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A P Wijaya*, T Yunarti and M Coesamin

Department of Mathematics Education, Faculty of Teacher Training and Education, University of Lampung, Bandar Lampung, Lampung, Indonesia

*Corresponding author's email: agung.wijaya@fkip.unila.ac.id.

Abstract. In order to achieve learning objectives optimally, learning is designed with attention to students' learning obstacles. The purpose of this research was to analyze the obstacles of junior high school students in understanding proportion. The subject of this research was 87 students of grade 7 at one of junior high school in Bandar Lampung, Lampung, Indonesia. This study used a qualitative method. The data of this research were obtained through test and interview. Based on the results of the research, 75.86% of students have obstacles in understanding proportion. The obstacles include ontogenic obstacle, epistemological obstacle, and didactical obstacle. The dominant obstacle that was appear was the didactical obstacle.

1. Introduction

Mathematics is one of the important subjects in education. If education is like a machine, then mathematics is one of the most important components to drive the machine. Mathematics is a science that is widely applied in other sciences. In other words, mathematics became the parent of the development of other sciences.

Mathematics learning that occurs in the classroom is basically a series of activities undertaken by teachers and students in the activities of teaching mathematics materials using educational facilities to achieve the goals set in the curriculum. Basically, the learning of mathematics relates to teachers, students, and mathematics matters [1]. Mathematics learning aims to prepare students to learn mathematics as a mind set in daily life and mathematics as a science. This task is certainly on the shoulders of a teacher who transferred mathematics materials to students. In learning mathematics in general, students are required to not only be able to understand a mathematical concept but also must be able to use the mathematics to solve problems more complex in real life.

Referring to the core and basic competencies that students must achieve, the scopes of mathematics material are algebra, measurement and geometry, probability and statistics, trigonometry, and calculus. One of the materials in learning mathematics that is important to learn is proportion. This is one concept that is closely related to the problems in daily life. The proportion is a concept that studies the process of comparing two kinds of magnitudes and has the same unit. The concept of proportion in grade 7 of junior high school discusses direct and indirect proportion. The direct proportion is a proportion of two magnitudes when one of the values of magnitude is greater than the value of the other magnitude will be greater and vice versa. The indirect proportion is a proportion of two magnitudes when one of the values of magnitude is greater than the value of the other magnitude will be smaller and vice versa.

In fact, the concept of proportion is one of the most difficult concepts for students to understand. Misconceptions that occur in students in understanding proportion include unit conversion, division

operations, fraction of value, concept of direct and indirect proportion [2]. Furthermore, the tendency of misconception occurred due to practical aspects, preconceptions, false intuition, students' comprehension ability, and incomplete reasoning [3]. One of latest research indicated that most students did not able to understand the proportion concepts well and had difficulty to solve the problems related to proportion in the different context [4].

Looking at the results of these studies certainly did not rule out the possibility of other difficulties experienced by students in learning the concept of proportion that has not been identified and sought the solution. The difficulties faced by students will certainly be an obstacle for students in learning the proportion in their entirety.

As an educator, there is an inner urge to solve the problem. To be able to solve the problem properly, the first thing to do is to examine and identify the students' difficulties in the learning process. The difficulty faced by students is known as learning obstacle. The emergence of obstacle learning as proposed by Brousseau is caused by three factors, namely the ontogenic obstacles (learning mental readiness), didactical obstacles (the way of teaching of teachers), and epistemological (the limited of students' knowledge about the application of context) [5]. Learning obstacles are categorized into three types: (1) ontogenic obstacles are obstacles to development. The obstacles associated with the stage of mental development of students according to age and biological development. Sometimes, students have lacked the necessary capacity for age-related cognitive goals. If the deficiency is only because of the slow mental development (and not for the pathological situation) then it will disappear together with its growth, (2) didactical obstacles are obstacles that arise as a result of learning options related to the education system. This limitation can be avoided through the development of alternative learning approaches, and (3) epistemological obstacles are the obstacles that arise from learning approach derived from the concept itself [6]. The epistemological obstacles can be construed as faulty ways of thinking but such a perspective ignores their importance, their developmental necessity, and their productivity in specific settings [7]. Brousseau has explained the relationship between learning and the mathematical structure of the learning content [8]. Contrary to the didactical obstacles (which is caused by the way of teaching), Brousseau has created the idea of the epistemological obstacle to obstacles that are rooted in the structure of the mathematical content itself, in the history and development of the application.

Many experts have then discussed the epistemological obstacles. The epistemological obstacle is visible errors of response or the response of students in answering the question or assignment of teachers [6,9]. The epistemological problems occur both in the history of scientific thought and the educational practice [9-10]. According to the epistemological obstacles cannot be avoided and important than the knowledge that will be acquired by a student. However, epistemological obstacles directly related to the student should be minimized in order to avoid the leap of information or knowledge acquisition. If the information jumps experiencing obstacles then their epistemological obstacle. Epistemological obstacles to scientific knowledge can lead to stagnation, and even a decline in a person's knowledge [6,11]. In building knowledge, a student should be based on a concept which is the beginning of their experience or knowledge. Definition of concepts embedded in the student must correct concepts that later became their initial knowledge in building new knowledge back. Some act of understanding is the act of overcoming obstacles epistemological and some act of understanding can be turned into action to obtain a new epistemological obstacle [12]. In line with what has stated earlier that the experts' epistemological barriers are obstacles that cannot be avoided, the error is a process to determine (knowing). Overcoming obstacles epistemological and understanding are two complementary images of the unknown reality of important changes in the human mind.

Based on the description, the researcher is interested to identify student obstacle learning on the comparison material. The results of this study will be used as a basis for preparing a didactic design alternative that is expected to overcome the obstacle learning experienced by the students.

2. Methods

This research was conducted at one of junior high school in Bandar Lampung City, Lampung Province, Indonesia. The subject of this research was 87 students. The subjects were the students who had learned proportion. This condition was selected because the researchers wanted to find out students' ability in understanding proportion and its applications based on previous didactical design.

The approach used in this research is a qualitative approach. This approach was chosen because it can be more detailed in explaining complex phenomena and difficult to disclose. The method used in this research is descriptive of the analysis method. J.W. Creswell defines descriptive of analysis method as a research method that attempts to describe and interpret the object as it is [13]. This research is often called non-experimental research because researchers do not control and do not manipulate research variables. This method can explain more complex phenomena that are difficult to express using quantitative methods. Through this method, researchers get a view of the problems that occur in detail, either in the form of words, pictures, and behavior, and not poured in the form of numbers or statistics, but in the form of qualitative.

The stages undertaken in this research are: 1) determining mathematical topics to be used as research materials; 2) analyze selected mathematical topics; 3) personalize selected mathematical topics; 4) create a test instrument to find out the obstacles on the topic; 5) provide tests on students followed by interviews; 6) conduct analysis of test results and interviews; and 7) make conclusions about the learning obstacles that arise. Instruments used in this research were the researchers, tests and interview guides. In qualitative research, the researchers are the main instrument in research. The functions of researchers were to define the focus of research, the limits of research problems, selecting data sources, collecting data, assessing data quality, analyzing data, interpreting data and drawing conclusions on findings. Furthermore, data analysis in this research using inductive analysis is to collect and integrate special data into information units [14].

In qualitative research, data analysis is done from the beginning of the research and during the research process implemented. The data collected are then collected for further systematic processing. Starting from the interview, classify, then submission of data and conclude the data [15]. The steps of data analysis in this study were: 1) reading the entire information collected; 2) classify the data; 3) make a detailed description of what then emerges from the test results; 4) look for relationships and compare between categories; 5) find and set patterns on the basis of the original data; and 6) presents narratively.

Students were given the test in 3-word problems for 3 indicators in proportion, that was (1) distinguishing the direct and indirect proportion, (2) solving the problems related to direct proportion by using tables and graphs, and (3) solving the problems related to the indirect proportion by using tables and graphs. Every problem represents one indicator. Students were given 60 minutes to finish the test. In the next day, the researchers do an interview to all students related to the solution of the problems before.

3. Result and Discussion

Based on the result of data analysis, only 21 (24.14%) of 87 students able to finish well all word problems. The other, 66 (75.86%) students are not able to finish all problem correctly. It means that there are 66 students do not have the good understanding in proportion. There are 66 students who have obstacles to understanding the concept of proportion. Students who have an obstacle in distinguishing the direct and indirect proportion (indicator 1), also they have an obstacle in solving the problems related to the indirect proportion by using tables and graphs (indicator 2) and solving the problems related to the indirect proportion by using tables and graphs (indicator 3). The dominant obstacle was in solving the problems related to the indirect proportion by using tables and graphs. Based on the analysis of the test, the complete obstacle can be shown in Table 1.

Table 1. The number of students who have obstacle.

No	Indicators	Students who Have Obstacles	
		Total	Percentage
1.	Distinguishing the direct and indirect proportion	51	58.62%
2.	Solving the problems related to direct proportion by using tables and graphs	57	65.52%
3.	Solving the problems related to the indirect proportion by using tables and graphs	66	75.86%

To get the clear type of obstacle, the researcher did the interview related to the answer of students in solving the problems. Based on the analysis of the interview, student's obstacle can be categorized into three categories, there are the ontogenic obstacle, epistemological obstacle, and didactical obstacle. The amount and percentage of the appearing of three categories of the obstacle can be shown in Table 2.

Table 2. The number of ontogenic, epistemological, and didactical obstacle.

Indicators	The Total of Students who Have Obstacles			The Percentage of Obstacle		
	Ontogenic	Epistemological	Didactical	Ontogenic	Epistemological	Didactical
1	5	13	33	9.80%	25.49%	64.71%
2	7	21	29	12.28%	36.84%	50.88%
3	12	19	35	18.18%	28.79%	53.03%

The results of the data analysis indicate that many students have to learn obstacles on each indicator on the concept of proportion, especially when it presented in the word problem. Based on the results of tests that have been done, it obtained some type of difficulty made by some students. The students' difficulties in solving the word problem were: (1) difficulty expressing proportion in mathematical models; (2) the difficulty to distinguish the concept of direct and indirect proportion; and (3) miscalculation.

In solving the problems related to the first indicator (distinguishing the direct and indirect proportion), the students' difficulty was in stating the word problem in the mathematical model. The result of the interview showed that 5 students did not understand the difference between the direct and indirect proportion. This indicated that there was an ontogenic obstacle [16]. This was caused by a lack of learning readiness. It leads to the students' inability to understand the different definition of direct and indirect proportion. The interviews with 13 of the other students stated that they were unable to answer this question correctly because they had never solved on previous exercises related to this problem. It means that there was an epistemological obstacle [16,17]. This indicates that students have limited knowledge related to the application of the concept of the students learned. A total of 33 of other students stated that had forgotten the concept of direct and indirect proportion that had been previously learned. This indicated that there was a didactical obstacle [16]. The learning process experienced by students so far has not succeeded in cultivating the concept of direct and indirect proportion well by the students. The tendency of learning that occurs as the direct learning, that teacher explains the definition of direct and indirect proportion orally to the students, without giving the opportunity to students to construct their own understanding related to the concept of direct and indirect learning, so they able to distinguish the type of proportion.

Students who did not able in solving the problem related to indicator 1 (distinguishing the direct and indirect proportion) also did not able in solving the problem-related to indicator 2 (solving the problems related to direct proportion by using tables and graphs). In solving problems related to the second indicator, the difficulties that arise were (1) stating the problem in the mathematical model, (2) distinguishing the concept of direct and indirect proportion, and (3) miscalculation. The result of the interview showed that 7 students were able to state the word problem into the mathematical model but did mistake in doing the calculation. This indicated that there was an ontogenic obstacle [16]. It was caused by a lack of students' learning readiness. This resulted in the students' inaccuracy in performing multiplication and division counting on the concept of proportion. The results of interviews with 21 other students stated that they were unable to answer the problem correctly because they had never done the same problem before. This indicates that there was an epistemological obstacle [16,17]. This indicates that students have limited knowledge of the application of the concept of direct proportion. A total of 29 other students stated that had forgotten the concept of proportion that can be used to solve the problem, whether to use a direct or indirect proportion. This showed that there was a didactical obstacle [16]. The learning process that was followed by students so far has not succeeded in cultivating the concept of direct and indirect proportion well by the students. The tendency of learning that occurs as the direct learning that teacher explains orally the definition of direct learning to the students, without giving the opportunity to students to construct their own understanding related to the concept of direct

proportion. Lack of time in the provision of exercise related to similar problems was also a weakness in the learning that has been followed by students.

The fact was students who have difficulties in solving problems related to indicator 1 (distinguishing the direct and indirect proportion) and indicator 2 (solving the problems related to direct proportion by using tables and graphs) also had difficulty in solving problems related indicator 3 (solving the problems related to indirect proportion by using tables and graphs). In solving problems related the third indicator, the difficulties that appear also similar, there were (1) stating the problem in the mathematical model, (2) distinguishes the concept of direct and indirect proportion and (3) miscalculation. The result of the interview showed that 12 students were able to declare the problem of indirect proportion in the mathematical model but did mistake in doing the calculation. This suggested that there was an ontogenic obstacle [16], that was a learning difficulty caused by a lack of learning readiness. This resulted in the students' inaccuracy in performing multiplication and division counting on the concept of proportion. The interviews of 19 other students stated that they were unable to answer this problem correctly because they had never done this kind of problem. This indicates an epistemological obstacle [16,17]. This suggested that students have limited knowledge of the application of the concept of indirect proportion. As many as 35 other students stated that had forgotten the concept of proportion that can be used to solve the problem, whether to use a direct or indirect proportion. This showed that there is a didactical obstacle [16]. The learning process that followed by students so far has not succeeded in cultivating the concept of direct and indirect proportion well by the students. The tendency of learning that occurs as the direct learning, that teacher explains the definition of direct and indirect problem orally to the students, without giving the opportunity to students to construct their own understanding related to the concept of direct and indirect proportion so they able to distinguish the type of proportion. The lack of time in the provision of exercise related to similar problems was also a weakness in the learning that has been experienced by students.

Based on the result of data analysis, the indicator 1 (distinguishing the direct and indirect proportion) be the basic indicator in proportion. If students able to distinguish between the direct and indirect proportion, then students have the good understanding of the definition of direct and indirect proportion. As the effect, if students understand well about the concept of direct and indirect proportion, students will be able to solve the problem (it may be word problem) related to direct and indirect proportion both using tables and graphs. The result of data analysis showed that if students have not able to solve problem-related to distinguish the direct and indirect proportion (indicator 1), students also have not able to solve problem related to indicator 2 (solving the problems related to direct proportion by using tables and graphs) and also indicator 3 (solving the problems related to indirect proportion by using tables and graphs).

As the recommendation of this research was the teacher should able to construct well understanding of students on the basic indicator, because the achieving of understanding in this indicator will help students to be able to achieve well understanding of next indicators, especially for the indicators related to the understanding of the definition of the concept. In mathematics, the definition is the basic concepts to achieve well understanding the all of the concepts. The teachers also should pay attention to students' obstacles to the learning process. The teachers should be able to design the learning to minimize students' obstacles include ontogenic, epistemological, and didactical obstacle.

4. Conclusion

Based on the results of the data analysis, 75.86% of students have obstacles in understanding proportion. Students who have not able to solve the problem related to distinguishing the direct and indirect proportion, students also have not able to solve problem-related direct and indirect proportion by using tables and graphs. The students' obstacles include ontogenic, epistemological, and didactical obstacle. The dominant obstacle that was appears was the didactical obstacle. It can be described: a). 51 students (58.62%) have the obstacle in distinguishing the direct and indirect proportion, that was 9.80% of the ontogenic obstacle, 25.49% of epistemological obstacle and 64.71% of the didactical obstacle; b). 57 students (65.52%) have the obstacle in solving the problems related to direct proportion by using tables and graphs, that were 12.28% of the ontogenic obstacle, 25.49% of epistemological obstacle and 64.71% of the didactical obstacle. c). 66 students (75.86%) have the obstacle in solving the problems related

indirect proportion by using tables and graphs, that were 18.18% of the ontogenic obstacle, 28.79% of epistemological obstacle and 53.03% of the didactical obstacle.

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