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Challenges and opportunities in applying scientific approach: The case of mathematics learning

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Abstract. A scientific approach provides opportunities for students to organize student learning experiences in a logical order. Some previous studies results indicated that mathematics teaching strategies using a scientific approach could improve students' learning achievement. However, teachers still experience difficulties in implementing mathematics learning. Therefore, this study wants to uncover teachers' obstacles in implementing mathematics learning with a scientific approach. This explorative study involved 19 mathematics teachers in Aceh Besar, Indonesia. The study approach used is qualitative. Data were collected through observations, interviews, and field notes. The results showed that the dominance of teacher obstacles was a mastery factor in the concept of a scientific approach and classroom management. Some teachers also have difficulties in designing and implementing mathematics learning with a scientific approach. The teacher still feels confused about applying all the five steps of the scientific approach.
Keywords. *Mathematics Learning; Scientific Approach; Teachers' Obstacle*

1. INTRODUCTION

Teachers must play a crucial role in the process of teaching mathematics. In the 2013 curriculum, an approach used in the teaching process is a scientific approach. Teachers should have the chance and opportunity to apply a scientific approach. Teachers can optimize learning in the classroom to improve the quality of education, especially students' achievement or competence.

Teaching strategies using scientific concepts can enhance students' achievement (Chang & Mao, 1999; Zakaria & Iksan, 2007). The principle of teaching mathematics is the teacher's confidence that can give a positive impression of the teaching process in the classroom (Skott, 2001). Continuous reflection on teacher teaching is one way of fostering teacher professionalism to promote a learning community (Cáceres, Chamoso, & Azcárate, 2010; Ho, Lee, & Teng, 2016). The value of teaching mathematics teachers is the personal virtue relating to expertise by considering the benefits for their thinking and acting in terms of the interests of the mathematics teaching process (Leu, 2005). Teachers must play an essential role in the teaching process that refers to the syllabus, learning models that are following the mathematics material to be taught, textbooks, and teacher's manuals (Permendikbud, 2014). Then the teacher also needs to get guidance on how to direct students to be willing and able to ask questions. Also, teachers accompany students to learn (starting from monitoring their learning progress, giving good feedback, and motivating students to foster creative ideas according to their ability) to be able to carry out learning as expected in 2013 curriculum.

According to Alemu (2010), active learning is about learning to do a task, do or carry out an action. Learning with a scientific approach is a learning process that is designed in such a way that students actively construct facts, concepts, laws or principles through 5 stages: observing, questioning, collecting data, associating the data, and communicating the data. Dewey state that

active learning is a form of learning that allows students to play an active role in the process of teaching and learning, which is useful in the way of interaction between students and teachers in the learning process (Castronova, 2002). Learning through a scientific approach is intended to provide understanding to students in knowing and understanding various materials using a scientific approach, that information usually comes from anywhere, anytime, not dependent on one-way information from the teacher. The expected learning conditions created are directed to encourage students to find out from various sources through observation, and not just being told. In this study, we want to investigate the teachers' obstacles in applying mathematics learning with a scientific approach.

2. METHOD

The type of this study is explorative research with a qualitative approach. The participants of the study were 19 mathematics teachers who teach in junior high school at Aceh Besar, Indonesia. We coded each teacher by T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15, T16, T17, T18, and T19. Qualitative research is a comprehensive study and the selection of participants is expected to provide in-depth information (Gay & Airasian, 2003). Qualitative data is based on the fact that the source of the description and explanation of the process in context (Johnson & Christensen, 2000). Whereas Miles & Huberman (1994) suggest that qualitative data has three important characteristics, namely: (1) maintaining the flow of events and identifying the causes and effects of an event more accurately; (2) a data can be obtained by analyzing qualitative in addition to improving the performance that is already available, and (3) the results of qualitative research findings are more convincing because the data are strong, lively and meaningful statements, compared only with the interpretation of quantitative data.

Data collection was carried out in four ways, namely observations, interviews, and field notes. Observations were made using a video recording device, in addition to field notes and documents collected by the researchers. Observation is an event as a whole without specifying what should be considered in detail (Johnson & Christensen, 2000). Observation is used to study deeply about a phenomenon that occurs in natural conditions. Through observation, researchers record all events that occur in class. During the observation, the researchers observed the situation and recorded all information during the teaching conducted by the research subjects. The researchers also conducted interviews with research subjects. During the interview, the researchers recorded with an audio recording device. Field notes are crucial for data analysis purposes and help researchers build questions during interviews (Kawulich, 2004; Liamputtong, 2009). According to Johnson and Christensen (2000), verbal quotes are involved with real explanations about language as dialect and personal intent while explaining how the subjects' think and empathize with issues from their experience.

3. RESULTS & DISCUSSION

Researchers conducted interviews before and after teaching. Besides, researchers also see the lesson plan used for teaching. The lesson plan describes learning procedures to achieve a basic competency set in the content standards and have been stated in the syllabus. There are objectives and benefits of making lesson plans that are to provide the main foundation for teachers and students in achieving basic competencies, and indicators that provide an overview of short-term work references. The lesson plan, which involves systematic planning, influences individual student development because it is planned carefully before learning. Preparation of lesson plans is very vital

and must be carried out by the teacher before implementing the teaching and learning process because the lesson plans are made clear about instructional objectives, material planning, planning tools, steps, and learning procedures to achieve these goals. However, in its implementation in the field, there are still teachers who have not fully implemented the procedures for making lesson plans before implementing the learning and teaching process. The teacher who implemented mathematics learning with the scientific approach can be seen in Figure 1.

Figure 1. The situation of implementing the scientific approach in the classroom

This study found that teachers who have implemented mathematics learning with a scientific approach. In this article, the teacher chosen to describe the learning process is T1. In the teaching process, T1 is capable at carrying out mathematics teaching with a scientific approach. The steps of the scientific approach are observing, questioning, collecting information, associating information, and communicating everything is done. In the observing step, students are given a case about Nani who give a doll gift to her friend. The doll is put into a box and then it is wrapped with paper. The size of the box is 30 cm, and the size of the wrapping paper is $50\ cm \times 60\ cm$. The wrapping paper is sold per roll, where each roll contains one paper. In the questioning step, there were some questions from students. The students' questions were focused to determine the amount of paper needed and find the surface area of the box. T1 came to group discussion and noticed some students in collecting data. This students' activity was done to solve the problem based on information that has been given on how to determine the amount of gift paper Nani needs. Besides, T1 also goes around looking at group discussions, if anyone experiences difficulties or problems, then T1 will repeat the explanation, so that the group understands and can solve the problem. In the associating step, students wrote the steps of solution and wrote the conclusion about the relationship between the amounts of gift paper and the size of the box. T1 asked students to complete the student's worksheet. In the communicating step, students wrote a surface area of the box. Also, students presented the results of group discussions, and the other groups responded the discussion. Furthermore, students complete the individual test.

Teachers feel challenged in applying mathematics learning with a scientific approach. This is an opportunity to practice the knowledge and theories of learning that have been obtained, primarily related to the application of scientific approaches in mathematics learning. Even so, teachers

experienced obstacles in the process of their implementation. The teacher felt less familiar and had difficulty in implementing the steps of the scientific approach. The teacher has problem in motivating students to question the material they have learned. The teacher could not encourage students to pose critical or creative questions. Lesson plan that has been designed by teachers sometimes do not match the activities that occur in class. The teacher must have spontaneous anticipation in handling classroom management so that the learning process is successful (Meier, Zimmermann, & Perrig, 2006; Tzur, 2019). Spontaneous action anticipation is needed to support students' understanding. Therefore, teachers should be able to prepare spontaneous activities in solving problems that arise in class. However, some teachers were very confidence in implementing mathematics learning with a scientific approach. Teachers' beliefs or confidence can guide students' development of knowledge (Stipek, Givvin, Salmon, & MacGyvers, 2001; Wood, Cobb, & Yackel, 1991).

4. CONCLUSION

To sum up, teachers have opportunities and challenges in applying the scientific approach. They understood the concept of a scientific approach. However, there were obstacles in implementing mathematics learning with a scientific approach in the classroom. Several teachers were confused in applying all steps of the scientific approach. Also, they had difficulty in carrying out the questioning step, especially stimulating students' in making higher-order thinking questions. Teachers can overcome the obstacle by following activities of scientific approach socialization, attending workshops, and following coaching mathematics learning with a scientific approach. They should be creative and innovative in implementing learning with a scientific approach. For the next study, it is imperative to investigate the effect of implementing mathematics learning with a scientific approach towards students' higher-order thinking, especially critical and creative thinking.

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