliling yang berbeda.

Kegiatan Inti :

1. Guru akan memberi tiap siswa 2 tali yang sama panjang dan siswa diminta untuk membuat bentuk bangundatar apapun dari kedua tali tersebut dengan bentuk yang berbeda. Kemudia guru memberikan pertanyaan kepada siswa" Menurut kalian, kedua tali yang kalian bentuk itu memiliki luas yang sama atau berbeda? Coba jelaskan".
2. Guru memandu diskusi dan mengarahkan siswa untuk mendapatkan kesimpulan bahwa luas yang sama dapat menghasilkan keliling yang berbeda dan sebaliknya.

Penutup :
Membimbing siswa untuk merangkum materi yang baru saja disajikan

V. Alat/ Bahan/ Sumber
Tali sama panjang (sepasang)
Kertas Poster, Spidol

VI. Penilaian :
Proses dalam kerja kelompok mencakup keaktifan siswa berpartisipasi

Diskusi kelas

Surabaya, 14
Februari 2011

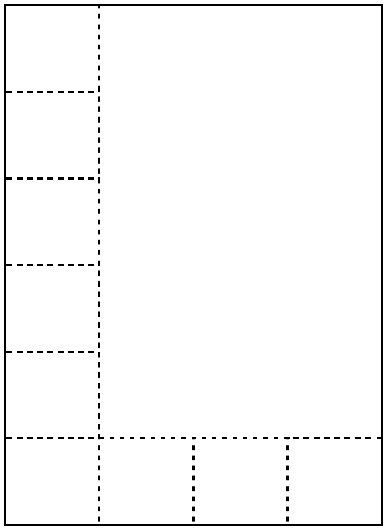
Kepala Sekolah
Kelas

Guru

Appendix C **Students' work (LKS)**

LKS I

1. Perhatikan gambar di bawah ini:

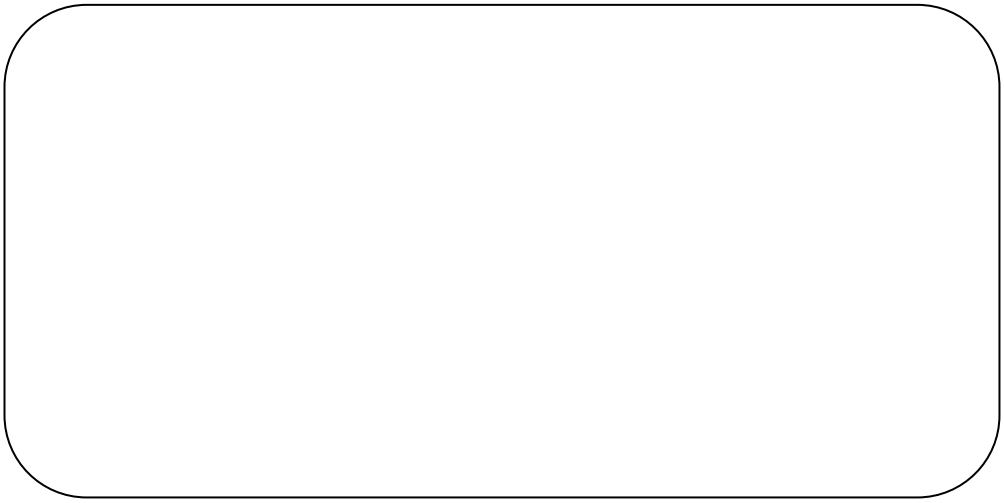


Kertas tempel persegi

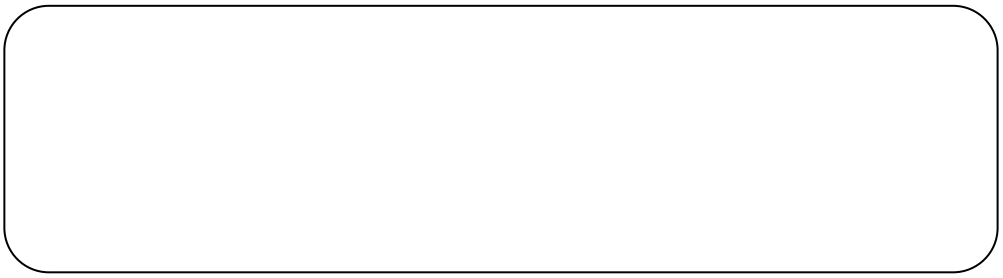
a. Jika tiap satu kertas tempel persegi berukuran sama degan tiap persegi dalam gambar, berapa jumlah kertas tempel yang diperlukan untuk menutup semua permukaan kertas di atas?

b. Berapa jumlah sisi terluar kertas tempel yang menunjukkan keliling gambar di atas?

c. Dengan jumlah persegi yang sama, susunlah gambar di atas secara berbeda. Gambarkan di bawah ini (satu susunan baru saja)



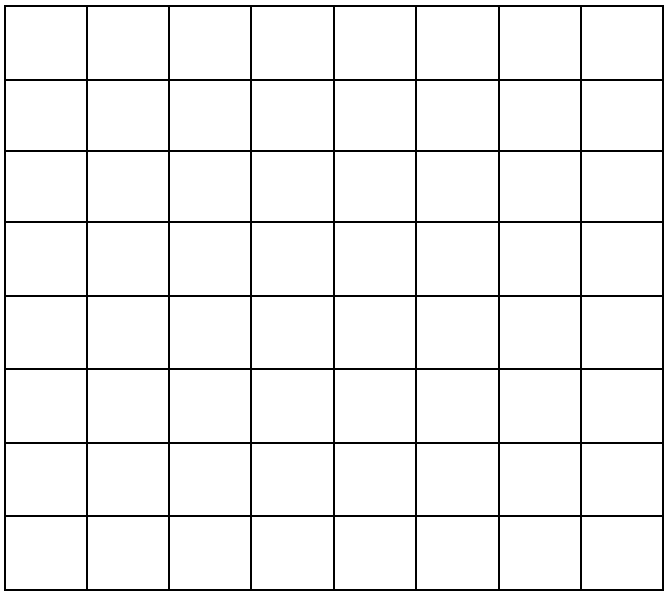
d. Apakah gambar yang kalian susun memiliki keliling yang sama dengan gambar sebelumnya?



LKS II

1. Bayangkan kalian mempunyai 10 batang korek api yang panjangnya sama dengan panjang tiap sisi persegi pada kertas berpetak di bawah ini.

a. Gambarkan bangun datar yang bisa kalian bentuk dari 10 batang korek api. (buat sebanyak mungkin)



b. Beri nomor pada tiap-tiap gambar, Gambar nomor berapakah yang memiliki luas terbesar dan gambar nomor berapakah yang memiliki luas terkecil? Coba jelaskan

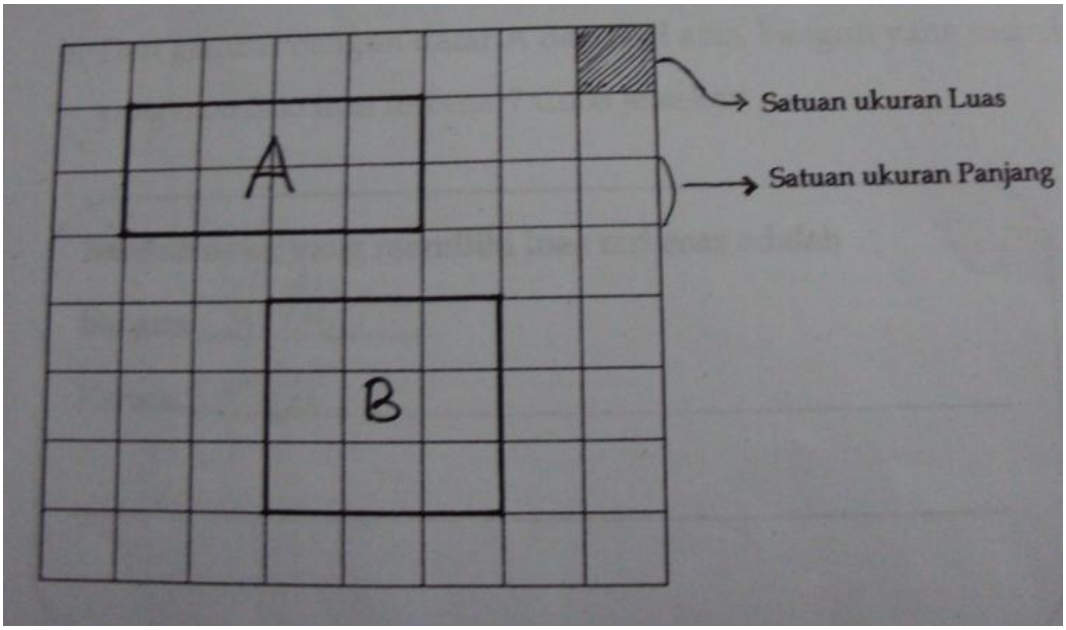
_____

c. Gambar nomor berapakah yang memiliki keliling terpanjang dan gambar nomor berapakah yang memiliki keliling terpendek? Coba jelaskan

Jawab _____

LKS III

1. Perhatikan gambar bangun datar pada kertas berpetak di bawah ini.



a. Hitung keliling dan luas bangun datar di atas, dan jelaskan bagaimana cara kalian menghitungnya.

Keliling bangun datar A = _____ Luas bangun datar A = _____

Keliling bangun datar B = _____ Luas bangun datar B = _____

Cara menghitung:

Keliling bangun datar A: _____

Luas bangun datar A: _____

Keliling bangun datar B: _____

Luas bangun datar B: _____

b. Dari gambar bangun datar A dan B di atas, bangun yang manakah yang memiliki luas terbesar? Coba jelaskan .

Bangun datar yang memiliki luas terbesar adalah

bangun _____

Karena_____

_____

c. Dari gambar bangun datar A dan B di atas. Gambar manakah yang memiliki keliling terpanjang? Coba jelaskan

Bangung datar yang memiliki keliling terpanjang adalah bangun

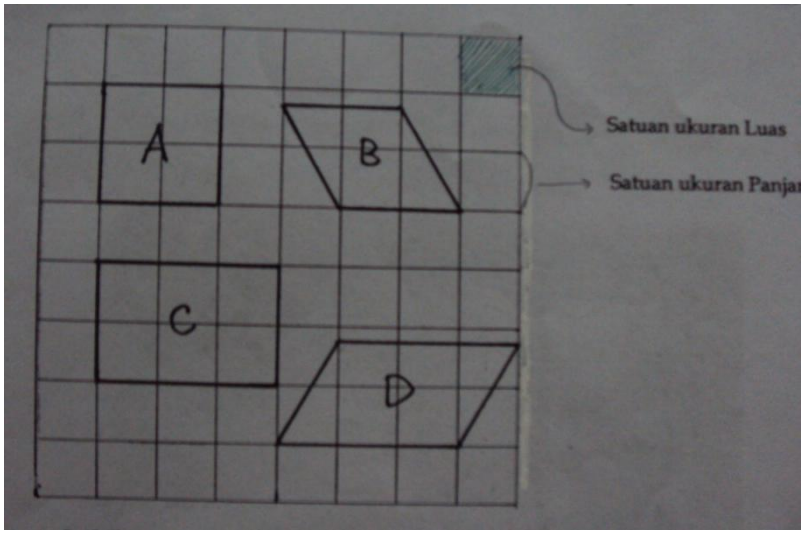
_____

Karena_____

_____

LKS IV

1. Perhatikan gambar bangun datar pada kertas berpetak di bawah ini.



a. Isilah tabel di bawah ini berdasarkan gambar di atas.

No	Keliling	Luas

b. Bagaimana cara kalian menghitung keliling dan luas bangun B dan D?

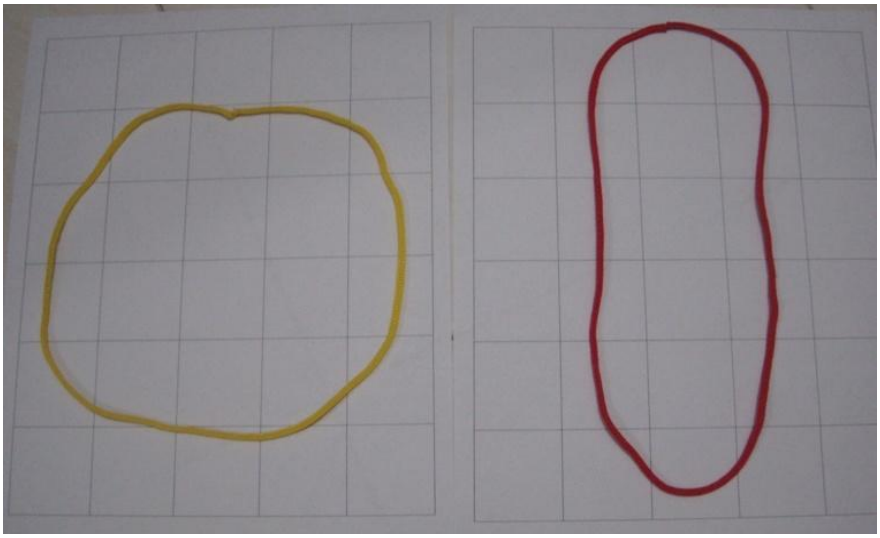
Cara menghitung keliling adalah

_____

Cara menghitung luas adalah

_____

c. Jika kalian mempunyai 2 tali sama panjang, digunakan untuk menyusun bangun datar seperti di bawah ini.



A B

d. Hitung luas bangun datar di atas. Bagaimana cara kalian menghitung luas tersebut?

Luas bangun A = _____ persegi

Luas bangun B = _____ persegi

Cara menghitung luasnya adalah

_____

_____

PRE-TEST

- Aktivitas.1

1. Dari kedua tali (merah dan kuning) yang diberikan, bandingkan panjang kedua tali tersebut.
    a. Bagaimana cara kalian membandingkan panjang tali tersebut? Coba jelaskan.

    b. Adakah persamaan atau perbedaan kedua tali tersebut? Coba sebutkan setiap persamaan dan perbedaannya.

Persamaan:

Perbedaan:

2. Bentuklah bangun datar yang berbeda dari tiap-tiap tali merah dan kuning tersebut.
    a. Perbedaan apa saja yang kalian temukan dari kedua bangun datar yang kalian bentuk? Sebutkan.

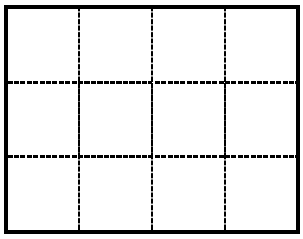
b. Menurut pendapatmu, bangun datar yang kalian bentuk itu memiliki luas yang sama atau berbeda? Coba jelaskan alasanmu.

c. Bagaiamanakah cara kalian membandingkan luas kedua bangun datar tersebut?

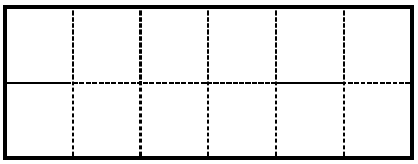
d. Menurut pendapat kalian, apakah luas itu? Coba jelaskan

- Aktivitas.2

Perhatikan gambar di bawah ini :



A



B

a. Sebutkan persamaan dan perbedaan kedua gambar di atas.

b. Bagaimana kalian membandingkan keliling gambar A dan B? Coba jelaskan.

c. Bagaimana kalian membandingkan luas gambar A dan B? Coba jelaskan.

d. Susun ulang persegi-persegi kecil pada gambar A di atas menjadi bentuk persegi atau persegi panjang baru yang berbeda. (Buat paling sedikit 2 bentuk.)

e. Dapatkah kalian menemukan persamaan dan perbedaan persegi dan persegi panjang yang baru ini dari gambar A? Coba sebutkan.

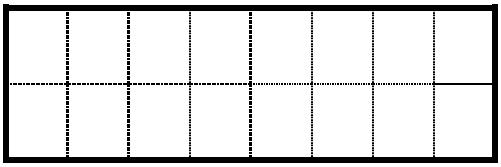
Persamaan:

Perbedaan:

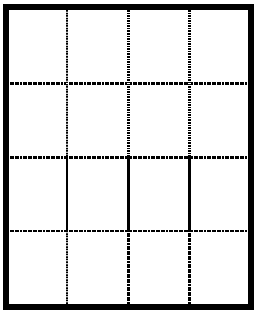
POST-TEST

- ***Aktivitas.1***

Perhatikan gambar di bawah ini:



B



A

a. Sebutkan persamaan dan perbedaan kedua gambar A dan B di atas.

Persamaan kedua gambar di atas adalah

Perbedaan kedua gambar di atas adalah

b. Bagaimana kalian membandingkan keliling gambar A dan B tersebut? Coba jelaskan.

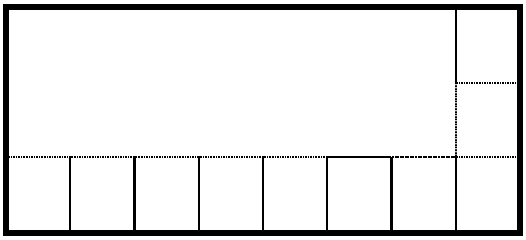
Cara membandingkan keliling bangun A dan B adalah

c. Bagaimana kalian membandingkan luas bangun A dan B di atas ? Coba jelaskan

Cara membandingkan luas bangun A dan B adalah dengan

- ***Aktivitas 2***

Perhatikan gambar berikut ini.



a. Berapakah keliling dan luas persegi panjang di atas? Coba jelaskan bagaimana cara kalian menghitungnya.

Keliling = _____

Cara menghitung keliling adalah

Luas = _____

Cara menghitung luas adalah

b. Coba jelaskan dengan kata-kata kalian sendiri yang disebut dengan Keliling dan Luas.

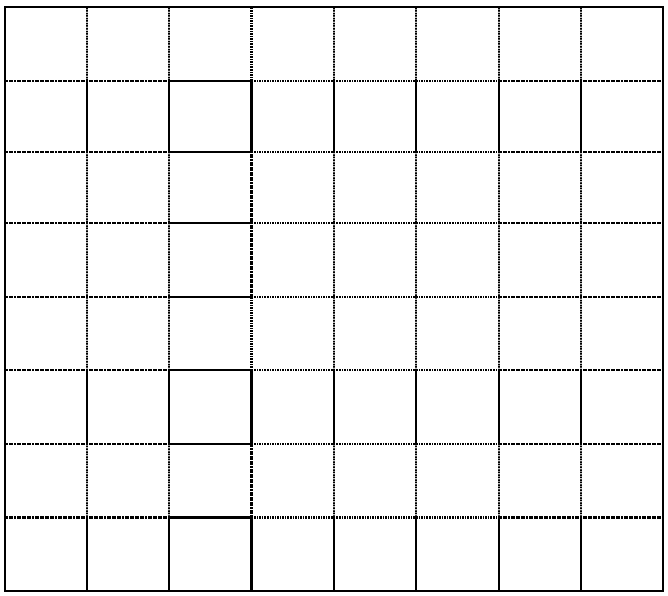
Keliling adalah

Luas adalah

- ***Aktivitas 3***

Bayangkan kalian mempunyai 8 batang korek api yang panjangnya sama dengan panjang tiap sisi persegi pada kertas berpetak di bawah ini.

a. Gambarkan bangun datar yang bisa kalian bentuk dari 8 batang korek api tersebut (buat sebanyak mungkin). Beri nomor pada tiap-tiap gambar.



b. Gambar nomor berapakah yang memiliki luas terbesar? Coba jelaskan

Gambar nomor_____ memiliki luas terbesar karena

_____

c. Gambar nomor berapakah yangmemiliki keliling terpanjang? Coba jelaskan

Gambar nomor_____ memiliki keliling terpanjang karena

_____

- ***Aktivitas 4***

1. Dari kedua tali (merah dan kuning) yang diberikan, Bentuklah dua bangun datar yang berbeda dari tiap-tiap tali (merah dan kuning), kemudian isilah tabel di bawah ini.

Bangun datar dari	Luas
Tali Merah	
Tali kuning	

2. Perhatikan tiap-tiap bangun datar tersebut.

a. Bagaimanakah cara kalian membandingkan luas kedua bangun datar tersebut?

Cara membandingkan luas adalah

b. Dari tabel di atas, bangun datar yang kalian bentuk itu memiliki luas yang sama atau berbeda? Coba jelaskan alasanmu.

Appendix D Result of Student's work

Pre-test

Question	Answer	How students work on question	Discussion on students work
Comparing two ropes 1.a How do you compare the length of those two ropes? Can you explain?	Same	We see it	6 students said that they just see the ropes to compare it. Actually most of them did more than just see, but since they did not use any measurement tools so they conclude that their activity was just see the ropes.
		Span the rope	6 students said that they need to span the ropes to see the length of it and compare it. These students actually did the same activity as the previous group. It just, this group able to describe their activity compare to the previous one.
		Measure it with measurement tools	3 students mention about measurement tools or ruler in comparing the ropes. Somehow they did not elaborate any further how they work on the measurement tools. Actually we thought that more students will come with measurement tools since they've learned about using ruler to measure length but maybe because we didn't state any measurement tool from the very first

Question	Answer	How students work on question	Discussion on students work
			place then not many of them recall their knowledge about ruler.
	Not same	With explanation: Span the ropes, then compare it whether it same or one longer/shorter than the other	10 students give further elaboration on how they work with the ropes, starting from span the ropes, compare it by using measurement tools or just see it.
1.b What do you get from comparing those two ropes	The color and the length are the same.		20 students conclude their answer from their activity of comparing the ropes.
	They are different		Johan span the rope to compare the length somehow he found that the ropes have different length. It might be happen that he made mistake in measuring.
	Circle, rectangle, square, parallelogram.		2 students mention several shapes. They might have in their mind that the ropes can be formed as those shapes they've mention
	The ropes are different or same		Bryan explain that by comparing both rope he can figure out whether the ropes same or different.
	Cut the ropes		Bryan answer that he need to cut the ropes, we don't have sufficient data to figure out why he need to cut the ropes somehow.

Question	Answer	How students work on question	Discussion on students work
2. Forming any shapes from the ropes given a. What difference that you can find from the shapes you created?	The shape are different, the sides are different, the angles are different, the area are different	Most of them mention the name of the shapes but Some said that the shapes, sides and angles are different, some give more elaboration on their answer such as explaining why the shapes are different	18 students describe the different by mention the name of the shapes that they make, here we can see that the very simple different that students can notice indeed the shapes that they make, event thought there area also some students who can mention that the sides or angles are different as well.
	The shapes are same Square and square		Two students said that both shapes are the same. Even though both shape most probably almost alike but they might see it exactly the same
	Long, average, short		Not sufficient data to support the conclusion on these answers.
	Both shapes are the same as circle it just slightly different.		Kiky can explain her work very well, she knew that her shape are almost same bit not exactly the same,
	No answer		Dony and Vira leave their work empty. Both of them actually did the activity of comparing the ropes somehow we don't have enough data to support the reason why they leave it empty.
b.Did you find the shapes have the same size or different? Give reason	Different	Because the shape and the angles are different	13 students answer that the shapes have different size, somehow their

Question	Answer	How students work on question	Discussion on students work
why those shapes have the same size or different?		Because the ropes have different length	reasoning in fact quite vary. One in common is that none of them put reasoning by measuring the area or perimeter of the shapes. They pay attention to the shapes and angles.
		Because oval is different from circle, oval is longer than circle	
		Because it's difficult to form the same shapes	
	Same	Because the length of the ropes are same	8 students answer that the shapes have the same size. The same as the answer for "different size", they put reasoning on the length of the ropes, angles and sides which are same, or they simply said it have been measured and it same
		Because the sides/angles are same	
		Because it have been measured and it's same	
		Because if it is different than we can't form it	
	some are same but some are not		This student did not elaborate more his answer. He might see in general that a lot of shapes around him, some are same and some are different
	No answer		This student leaves his page blank. He might do not understand the question or he confuse about his own answer.
c. How did you compare the size of	See it, measure it, from big and small		12 students say they see or measure

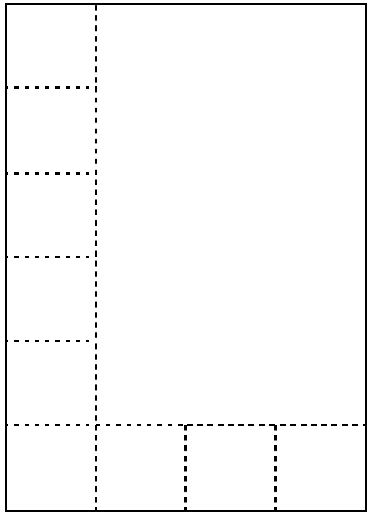
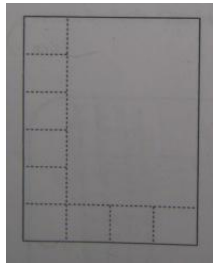
Question	Answer	How students work on question	Discussion on students work
those shapes?	Using ruler, ropes, ribbons		the shapes to compare it, and 2 students say they see it from big and small. 7 other said they use ruler, ropes or ribbon to measure. This group of students basically has the same idea that they see it, measure it using a certain tools.
	Plane figure, form it differently		These 2 students have answer that is not in line with the question. They might not understand the question given.
	No answer		2 students leave their page blank. They might run out of time or they don't understand the question given.
d. How did you describe the word 'area'? explain in your own words	Area is area		Many students seemed still struggle with the concept of area. So many different variation of answers, but we also found that some students already consider the small boxes/square inside the shape as the description of area. Others even go a little bit more formal by considering area as the left, right, up and down sides. We also found some students who still confuse or might be don't know at all, they leave the answer empty.
	Area is wide/a wide space		
	Area is large/a large space		
	If area then the area is the same		
	Left, right, up and down		
	By seeing the small boxes inside the shape		
	Because wide and area		

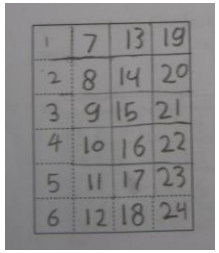
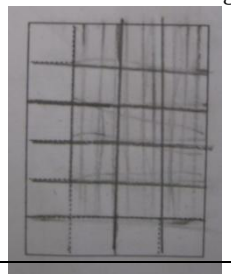
Question	Answer	How students work on question	Discussion on students work
	No answer		
Activity.2 given two different shape with grid in it a. Explain the similarities and difference from those two shapes.	Similarities: same number of boxes, number of space, Differences: the shapes are different		Many students in fact paid attetention to the boxes/squares. We can make a preliminary conclution that the use of square grid was quite logic for students. They can represent what they thought by using the square grid. They count the number of square grid to see see whether the shapes area same or not. Somehow, we also found some students who did not considetr about the square grid but more to shapes whether it looks longer or shorter.
	The shapes are same and the total are same		
	The equation are different		
	The total is 12 and the long one also 12, the differences is that box 1 has 3 rows and box 2 has 2 rows		
	A has many boxes		
	(redraw the boxes)		
	Similarities: the boxes are same Difference: the size of the boxes are different		
	A: wide, high but short B: long but short		
b. How do you compare the	A: tall-short.2		Most of the students in grade 3 still

Question	Answer	How students work on question	Discussion on students work
perimeter of picture A and B?	B: long-low		struggle in handling the question "how" describing the process was not an easy work for them. We found some students give short explanation like: measure it, see it, or count it but many students give direct answer instead of the explanation of the process.
	(re-draw the shapes)2		
	From the shapes.10		
	By seeing it/measure it/count it.5		
	By seeing the sides.2		
	A: square B: rectangle.1		
	No answer.3		
c. How do you compare the area of picture A and B?	Measure it, see it, count it.14		Same as the previous question, describing an explanation was not easy for grade 3 students. Some area able to describe very short explanation like: see it, count it and measure it but some others give direct answer without any explanation.
	From the area of A and B.3		
	A is shorter than B.1		
	No answer.4		
	The area is same		
	Because I know the meaning of area		
d. Rearrange the small squares in the picture above into a different new square or rectangle (make at least 2	Rearrange the shape.14		Most of the students can understanf the question very well, tey also able to re-arrange the shapes correctly.
	No answer.6		

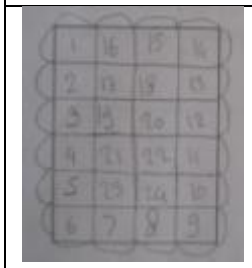
Question	Answer	How students work on question	Discussion on students work
shapes)	Re-arrange but wrong.4		Just minor students who made mistake in re-arrange the shapes and it might also miss counting the number of grid. Somehow we still found six students who leave their work empty for this particular question.
	On its side		
e. What are the similarities and differences from the new shapes? Explain it	Same shape and same number of boxes		Since every student has their own model to re-arrange the shape so we found different answer as well. Some get the shapes with the same form but with different number of square grids/boxes. Some other have the same shapes and the same number of square grid as well. Some students, somehow, leave their answer empty for maybe they still confuse with the question given.
	Different shape but same number of boxes		
	By seeing it		
	Long, short, low		
	If it's big then it's a lot		
	No answer		

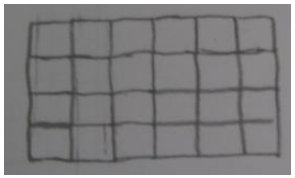
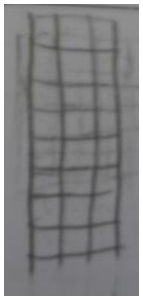
LKS-I

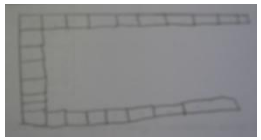
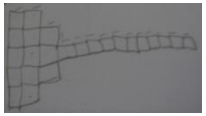
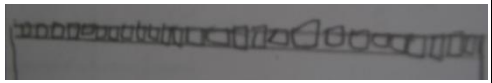
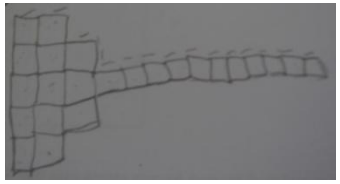
Questions	Students answer	How student works on the question	Discussion on students answer
See the picture below 	**24**	Keep the picture blank. 	5 students keep the picture blank while they try to answer the number of "kertas tempel persegi". There are some possibilities, first they can imagine the grid without drawing it so by head they can calculate the number of grid, second they aware that there are 4 square grids at the bottom rows and there are 6 stacks so it means they need 6 stacks of 4 square grids rows which is 24, last they might come to the formal one when they notice the row has 4 square grids and the column has 6 square grids so 4x6=2
		Make lines to continue the pattern of the grid	12 students make the lines to help them counting the number of "kertas tempel persegi". Then they count the grid one by one to get the total number of 24

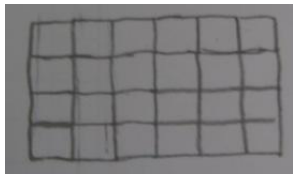
Questions	Students answer	How student works on the question	Discussion on students answer
 **Kertas temple persegi** a. If every "kertas temple persegi" has the same size as every square grid on the picture, how many "kertas temple persegi" needed to cover all the surface of the picture above.			
		Make the lines to continue the pattern of the grid then number all the grids.  	8 students make the lines to help them counting the number of "kertas tempel persegi" and put number in each square consecutively. Some of them did this because indeed they get mix up in counting if they did not put numbering but some of them just to asure them selve that they count correctly.
	25	Make the lines to continue the grid pattern. 	Jofan and Naufal made the lines to follow the grid pattern correctly and it suppose to be 24 grid squares. Somehow he might made skip counting or jumping in his counting that's why he got the final answer 25.

Questions	Students answer	How student works on the question	Discussion on students answer
b. How many outer sides of "kertas tempel that described the number of	**20**	 	17 students answer 20 for the outer sides of "kertas temple" they use their previous work to decide the number of outer side. They seems already understand that they need to count each outer side of every outer squares.

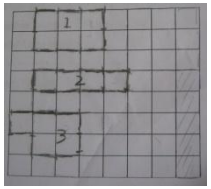
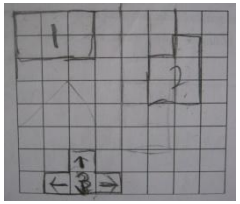
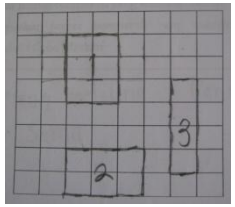
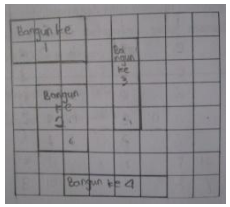
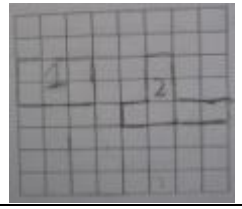
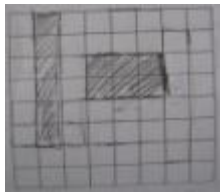
Questions	Students answer	How student works on the question	Discussion on students answer
			
			5 students make a curve in each outer sides of square to help them count the number of outer sides that represent the perimeter of the figure.
	18		Jofan and Naufal said the perimeter is 18. There are not sufficient data to conclude how they got 18 for the answer. It seems they miscalculate the square. Indeed student to do their work in hurry as well
	5		Diva wrote 5 as the answer, it seems she did not understand the question given or even she still confuse with the concept of perimeter

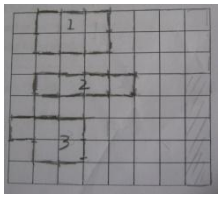
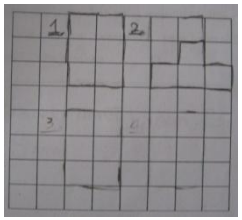
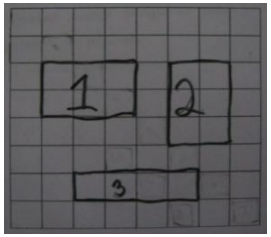
Questions	Students answer	How student works on the question	Discussion on students answer
c.With the same number of square grids, rearrange the figure above in different form.	Rectangle in 4 rows and 6 columns of square grids		18 students rearrange the form in the combination of 4x6, 3x8 and 2x12 that make a result of 24 square grids. These students notice that they have to keep the number of grids as 24 so they find other combination that result in 24.
	Rectangle in 3 rows and 8 columns of square grids or vice versa.	 	
	Rectangle in 2 rows and 12 columns of square grids	 	

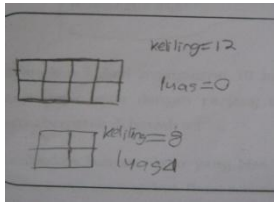
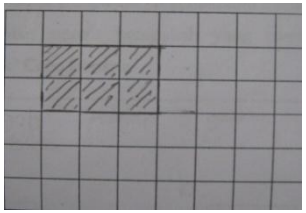
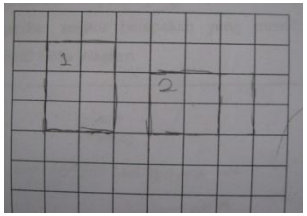
Questions	Students answer	How student works on the question	Discussion on students answer
	Random form	 	4 student make random arrangement because indeed no instruction to make it in the certain form of shape. They seems just keep arranging the square until 24 and ignoring the shape.
			3 students make random arrangement but with the total square more than 24. It seems they just miscalculate the number of grid. But one student made 80 square grids. For him the question might still unclear.
d. does the new shape that you arrange has the same perimeter with the previous one? How about the area?	They have different perimeter but have the same area	  	11 students rearrange the figure in composition of 3x8, 2x12 or random. For this reason then they could say that the figures have the same area but different perimeter.

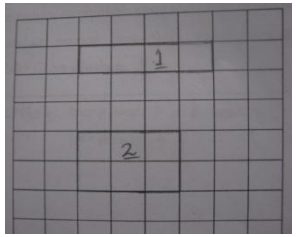
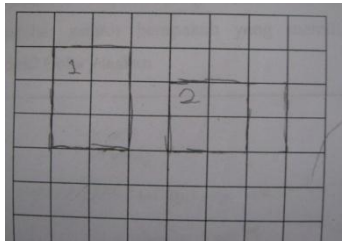
Questions	Students answer	How student works on the question	Discussion on students answer
	They have the same perimeter and area		9 students rearrange the figure in composition of 6x4 which actually the same with the first figure but horizontal. That's why they still conclude that the perimeter and area of both figure are the same. Somehow one student which rearrange the squares in random also conclude the same. This student seems to have an understanding that the same number of squares grid or area then the perimeter will turn the same as well.
	Area= 8, 20		These two students have different answer than the other. One said the area is 8 and the other one write 20. They seems still confuse where this question heading to.
	No answer		2 students leave the space blank. They seems run out of time or they don't understand the question.

LKS-II

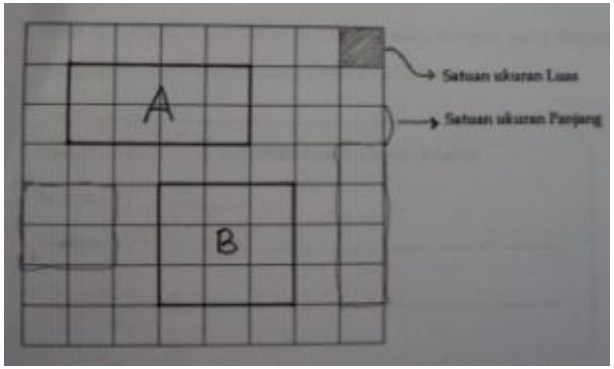
Questions	Answers	How students work on question	Discussion on students answer
Imagine that you have 10 wooden matches which its length equal to each square side on the grid paper below. a. Draw the shape that you can form from those 10 wooden matches (make as much as possible)		 	7 students draw different possibilities of shapes with 10 matches. In this activity, students do not bound themselves with the types of shape that they have learned already but more to consider the number of matches.
		 	15 students draw the interpretation of 10 wooden matches in the form of rectangle even sometimes alike rectangle but draw it vertically and horizontally. It happen because maybe these students only experience rectangle shape somehow the grid pattern might influence the students thinking when designing the shape to draw. Since it has square form then they tent to make it in the shape of rectangle or square.
		 	4 students make the drawing. Somehow they interpreted more than 10 matches on the drawing. Some of them might make some miscalculation but some of them might not clear enough with the question given.

Questions	Answers	How students work on question	Discussion on students answer
b. Put number on each figure. Which number that has the biggest area and which number has the smalles one? Explain	The biggest area is number.1, it has 6 squares. The smallest area is number.2, it has 4 squares.(Mizar)		This student has a clear description on his work. He seems understand already about the concept of measuring area by using square units. He describes the number of square that represent the area. The more number of squares the bigger area.
	Figure.1: area=6, perimeter=10 Figure.2: area=4, perimeter=10		This student has good understanding about measuring area by using square grid unit and also interprets wooden matches as the unit for measuring perimeter. He counts the number of square grid to figure out the area and he counts the number of sides to figure out the perimeter of the shapes. Somehow he didn't describe the biggest or smallest area. We can't conclude that he can't make comparison yet, he might miss out the explanation.
	The biggest area is 2 and 1 because large, long The smallest area is 3 because small, narrow		This student made good interpretation of 10 wooden matches in 3 different shapes. Somehow in describing the area of the shape, he just pays attention on how the shape looks like. He did not pay attention on the number of squares. This student seems still struggle to understand the concept of measuring area with square grid unit.

Questions	Answers	How students work on question	Discussion on students answer
			This student seems did not understand well about the question given. He can represent 10 wooden matches but for area problem he gave example of his own. But actually he has the concept of measuring area with square grid unit. We can see it from his answer that he describes very well the area based on the number of squares and the perimeter based on the sides.
	Number.2 is the smallest and number.1 is the biggest because the perimeter of number.1 is 6 and the perimeter of number.2 is 8, if we combine then it becomes 13		This student seems still struggle a lot with the concept of area and perimeter. He mixed up the area and perimeter. When he answers number 2 as the smallest and 1 as the biggest, his reasoning is mixing up between area and perimeter. If we pay attention on her drawing, picture 1 has area 6 but she said 6 as perimeter and for picture 2 he did correctly that the perimeter is 8 somehow we didn't have enough data to figure out why he decide to add up those 6 and 8.
c. Which number that has the longest perimeter and which number has the shortest one? Explain	All shapes have the same perimeter which is 10		8 students said that the perimeter for all shapes is the same which is 10. They aware that they only use 10 wooden watches for every shape that they draw.

Questions	Answers	How students work on question	Discussion on students answer
	The shortest perimeter is number.2 and the longest perimeter is no.1		6 students said that the perimeters are different. Even though they made a correct interpretation in their drawing somehow they did not aware that for each of shape they use the same number of matches which is 10. They decide the perimeter by seeing the pictures. As the picture beside, indeed number 1 looks longer than number 2 but the number of squares sides still 10. The students here still did not understand very well about the squares side as the unit measurement of perimeter.
	Number.2 is the smallest and number 1 is the biggest, because number.1 the perimeter is 10 and number.2 the area is 4 so if we put together there are 14		This student has different answer from the other. She mixes up area and perimeter as one. When he answers for number.2 he gave perimeter reasoning but for number.1 he gave area reasoning and both for the same question about perimeter. It seems he did not understand well the different between area and perimeter

LKS-III

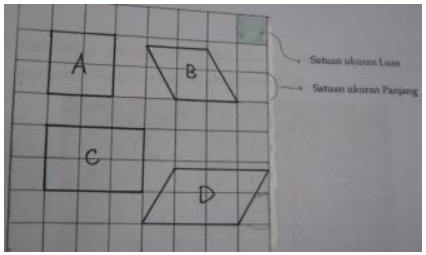
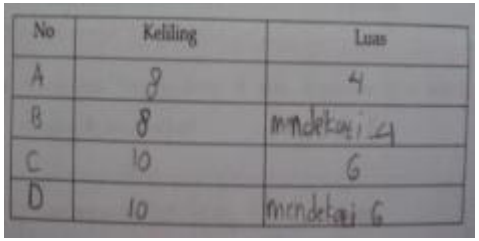
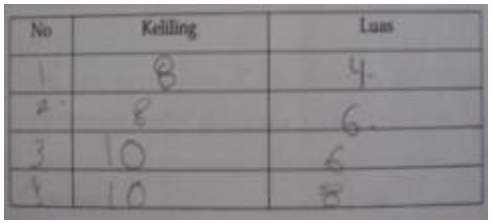
Questions	answers	How students work on question/reasoning	Discussion on students' answer
See the picture below  a. Count the perimeter and area and explain how you counted it.	Shape A: perimeter=12, area=8 Shape B: perimeter=12, area=9	Perimeter A= (2x2)+(4x2)=12 Area A= count the squares Perimeter B= 3x4 = 12 Area B=count the squares	Mizar is the only one who used quite formal way to count the perimeter. He notice that opposite sides in rectangles have the same length that's why he times it by 2 then for 4 square he also notice that all sides are the same that's why he times it by 4. Somehow he just counted the number of square to find the area instead of using multiplication.
		Perimeter A and B = count the outer sides of a shape/count the sticks Area A and B = count the number of squares	25 students have the same answers. These students understand very well the instruction given and also the information given in the question. They count the square grids to figure out the area of the shapes and they count the sides of the squares to figure out the perimeter of the shapes.
		Shape A: perimeter=12, area=8 Shape B: perimeter=12, area=9	Instead of showing how to count the perimeter and area, they just rewrite the value of

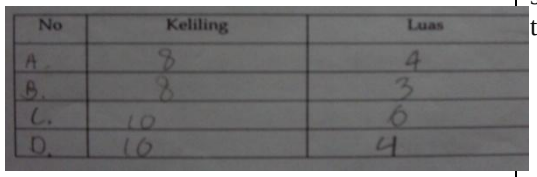
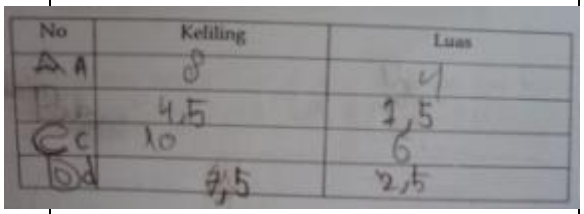
Questions	answers	How students work on question/reasoning	Discussion on students' answer
			perimeter and area.
		Perimeter=from the outer line Area= from the inner line	They give reasoning which in fact did not support their answer.
	Shape A: perimeter=12, area=8 Shape B: perimeter=11, area=9	Shape A: perimeter=12, area=8 Shape B: perimeter=11, area=9	Bryan is the only student who made minor mistakes in answering the area of shape B. he wrote 11 for the perimeter. It seems this student have good understanding already same as his other 25 friends, it just in a matter that he might be careless or skip counting the number of squares
b. From the picture of shape A and B, which shape has the biggest area? explain it.	Shape B/squares	-Shape B has the total squares more than shape A -Shape B has 9 squares but shape A has 8 squares	19 students describe that B bigger than A. They have the concept of measuring area and perimeter already. In this case they count the number of squares to count the area and count the number of sides for counting perimeter.
		-The perimeter is a lot. -long	4 students describe their reasoning that not supports their answer. They reason about perimeter when the question was about area. These students

Questions	answers	How students work on question/reasoning	Discussion on students' answer
		-big	might still mix up
c. From the picture of shape A and B, which shape has the longest perimeter? explain it	Same/A and B	-They have the same perimeter -The number of stick are same	15 students realize that both shapes have the same perimeter. They count the number of sides but some of them also still have model of sticks instead of sides of squares. It's not a problem because indeed students have their own level of understanding.
		-The sticks have the same length -The shapes area squares so that's why they're same -they have the same lines -it's smaller -long	7 students describe their reasoning that not supports their answer. For instance "the sticks have the same length/ have the same line" in this answer they might understand that it is about the same number of sides but they might get difficulties to write in on their own. Somehow for not having enough data for some answer then we have no idea why they answer that way. "it's smaller', for instance, it's not supporting the answer that both perimeter are the same.

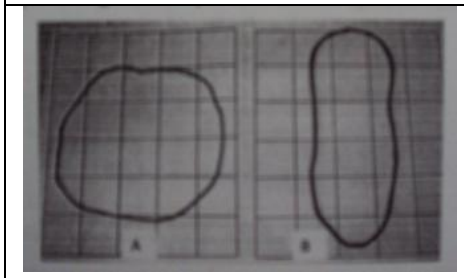
Questions	answers	How students work on question/reasoning	Discussion on students' answer
	Shape A has the longest perimeter	-The perimeter is a little -Short -The area is a little -the perimeter is long	Here the student really struggle with the idea of longest perimeter. Even their reasoning didn't support their own answer. They seems still confuse about the different of area and perimeter still.
		-The perimeter area same = 12 -same	2 student said that the longest perimeter is A, somehow their reasoning support the answer that both shape have the same perimeter. After farther elaboration then it seems students understand that both shape have the same perimeter but again they saw the physical of the shape where shape A horizontally longer than shape B. For the question is about the longest perimeter then they said that A is the longest by seeing the picture and ignoring their finding on the number of sides which area same.

LKS-IV

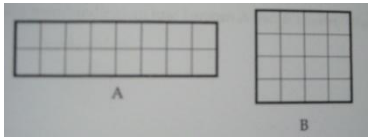
Questions	Answer	How students work on question/reasoning	Discussion on students answer
1. See the shapes on the grid paper below 		They count the whole square first then look for another squares which area not full, they try to combine those parts and estimate the number of it. For perimeter they simply count the sides of the squares.	13 students use an estimation to count the area of shape B and D, even though their estimation might be different but we can see here that they understand about how to make estimation.
		They count the number of squares to get the area of the shape. For perimeter they simply count the sides of the squares.	5 students count the number of squares and ignoring that there are some squares which are not full. As long as the squares are included then they count it as one. This student might not have the sense of estimating. It still hard for them to make approximation of certain value.

Questions	Answer	How students work on question/reasoning	Discussion on students answer
a. Fill in the table based on the pictures above		For perimeter they count the total sides of each shape, then for area they count the number of squares.	6 students have similar answer, somehow they have struggle for shape B and D. They seems made estimation but they keep write it in whole number. The data in fact did not support to figure out the more detail about uncertainty in students mind about estimation it self.
		For perimeter Johan count the sides of the squares and for the parallelogram he consider the full side first then make estimation for the sides that's not in line with the grid paper. The same for area, he counts the square and for parallelogram he made estimation that seems not quite precise.	In counting perimeter and area of shape A and C, Johan seems found no problem because he has the knowledge about it from previous discussion already. Somehow fro shape C and D he seems struggle to make good estimation
b. How did you count the perimeter and area of shape B and D?	Perimeter: count the lines Area: make an estimation	-	2 students said that they need to make estimation to count the area of shape B and D count the perimeter by counting the lines or the shapes.

Questions	Answer	How students work on question/reasoning	Discussion on students answer
	Perimeter: count the outer lines, count the number sticks, count one by one, add it up Area: count the squares, count one by one	-	Even though we found that most of students give answer in approximation for area but they said that they need to count lines for perimeter and count the squares for area.
2. If you have 2 ropes with equal length, used to form these shapes below	Area of shape A=23 Area of shape B = 18	Count the squares	They count the number of squares to get the area. Here the students ignore whether the square is full square or just a part. As long as it's including in the shape then they count it as one.

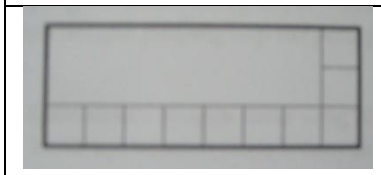
Questions	Answer	How students work on question/reasoning	Discussion on students answer
 a. Count the area of the shape above. How did you count those areas of shapes?	Area of shape A = around 15 Area of shape B = around 17	Count the squares and make estimation for some squares that are not full covered.	Some students make estimation in counting the squares because they aware that some of the squares are not full covered. The estimation is varied but the idea is that they have the sense of estimation in this calculation.

Post-test

Question	Answer	How students work on question/reasoning	Discussion
Activity.1 See the picture below  a. Explain the similarities and difference from those two shapes.	No answer .1		We divided the answers in 8 different groups. The group that has most members is the one who answer that the area/the number of squares from both shapes are same but the perimeters area different. There are 18 students from the total of 28 students. These students seem understand well which one is area and which one is perimeter and how to count it. Somehow, we still found other group who still struggle, like they describe that both area and perimeter of the shapes area same. Overall for those who still struggle in answering this question is about the perimeter, they often mix up with the idea that longer perimeter is when the appearance of the shape looks longer.
	S: P shape A = P shape B.1 D:A shape A = A shape B		
	S: area/number of squares.18 D: perimeter		
	S: the number of squares=16.1 D: the number of squares=16		
	S: - D: A has rectangular shape B has square shape		
	S: area D: shape A=rectangle, shape B: square		
	S: 16 boxes D: pic A is longer than pic B/ shape are different		

Question	Answer	How students work on question/reasoning	Discussion
	S: inside the box there are two small boxes and they are very long namely rectangle D: inside the box there 4 small boxes namely square		
b. How did you compare the perimeter of shape A and B. Explain it	By counting the lines/the outer line/the sticks/.12		There are 7 different groups of answer. 12 students explain very well that they use the outer line to count the perimeter but there are some students also who explain that they use ropes, ruler or just by seeing it to count the perimeter. We also see some students also struggle to answer this question, they even count the number of square grids to answer it or just by seeing it and decide that A is longer than B. Student who still struggle to count perimeter even until their last lesson seems still need more guidance to understand the concept. For them, it might be confusing to have the area and perimeter at the same time, or maybe for them perimeter is less abstract then area when they come together.
	By using ropes/ruler/ count one by one/measure both shape.5		
	Count the boxes/area and the perimeter/the sides.4		
	Times it:4x4=16 .1		
	P.A=20 P.B=16, not the same.1		
	By seeing it.3		
	A: 16 squares.1 B:16 squares		
	Pic.A the perimeter is longer compare to B.1		

Question	Answer	How students work on question/reasoning	Discussion
c. How did you compare the area of shape A and B. Explain it	Count inside of sides/boxes/squares.14		Overall the students have well understanding about area even though they have different way to work in comparing the area but they have the concept that area is inner part, the number of square grid cover the shape, the value of length time width. It seems the concepts of area were well understood by most of the students
	Count/see/measure it.5		
	Measure it with rope/use ruler.3		
	A: times it:8x2=16 B: times it:4x4=16		
	Differentiate		
	The area of A=16, the area of B=16, so they are same		
	Multiple The length and area then add it up		
	B has more perimeter		
	Pic.B can be counted easily compare to A		
Activity.2 See the picture below	P=22 A=24.14	P: count the sides/outer sides/sticks A: count the boxes/squares/inner part.11	For the 1st type of answer, 14 students answer it very well, they also explain how they count, most of them count the sides and square grid but there are two students who come into more formal level as using multiplication. Somehow one
		P: times the line A:times the square.2	

<table>
<tr><th>Question</th><th>Answer</th><th>How students work on question/reasoning</th><th>Discussion</th></tr>
<tr><td rowspan="7"> 

a. What is the perimeter and area of the shape above. Explain how you count it.</td><td colspan="2"></td><td colspan="2">No reason.1</td><td rowspan="7">student left without explanation.

Somehow there are some students who still struggle with the question given, those who still have problem in their spatial ability found it difficult to imagine the whole square grids from the picture given. They might know the concept of area as the number of square grids covers the whole surface but they struggle to form the next grids. But it also possible that they confuse still with the concept of area itself.</td></tr>
<tr><td colspan="2" rowspan="3">P=22

A=16.3</td><td colspan="2">P:count one by one

A: count the squares</td></tr>
<tr><td colspan="2">P: count the sticks

A: in its lines</td></tr>
<tr><td colspan="2">P: measure it

A: measure it</td></tr>
<tr><td colspan="2">P=24

A=22.1</td><td colspan="2">P: count the boxes

A: count the black lines</td></tr>
<tr><td>P=9

A=4.1</td><td>P=9

A=10.1</td><td>A:count the boxes

B: count the boxes carefully</td><td>A: count the boxes

B: count the boxes</td></tr>
<tr><td colspan="2">P=21

A=24.2</td><td colspan="2">P: count the black lines

A: complete the boxes</td></tr>
<tr><td>P=4

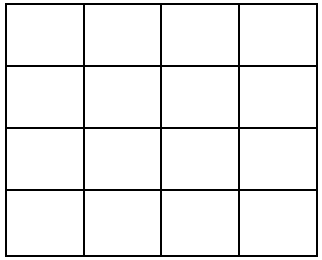
A=24.1</td><td>P=4 lines

A=4 sides.1</td><td>P: count the perimeter

A: add the</td><td>-</td></tr>
</table>

Question	Answer		How students work on question/reasoning		Discussion
			squares		
	P=10 A=8x3=24.1		P:count the partition A: multiple it		
	-	-	P=add 1+1 and on A=count the boxes.1	P=count the lines A=count the boxes.1	

Question	Answer	How students work on question/reasoning	Discussion
b. Try to explain in your words, what is perimeter and area.	P=the outer side/outer part/outside A=the boxes inside perimeter/inner part/inside.20		Most of the students have the same idea about their interpretation of the words area and perimeter. They describe those words in a matter of physical appearance of perimeter and area. Somehow one or two student also consider about area and perimeter in the matter of measuring. At the contrary one students still understand perimeter which in bahasa known as keliling into the meaning of taking around. From this answer only we can't claim that students are understand or not understand but we also need how they demonstrate the measuring activity, how they compare and how they structure their reasoning about area and perimeter.
	P= unit perimeter A= unit area		
	P= part inside the squares A= part inside the squares		
	P= count perimeter inside the lines A= count area on the lines		
	P= count the number of partition A= Area of rectangle		
	P= we count the boxes A= we count the box which contains boxes		
	P= people selling food		
	No answer		

Question	Answer	How students work on question/reasoning	Discussion
Aktivity.3 Imagine you have 8 wooden matches which its each side has the same length with the side of square grid below 	Students draw the form of rectangle and square.17 Students draw the form of rectangle and L but some also with square.6 4 students draw in random, ignoring the number of sticks		In fact almost 100% of students have no problem in arranging the picture but we can see the pattern here that most of the students tend to make the shapes of rectangle and square. It might be because from the very first introduction of this lesson they meet with rectangle and square more often than other shapes. There are some students also who make the shape in L form or even in random.

Question	Answer	How students work on question/reasoning	Discussion
a. Draw any plane figure that can be formed from 8 wooden matches (as many as possible). Number it	One student draw rectangle and square but she add one more shapes with diagonal sides		
b. Which picture has the biggest area? Explain it	14 students choose the right shape by reasoning that it has the most squares/area it the most/the most boxes, for the same number of squares they also reason it's same.		Even though almost all students able to draw the shape but to decide which shapes has the biggest area, then some students still struggle with it. 14 students make very well reasoning by saying that for he most number of square grids then it's the biggest area. Somehow, some other reason that because the shape is square then it's the biggest, for them how the shape looks like is the most important, it might still difficult for them to accept that the shape that looks smaller in fact has more number of square grids.
	5 students reason the biggest area because the shape is the biggest		
	3 students reason that the area is the biggest because it has square shape		
	One students choose the right shape but her reasoning is because it spent the most matches		
c. Which picture has the longest perimeter? Explain it	8 students answer that the perimeter remains the same because it has the same number of wooden matches		Only 8 students aware that both shapes have same perimeter, 9 others reason one shape is longer because it has longer side, 5 other
	9 students reasoning for the longest		

Question	Answer	How students work on question/reasoning	Discussion
	perimeter because it has longer sides		reason that the rectangle shape has longer perimeter and still there are 6 students that still struggle to answers. We can see here that many students still can't synchronize their spatial ability and their ability to count perimeter. It might be possible for them to understand how to count the perimeter very well but when it comes into comparing two shapes for its perimeter still they pay attention to its looking only. Perimeter might be less real for students compare to area, it seems easier for them to synchronize spatial with area than with perimeter
	5 students reasoning for the longest perimeter because the shape is rectangle		
	6 students seems struggle to answer the questions.		
Activity.4 1. Form two different plane shape from the two ropes given then fill in this table.	Only one students use estimation in his calculation		It is still difficult for the students to come into the sense of estimation when they get used to work with whole number previously. Students seems still unsure about the concept of estimation it self.
	One students answer short and long		
	The rest answer it in whole number		
2. Pay attention to each of those two plane shape a. How did you compare the area of those shape?	Count the squares/boxes		At the contrary from the first question, here students can answer very well that they need to count the square to find its area or even do multiplication for those in more formal level. If we try to link it with
	Count/measure		
	For area we do multiplication and for perimeter we add it up		

Question	Answer	How students work on question/reasoning	Discussion
	Form it in different shape		the previous question, students already know about the concept of area somehow it still difficult for them to work in estimation
	See the outer side		
b. From the data you've fill in the table. Do the shapes have the same area or different?	Different	Because it has different number of squares/boxes	Some students said that the shapes have different area but in fact they have different reasoning about it. First group said that since the number of squares is different so the area of the shapes remains different. Other group said that since the shapes are different so as the area, they ignore the number of square grids. Last group even pay attention on the ropes/perimeter of the shapes. To them, the longer the ropes, the greater the area.
		Because the shapes are different	
		Because one shape has longer ropes than the other one	
		No reason	
	Same	Because it has the same area	This group considers the shapes have the same area but they did not show how their work was. It might be possible that they miss calculate the number of the square grids or they might create two shapes that identically same.
		No reason	For this student, they might still struggle in reasoning. They just simply answer the question.

Question	Answer	How students work on question/reasoning	Discussion
	No answer	-	This students seems do not understand the questions given, or it might be because still confused with the concept of perimeter and area.