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TEACHER'S MISTAKES RELATED TO DECLARATIVE KNOWLEDGE IN MATHEMATICAL LEARNING

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Abstract
Declarative knowledge is a crucial component of teacher expertise in education. It describes the utilization of knowledge for noticing highlights in the classroom. However, a teacher may make an error in the teaching and learning process. Therefore, we want to investigate the teacher's mistakes associated with declarative knowledge in mathematical learning. The research is a descriptive study involving a teacher in primary school. Data were collected through a videotaped, an observation, and an interview. The results showed that the teacher demonstrated the mistakes in declaring knowledge (facts and concepts) visually and verbally. The teacher did not realize her mistakes. The teacher also did not predict classroom situations.

Keywords: declarative knowledge, mistakes, mathematical learning.

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INTRODUCTION

Declarative knowledge is the knowledge of something that is described in the form of words (Miskel & Hoy, 2001). Meanwhile, Miller and Hudson (2007) define declarative knowledge as information retrieved from memory without hesitation. Whereas, Byrnes (1996) states that declarative knowledge is knowledge about facts. Based on those definitions, it can be interpreted that declarative knowledge is knowledge of facts and concepts that are usually described in words (sentences) either orally or in writing.

Anderson et al. (2001) describe declarative knowledge into two types of knowledge, namely factual knowledge and conceptual knowledge. Factual knowledge is the knowledge of the basic elements of material. Meanwhile, conceptual knowledge is the knowledge of the relationship between the basic elements of a material topic and its relation to classification, categories, principles, generalizations, theories, models, and structures.

In mathematics learning, declarative knowledge is required by the educator as the basis and substance in learning the concepts and facts of mathematics meaningfully. Declarative knowledge is essential knowledge for teachers' expertise (Seidel & Stürmer, 2014). Declarative knowledge is also needed by students to understand both facts and concepts of mathematics. Carlson and Dulany (1985) state that declarative knowledge can guide and predict implicit learning. Declarative knowledge also has an important role in the learning process, especially explicit learning (Kirkhart, 2001). Besides, declarative knowledge is a key to achieving success in mathematical learning (Miller & Hudson, 2007).

In the Australian Curriculum Assessment and Reporting Authority (ACARA), it is also affirmed that declarative knowledge for mathematics teachers is a substance of mathematics learning (ACARA, 2014). This explanation can be interpreted that the mastery of the declarative knowledge of a mathematics teacher will be the key to success for the teacher in learning the concepts in learning mathematics. Although declarative knowledge is important in mathematics learning, the problem is that teachers often disregard this declarative knowledge. Teachers regarded declarative knowledge as merely memorizing, unattractive, and unimportant knowledge.

The problems that occur in the field of education and mathematical learning today are often associated with teachers' conceptual knowledge and factual knowledge. It means that the level of declarative knowledge of teachers in mathematical learning is still low. This issue not only pressure on the mathematics education and learning system in Indonesia but also it becomes a problem for the teaching and learning of mathematics in the world.

Several studies had shown the low level of teacher declarative knowledge in mathematics learning is that some mathematics teachers only focus on teaching a procedure without explaining why the procedure works (Cohen, 2018; Ebby, 2018; Moschkovich, 2018; Newton, 2018; O'Meara et al., 2017; Swars et al., 2018). Our observation found that a primary school teacher only described the solution procedure of tasks on the blackboard without explaining. This fact is caused by the low level of teacher's declarative knowledge in mathematics.

The low level of declarative knowledge of a mathematics teacher can cause the teacher to be wrong in describing or declaring mathematical concepts learned. Ashlock (2010) suggests the two things are always associated with a conceptual understanding of declarative knowledge that often leads to errors and misconceptions in the learning of mathematics such as overgeneralizing and overspecializing. One example of overgeneralizing is giving a picture name of a triangle or rectangle based on its position. Whereas, the example of overspecializing, for instance, someone believes that the height of a triangle can only be found in a triangle or someone always has to equate the denominator when solving the addition and subtraction of fractions in mathematical learning.

Several researchers have conducted studies of declarative knowledge (Kalyuga, 2009; Seidel & Stürmer, 2014; Stürmer et al., 2013; Tanase, 2013). Tanase (2013) examined the teaching of place value concepts in Romanian first class students. Miller & Hudson (2007) found that building conceptual knowledge is a learning guide in practicing a comprehensive mathematics curriculum on all mathematical materials. Kalyuga (2009) examined the elaboration of knowledge in learning and teaching. The result of research by Stürmer et al. (2013) suggested that there are three aspects of professional ability

and vision of teachers guided by the declarative knowledge that is the ability to describe, explain, and predict the class situation. Teachers should have those three abilities to apply significant learning components and effective teaching.

Friege & Lind (2006) argue that declarative knowledge is an excellent predictor of performance problems. It includes the performance of teachers in describing the material in mathematics learning. The declarative knowledge for a mathematics teacher will be a predictor for addressing performance problems in mathematics learning. Marzano (2007) explains that a powerful way for teachers to deepen their understanding of declarative knowledge is to analyze problems and mistakes in learning. Hence, it is necessary to investigate the teacher's mistakes in delivering the material in learning mathematics.

Relating several studies about declarative knowledge, we have not found any studies that reveal the mistakes of teachers in teaching mathematical material concerning declarative knowledge. Therefore, we want to investigate the teacher's mistakes related to declarative knowledge in the mathematical learning. The finding can be used for teachers to make reflection thinking and teach mathematics well.

METHOD

The study was descriptive research using a qualitative approach. The study was conducted in a primary school located at East Kalimantan, Indonesia. The study involved a teacher who teaches mathematics in the sixth grade. The object of the study was the teacher's mistake in declaring the presentation of the mathematics material. We collected data using observation, videotaped, and an interview.

The observation was done by observing and recording the activities of the teacher when teaching a plane. This observation aims to see some teacher's mistakes regarding declarative knowledge. In the learning process, the first author recorded the learning activities. Some researchers used a videotaped to capture the central activities of the lesson, teacher and students communication, and interaction between teacher and students (Hoth et al., 2018; Kersting, 2008; Seidel et al., 2011; Van Es, 2009; Van Es & Sherin, 2008). The interview with the teacher was conducted after the implementation of her learning. This video-based interview was aimed at exploring and clarifying matters relating to declarative knowledge and the teacher's mistake that occurs in teaching a plane. We analyzed the data qualitatively.

RESULTS AND DISCUSSION

Declarative knowledge possessed by a teacher of mathematics will greatly assist the teacher in learning mathematics. Solaz-Portolés and Sanjosé (2008) explain that one of the main components of knowledge needed to solve problems in learning is factual in declarative knowledge. The following is described the teacher's mistake regarding declarative knowledge in learning mathematics. In this study, we conducted observation during the learning and interview on the subject (teacher) after the learning by using the validated observation and guidance format of the interview. The data were processed and analyzed after observing the teacher. It was known that in describing/writing problem solving related to the area and the perimeter of a plane, the teacher did not pay attention to factual and conceptual matters. Even in describing and writing the solving problem, the teacher was misunderstood and experienced misconceptions. The teacher misrepresented the delivery of concepts and facts about the area and the perimeter of the plane in writing.

In describing the oral presentation of the concept, the teacher explained by declaring that "to determine the area of a plane as shown in Figure 1, we must divide it into three regions consisting of one square and two congruent triangles. " Based on the teacher's explanation, it appears that there was an error in describing the concept of "square", both oral and written. The rectangle with sides 10 cm and 15 cm was regarded as the square. The statement is wrong. The error is shown by the video recording passage during the lesson.

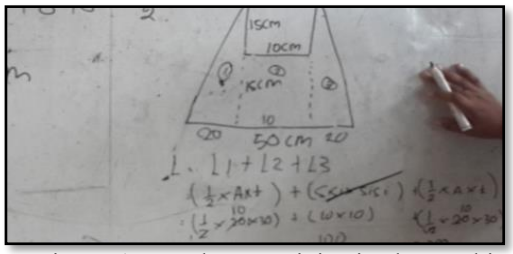

Figure 1: Teacher's activity in the teaching area of a plane

In finding the area of a plane in Figure 1, the teacher said that we have to divide the area into three regions consisting of one rectangle and two triangle regions congruent. It can be concluded that the teacher has made a mistake of mislabelling the square concept. Thus, the teacher's expressions of one square area and two congruent triangles are inconsistent with the facts. It means the teacher has described/declared a concept that is inconsistent with the fact of the concept.

In describing the perimeter of a pentagon, the teacher declared that "to determine the perimeter of the plane, we can divide the plane become 3 regions consisting of 1 rectangle area and 2 congruent right triangles with size: hypotenuse 8 cm, height 6 cm, and base of each triangle 4 cm as shown in Figure 2." Based on this evidence and video analysis, the teacher made a mistake again. In this case, the teacher "misrepresented/wrong declared the concept and principle of Pythagoras in writing as well as orally." Based on the results in Figure 1 and Figure 2, the teacher made a mistake in describing/declaring the delivery of the area concept and the perimeter of a plane with words, sentences, and figures either in writing/drawing or orally/verbally in mathematical learning.

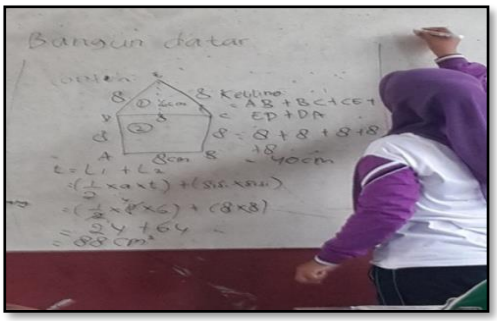

Figure 2: Teacher's activity in describing/writing and communicating a perimeter of a plane

The teacher regarded triangle with sides 8 cm, 6 cm, and 4 cm is a right triangle. The two right triangles can be seen in Figure 3. The teacher also declared the Pythagoras' principle wrongly associated with the right triangle. This phenomenon is a misconception of teachers in the teaching area and perimeter of a plane.

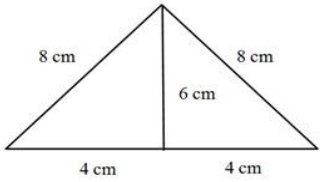

Figure 3: Two right triangles presented by the teacher

During the lesson, the teacher was unaware of any mistakes made or misconceptions occurring in declaring the area and the perimeter material. The teachers' mistakes were reinforced by the teacher's voice recording at the time of declaring a mathematical material in learning and excerpts of interviews between the first author and the teacher after the lesson. Based on the interview excerpts, it can be interpreted that the mistake made by the teacher in teaching area and perimeter is not temporary mistake Still, it is an action done with overconfidence and sense of reflective thinking.

These mistakes indicated that the teacher's declarative knowledge was low and will cause the student's errors (Jacob et al., 2017; Schenke & Richland, 2017). The teacher did not realize her mistake because during the learning, she did not predict the class situation. In the teaching area and perimeter of the plane, the teacher did not think deeply and did not pay attention to what the student thinks and will do with his description in delivering the area and perimeter of the plane both written and orally. The teacher did not make a reflection to inquire about her mistake. Reflective thinking can be used by someone to make an investigation the error (Syamsuddin, 2020). The teacher's understanding is not meaningfully. This is in line with some studies that reported participants' understanding is not focused on deep understanding (Rofiki, 2015; Rofiki et al., 2017).

Teachers play a vital role in organizing the learning process effectively and efficiently (Suryani et al., 2020). To producing effective learning, teachers must understand and be able to implement their declarative knowledge in mathematical learning. This is in line with the ideas by some scholars (Seidel & Stürmer, 2014; Stürmer et al., 2013) who assert that three important professional vision and abilities depend on declarative knowledge and must be possessed by teachers to apply pedagogical content knowledge effectively and significantly, namely the ability to describe, explain, and predict the class situation. The teachers should be able to master the material and the precise learning strategy so that they can provide scaffolding to students who experience difficulties (Anwar & Rofiki, 2018).

CONCLUSION

To conclude, the teacher made mistakes in the teaching area and perimeter of a plane. The teacher's mistake was shown by describing the concepts and facts of the area and perimeter of the plane inappropriately. The teacher also gave the wrong explanation. Moreover, the teacher did not predict the class situation. The teacher had low declarative knowledge of the facts and concepts of square, two congruent regions, and Pythagorean principle. For the learning implication, it is crucial for the teacher to have good declarative knowledge so that teaching conduct appropriately. For future study, it is imperative to examine the characterization of teachers' declarative knowledge.

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Conflict of Interests

The authors declare no conflict of interest.

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