Didactical design of mathematics teaching based on gobak sodor traditional games in primary school

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Abstract. The research is motivated by the results of the preliminary study analysis that there are students' learning obstacle in the perimeter of rectangles material that makes students' understanding were low. Therefore, it is necessary to plan a didactical design to overcome the learning obstacle experienced by students. Didactic design based on traditional games is planned as an effort to preserve local wisdom. The formulation of the research problem is how to implement didactical design on the perimeter of rectangles material based on gobak sodor traditional games in primary school. The purpose of the study was to describe the implementation of didactical design on the perimeter of rectangles material based on gobak sodor traditional games in primary school. The method used is DDR (Didactical Design Research) with 3 stages of procedure, namely: prospective analysis, metapedadidactic, and retrospective analysis. Research subjects were fourth grade elementary school students. The study was conducted in two elementary schools located in Indonesia. The results of the study are learning design in the form of teaching materials in the form of student activity sheet and lesson plan which are developed as alternative learning design that can be used in mathematics learning on perimeter of rectangles material to overcome learning obstacles experienced by students.

1. Introduction
Mathematics is a subject that plays an important role in everyday life where the field of mathematics is one component of basic education in the fields of teaching [1]. This field of mathematics is needed for the calculation and thinking process required by people in solving various problems. One topic of discussion which is fully important in mathematics is geometry. Geometry is the science of measuring (metri) the surface of the earth (geo) and a branch of mathematics that was invented centuries ago [2,3]. The basics of geometry were used by Egyptians and Greeks before century to solve their daily problems, such as reconstructing land boundaries. Furthermore, Three reasons why geometry needs to be studied, as follows: First, geometry improves children's understanding of the world, which results in improving one's ability to understand pictures or diagrams in textbooks related to concepts-existing mathematical concepts [4]. Second, reasoning and communicating are two things that are closely related to learning geometry. Third, many elementary school topics and skills depend on children's spatial understanding.

Unfortunately, geometry learning in elementary school is still considered as a difficult thing for students. Lack of students' understanding of concepts, symbols, formulas, calculation processes, and place values become the common error factor for students who have learning obstacles, especially in the rectangle’s perimeter material as the material chosen by the researchers in this study. Lack of understanding of students is known through interviews and tests conducted first.
We conducted direct interviews with fifth-grade teachers and written interviews that researchers had conducted with the fifth-grade teachers of primary school. We obtained data problems in learning mathematics. One of the factors was understanding and mastering of the material in students themselves. In addition, we conducted a preliminary study of fifth-grade students of primary school who had previously studied the concept of rectangle’s perimeter in class 4th, we found several learning obstacles experienced. It is known that most students have not understood and mastered the concept of a rectangle properly.

Learning geometry can be through various ways, one of which is using traditional games. Traditional games can be easily played in a wide variety of environments and without the need for sophisticated or expensive instruments [5]. Traditional games are chosen to help students in connecting geometry with everyday life because traditional games are based on cultural values and beliefs [6]. In addition, the use of traditional games in learning as an effort to preserve cultural diversity of ancestral heritage to the next generation. Traditional games have a recreational, competitive, pedagogical, magical and religious background that are derived from the community's environmental wealth and environmental wisdom. gobak sodor is the original Indonesian traditional games originating from West Java, Indonesia. The game is a group game that is played by two groups in which each group consists of 3-5 people or more with a rectangular field guard line pattern.

Based on the background, the general formulation of the problem is how didactical design of rectangles perimeter concept based on gobak sodor traditional games. The purpose of this study is to develop didactical design of rectangles perimeter concept based on gobak sodor traditional games.

2. Methods
The research method used in this study is the Didactical Design Research (DDR) method. DDR is a Design Research application refers to both that validation study and development study. However, the use of didactical design shows that there is an emphasis on didactic aspects in learning design that refers to more micro-theory of learning. The DDR consists of three stages, namely: (1) prospective analysis, a learning design which forms a didactic hypothesis design including ADP; (2) Experiment, (analysis of meta-pedaddidactic); and (3) retrospective, an analysis that relates the results of a didactic hypothetical situation analysis to the results of the analysis of meta-pedaddidactic [7].

The planned design aims to reduce learning obstacle, particularly in epistemology. Research focuses on a plan, development, and evaluation of a design used as an alternative to solve problems that exist in educational practice. The preliminary study instrument test is carried out to find out, to explore and to identify the obstacles of student learning in the perimeter and area of the rectangle’s material as consideration in designing didactic designs. Data collection techniques are interviews, documentation, and observation. The instruments used in the implementation phase of the didactic design are student activity sheet (SAS), lesson plan, question sheet, student response scale and interview guidelines for teachers.

3. Results and discussion
3.1. The students’ learning obstacles
The preliminary study was conducted in the 5th class of primary school with the respondent number of 35 students by completing written tests and conducting interviews. Based on the results of preliminary studies conducted by researchers, it was found that learning obstacles experienced by the students in learning the concept of rectangle’s perimeter, namely: learning obstacle type 1 related to the properties of rectangle’s perimeter, learning obstacle type 2 related to calculating a rectangular perimeter, and learning obstacle type 3 related to calculating the perimeter of a rectangle based on a word problem.
3.1.1. Learning obstacle type 1. Figure 1 showed learning obstacle type 1 based on the result of the pre-research by showing three rectangles of different sizes. Students were asked to write the name of the rectangles based on the pictures presented and to write the rectangular properties. Based on the answer, the student had already known the shape and the name of rectangles. However, their answers in writing the rectangle properties were not detailed yet. The student did not write the answers in detail and accurately regarding the rectangle properties. They should write that rectangles have four 90° right angles and have two diagonal sides of the same length. It was difficult for them to write the rectangle properties in detail and accurately. It was supported by their statement when we gave the questions regarding the rectangle properties, they still had the wrong concept of rectangle properties. Students stated that rectangles have four sides without noticing the size of its sides. This obstacle was included in the epistemological obstacle it was a kind of learning obstacle caused by the limited context used when the students learned a concept at the first time.

![Figure 1. Learning obstacle type 1.](image)

3.1.2. Learning obstacle type 2. Figure 2 showed the students’ learning obstacle found in question number 3 according to the analysis result which the researcher had done. The student forgot the formula to calculate the perimeter of the rectangle that they had learned previously so that they just wrote the final answer without using the formula of the perimeter in solving the question. It was incorrect because the correct formula of the arithmetic operation was needed to answer the question.

![Figure 2. Learning obstacle type 2.](image)
Based on the students’ response on question number 3, learning obstacle type 2 experienced by the student happened since they did not understand the concept comprehensively so that they tended to forget the exact arithmetic operation formula to calculate the perimeter of a rectangle which had been learned by them.

3.1.3. Learning obstacle type 3. Figure 3 showed the students’ learning obstacle found in question number 4 according to the analysis result that the researcher had done. That was, the students were asked to calculate the length of a rectangle based on word problem presented in accordance with students’ daily activity related to gobak sodor traditional games. The student got difficulty in solving the daily life problem related to the calculation of the length of a rectangle considering the question that the researcher presented was different from question number 3. In question number 3, the length and width of the rectangle were stated in the question so that it would facilitate the students to calculate the perimeter. In contrast, in question number 4, the length of the field should be calculated by the students by only knowing the perimeter and the width of the field. Learning obstacle type 3 occurred since the students did not understand the concept of rectangles perimeter comprehensively. It happened since the students did not frequently carry out questions presented by the researcher. Thus, it impacted on the improper way of solving the question.

Figure 3. Learning obstacle type 3.

3.2. Revision of didactical design based on gobak sodor traditional games

An early didactic design was designed and developed based on the learning obstacle found and it was related to some learning theories. Didactic represent merely elements of intentionally organized and directed educational process [8]. We had previously analyzed the Standard Competence and Basic Competence before designing the learning design. The organization of the didactical design was done by the researcher by doing prospective analysis on the didactic design namely making lesson plan with hypothetical learning trajectory (HLT). The prospective analysis on the didactical design contained the preparation activities of the learning objectives, the steps of learning activities that would be held, prediction of the students’ response that would arise and the anticipation of pedagogic didactic design on the students’ response to overcome the learning obstacles experienced by the students so that the learning activities could be more well-structured. Thus, we designed a diagram from the implementation of the didactical design that had been prepared.

Furthermore, we concluded, analyzed, reflected, and revised the early design to be re-developed by designing the revised didactical design. The activities done in the revised didactical design were not
much more different than that of the early didactical design. In the revised didactical design, several things were added, they are the presentation of SAS, question context, and the prediction of the students’ responses.

The first activities intended to minimalize of learning obstacle type 1. The activities were that the students identified the shape of the field and the name of the traditional games based on the presented picture, the students identified the things having the rectangular shape, and the students identified the rectangle properties based on the hints on the picture. The second activities were playing gobak sodor traditional games, concluding the perimeter of the rectangle based on the way and rules of the games, and then calculating the perimeter of the rectangle. Through gobak sodor, students discover how to learn new things and new patterns, deal with the world, perform their tasks, and use their abilities to overcome problems [9].

The third activities were to make the students calculate the perimeter of a rectangle related to the gobak sodor traditional games in daily life. In this activities, the students analyzed a rectangle picture with the information of its length and width and did exercises that lead the students to find out the length of a window’s glass.

3.3. Students’ respond on didactical design of rectangle perimeter concept based on gobak sodor traditional games

Didactical design of rectangle perimeter concepts based on gobak sodor traditional games made the fourth-grade primary students more enthusiastic when learning took place. Primary students’ characteristics are that they like to play. We know that play is among the most important strategies for learning [10]. Thus, this didactic design was adapted based on student characteristics by creating interesting and meaningful learning activities. Students’ respond prediction that appeared in the didactic design implementation process could be generally anticipated with the formulated ADP both during the implementation of the first cycle of didactical design and during the implementation of the second cycle of revised design. The analysis was carried on based on the implementation of the initial didactic design. We made improvement in teaching materials including students’ respond prediction as well as an anticipation of pedagogical didactic to prevent learning obstacle that might arise during the learning process.

4. Conclusion

Learning obstacle on rectangle perimeter material in fourth-grade elementary school is divided into 3 types: (1) learning obstacle related to the properties of the two-dimensional rectangle; (2) learning obstacles related to calculating rectangle perimeter; (3) learning obstacle related to calculating rectangle perimeter based on math story problems.

Didactical design of rectangle perimeter concept based on gobak sodor traditional games in fourth-grade primary school make students more enthusiastic when learning took place. Primary students’ characteristics are that they like to play. Thus, this didactical design was adapted based on student’s characteristics by creating interesting and meaningful learning activities. Students’ respond prediction that appeared in the didactical design implementation process could be generally anticipated by using formulated ADP both during the implementation of the first cycle of didactical design and during the implementation of the second cycle of revised design.

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