ME – 43

EPISTEMOLOGICAL OBSTACLES ON MATHEMATIC'S LEARNING IN JUNIOR HIGH SCHOOL STUDENTS: A STUDY ON THE OPERATIONS OF INTEGER MATERIAL

Nyiayu Fahriza Fuadiah
Universitas PGRI Palembang
Doctoral student in mathematics education Universitas Pendidikan Indonesia

Abstract

As a lesson considered as a difficult lesson, many factors affect learning opbstacles in learning mathematics. Learning obstacles could be experienced by the students with different levels of ability. The most common factor that causes learning difficulties is the lack of teacher's ability to manage learning process and apply a suitable methodology. For example, the teacher goes directly to a new material regardless the prior knowledge of students. Moreover, in applying the learning plans, the teacher are less considering the variety of the students' responses on the developed didactic situation. As a result, the students give no response at all since the students' responses are beyond the teacher's ability. This paper focused on the student's epistemological obstacle on the operations of integer material in grade seventh.

From the results of the survey in class VII at two Junior High School in the city of Palembang on the operations of integer, epistemological obstacles occured in understanding the concept of integer operations. Students understood in concept of addition and subtraction, but not able to apply to the problem, especially on addition and subtraction that involving positive and negative integers all at once. The forms of a + (-b), -b + a, and a - (-b) are still difficult to be solved by the students. Based on the analysis of epistemological obstacle against their answers, students seemed not to understand the meaning of negative numbers as a abstract numbers in their minds. Consequently, integer applications problem cannot be solved properly by most students.

Key words: Learning Obstacles, epistemological obstacles, operations of integer

INTRODUCTION

Every child is in fact experiencing learning obstacle in understanding mathematics. If we examine learning obstacles are not only experienced only by students who are capable of 'low' but can also be experienced by students with the ability level of 'good'. Obstaclesor learning difficulties may be experienced by students with different levels of ability and any group. These obstaclesneed to be identified to find a way around that and define strategies to reduce these obstacles.

Balacheff (Brown, 2008) states that the errors and difficulties students mostly come from what is called constructivist hypothesis, which is the hypothesis that students' mathematical error arises from how students adapt in response mileu or knowledge in a learning environment. Brousseau (2002: 82) refers to obstacles from the theory presented by Bachelard (1938) and Piaget (1975) regarding the "errors", that mistakes and failures are not simple role. Errors of this type are not necessarily and unpredictable, which is called the obstacles. This error is part of the acquisition of knowledge. This is one of the obstaclesexperienced by students in the process of constructing a knowledge. Through obstacles in its path will enrich their learning experience through the process of thinking and cognitive conflict that occurred in the

mind of the child. Students are almost always encountered resistance as part of the process of thinking in every learning process. In other words the obstacles are one way to find out (Brown 2008).

The idea was first introduced cognitive obstacles in natural science with Bachelard (1938) and developed in mathematics education by Brousseau (1987). In terms of their obstaclesare part of the knowledge of the students in general to solve certain problems, but when faced with a new problem, which has owned the knowledge can not be fully used and difficult to apply to the new material.

Cognitive obstacles interesting to study to help identify the difficulties faced by students in the learning process, and to determine the right strategy for teaching (Cornu 2002: 158). Tall stated that cognitive obstacles is the term for an epistemological obstacle (Nyikahadzoyi et al, 2013). As with Herscovics, Tall view based on the understanding Bachelard on epistemological obstacles in the context of the development of scientific thinking and not in the context of invidual student's learning experience. Cognitive Constraints expressed by Herscovics, identified from the work of Bachelard, include: the tendency to rely on intuitive experience hoax, the tendency to generalize, and the drag caused by natural language. Herscovics (Nyikahadzoyi et al, 2013) using an epistemological obstacle refers to an existing mental structure or the structure of the new material. According to him, there are two basic types of learning difficulties, namely: 1) students try to map the new material into existing mental structures applicable in other domains but not appropriate for the material being studied, and 2) the structure inherent in the new material so that students may not have the mental structure that will allow the assimilation of new material.

The theory of didactical situations gives particular attention to mathematics and his epistemology (Artigue, 2014: 48). In the theory, special attention is shown in a different way, especially referring to the epistemology of Bachelard and didactic conversion in the idea of epistemological obstacles, and also through his ideas about the fundamental situation. Referring to Bachelard studies in the field of physics that generates a list of epistemological obstacles, Brousseau expand the didactical applications in mathematics then, by detailing the epistemological constraints as a form of knowledge that is relevant and has been successful in certain contexts, especially in the context of schools/ educational institutions.

According to Brousseau (2002: 86) learning obstacles are categorized into three types: (1) *Ontogenic obstacles* are obstacles of development, the obstacles associated with the stage of mental development of children according to age and biological development. Some children sometimes have lacks the necessary capacity for age-related cognitive goals. If the deficiency is only because of the slow mental development (and not for 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. Brown (2008) states that 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*". Brousseau has explained the relationship between learning and the mathematical structure of the learning content (Prediger, 2008). Contrary to the 'didactical obstacles' (which is caused by the way of teaching), Brousseau has created the idea of 'epistemological obstacle' to obstacles that are rooted in the structure of the mathematical content itself, in the history and development of the application.

Widdiharto (2008; 6) the source of the difficulty classifying it into two main factors, namely: (1) factors derived from the student who is affected by the students themselves and the state of the environment, such as physiological factors, social and cultural, emotional and psychological, and intellectual students, and (2) external factors that influenced students associated with the learning process of students in the class or group where there is interaction

between teachers and students, the pedagogical factors. Factor is less exactly pedagogical teachers manage learning and applying the methodology. For example, teachers still lack the capability of the beginning of the students, the teacher directly into the new material. When difficulties are students in understanding, teachers repeat the basic knowledge required. Then resume again severed learning new material. If this continues, it would appear that the general difficulty of confusion because it is not structured teaching materials that support the achievement of a competency. Sometimes when the teacher explains the parts of teaching materials that support the achievement of a competency is clear, however, if the whole is not packaged in a good learning structure, the basic competence in the mastery of the material and its application can not always be expected to succeed.

Many experts are then discussed the epistemological obstacle. Bachelard, Brousseau (2002) and Cornu (2002) states that the epistemological obstacle is visible errors of response or the response of students in answering the question or assignment of teachers. Bachelard (Cornu 2002; 158, Manno 2006: 32) states that the epistemological problems occur both in the history of scientific thought and the educational practice. According to the epistemological obstacles can not be avoided and important than the knowledge that will be acquired by a student. However, barriers epitemologis 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 there epistemological obstacle. Epistemological obstacles of scientific knowledge can lead to stagnation, and even decline in a person's knowledge (Brousseau 2002: 98, Moru, 2009: 433). 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. Sierpinska (1998: 28) states that 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. In line with what was stated earlier that the experts epistemological barriers are obstacles that can not be avoided, the error is a process to determine (knowing). Overcoming obstacles epistemological and understanding are two complementary image of the unknown reality of important changes in the human mind.

Operation of Integers

Although it looks easy, one of the materials that can not be controlled well by the students of class VII is an integer operations. Based on the narrative some math teacher in class VII, there are many students who can not operate integers. Number line is a common tool used to introduce figures in primary and secondary schools in many countries (Heefeer, 2008). This way seems simple and largely successful, although students have never understood why a positive number should move to the right and negative numbers should move to the left. The weakness of the author encountered in some current students work about the number line is for larger numbers, the students are not able to answer correctly. In addition, the number line gives the students the concept image that has positive numbers to the right and negative numbers always to the left, but not all of reality in the real world as it is. Furthermore Hefeer (2008) states the number line may not be suitable for introducing operations involving negative numbers.

This paper examines the student's learning obstacles in learning mathematics to determine and describe the student learning obstacles in mathematics learning, especially in the light of aspects of epistemological obstacle in Junior High School. The author gives examples of the material integer operations. Through this study are expected teachers to develop teaching materials and design can minimize the learning of mathematics that students' epistemological obstacle.

RESEARCH METHOD

The author conducted a survey to diagnose the learning obstacles of epistemological aspects of the 20 students in one class VII in one of the Junior High School in the District

Indralaya and 20 junior high students in the city of Palembang, South Sumatra. Students are given a set of questions about the concept of integer operations and some problems related to the real world. From interviews with teachers of mathematics in the relevant class is known that there are many students who have difficulty operate integers with different signs (addition and subtraction). This is demonstrated by the achievement of the learning outcomes of this material are unsatisfactory. Students come from a variety of heterogeneous ability levels. The results were analyzed student work based on the type of error that depicted aspects of epistemological obstacles.

RESULT AND DISCUSSION

The author conducted a first survey at one junior high school in Indralaya District. The author first lead students in understanding integer operations through a series of activities carried out students by using *algebra chip* to see the extent to which students' understanding regarding this matter. Furthermore, the authors conducted a second survey in one of the junior high school in the city of Palembang. Assuming that the students have learned the concept of integer operations like the previous SMP, the author only gives problems related to integer operations with different number sign (positive and negative numbers). With this method, I expect get an idea of the epistemological obstacle in more detail in the material integer operations. Here are the results of the work of students who are finding the author:

Epistemological obstacles st

The first epistemological obstacles associated with the concept of the sum of two integers are same sign. I suspect that this question will be answered correctly by suluruh students, but there are students who give wrong answers. Students constrained to infer the type of numbers in the sum equal numbers sign.

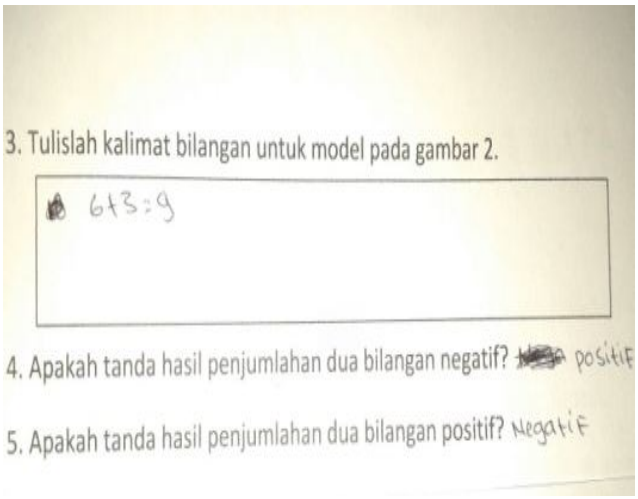

Figure 1

In Figure 1 the student looks to answer the question number 3 correctly (previous students also answered questions No. 1 and 2 correctly). But the question that is the conclusion (numbers 4 and 5), there are two students who answered incorrectly.

Epistemological obstacles 2nd

The second epistemological obstacles associated with the concept image that is limited to the illustrations given. As a result, students are not appropriate to interpret the concept of the sum of the number of different signs.

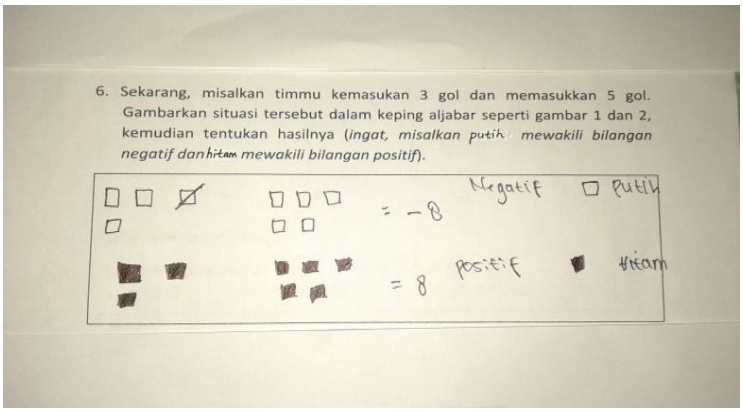

Figure 2

In figure 2 the student is able to write that the white pieces and black represent negative numbers represent positive numbers, but the difficulty in 'merge' the two in a number operation. Students looked confused represents the intent of matter through the puck algebra in question, even if the student already captures the problem, seen from the number of chips used algebra. It seems that the purpose of the question is not as expected that students can distinguish negative numbers and positive numbers through different pieces of algebra. With a pair of white and black pieces, is expected to provide information to students that pieces unpaired algebra is the result.

Epistemological obstacles 3th

The third epistemological obstacles related to the application of the concept. Students are largely constrained by the time operate the sum of two integers of different signs, although it has shown a good understanding of the concept of the previous question.

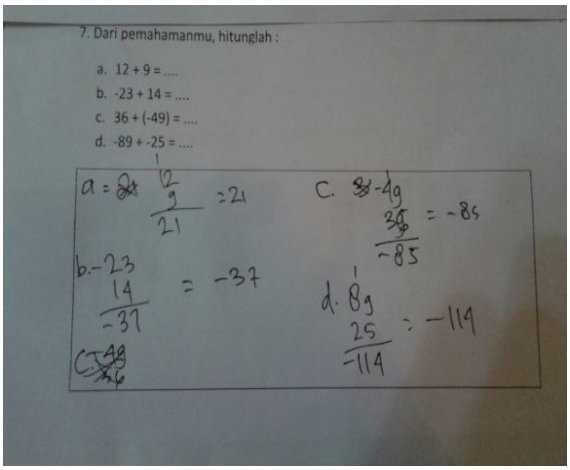

Figure 3

All students answer correctly in Question 7 (a), but most of the students answered incorrectly at 7 (b) and (c), which is the sum of two integers of different signs. Some students solve problems by way of preparation to the bottom, they use a common way since elementary school in the operations of addition and subtraction. Way also applied to the sum of two different numbers signs.

More or less the same mistake I have found the next school. Some of the questions given writers such as choosing where higher temperatures (problem 1st), the sum of the integers (problem 2nd), and problems of application (about 3-5). Here are some examples of student answers:

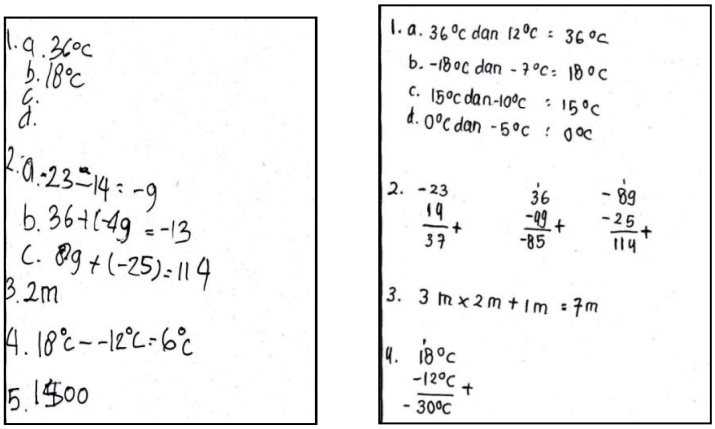

Figure 4. Student's answer

From students' answers, the authors conclude that students have difficulties in integer operations involving negative numbers. According Thomaidis (1993) negative numbers always been a topic of particular interest, from a mathematical point didactic. The problem is the students interpreted the concept of negative numbers as numbers that have different properties at all the positive numbers. Two different concepts of positive and negative numbers will lead to the opposite pole with a different domain. Brousseau stated that the negative number is the amount which basically is positive. Thus the properties of a given positive integer operations also applies to negative numbers. Thomaidis (1993) explains that the term 'name positive' and 'negative name' does not mean positive and negative numbers but 'what is written' and 'what are reduced'.

Some studies suggest the cause of the difficulties students in understanding the negative numbers is due to the abstract nature inherent in negative numbers (Altiparmak & Ozdogan 2010, Blair et al 2012, Larsen, 2012, Heeffer 2011, Thomaidis 1993). Glaeser (Heeffer 2011) suggests a number of epistemological obstacles learn a negative number is the inability to manipulate the amount of negative and difficult to give meaning to a negative number. Students' difficulties in understanding negative numbers because the number of objects that exist around them is denoted as positive numbers. This epistemological obstacles described by various researchers in three categories (Altiparmak & Ozdogan, 2010): 1) the meaning of the numerical system of direction and a lot of numbers, 2) with respect to the meaning of arithmetic operations, and 3) associated with the meaning of the minus sign. This issue contains a third domain of abstract concepts.

The idea of epistemological obstacles have some linkage with the conception or rather that misconceptions (misconceptions), but also with social-cognitive conflict or cognitive (Schneider 2014: 214). The term "misconception" implies inaccuracies or errors because the prefix "ex." However connotation never imply fault of the child's perspective (Fujii 2014: 453). From the point of view of a child, it is reasonable and feasible conception based on their experience in different contexts or in the activities of their daily lives. When the conception of children who are considered contrary to the accepted meaning in mathematics, misunderstanding the term tends to be used. Therefore, some researchers or educators prefer to use the term "conception altenative (alternative concept)" instead of "misunderstanding."

If these obstacles are not anticipated it will continue in the next materials especially materials related to previous material. Learning obstacles that occurs as described above is possible as a result of learning in the classroom. Mathematics learning process during which tend to be directed at the imitative thinking, have an impact on the lack of didactical anticipation reflected in the lesson planning (Suryadi, 2013). This is caused by some students' responses on the didactical situation that developed beyond teacher's prediction and it is not anticipated so that learning obstacles are not getting a response by the teachers that caused the lack of students learning. To overcome these obstacles that may arise in the future we need a learning process can lead to a more optimal learning situation, which must be done before the study. The effort is

an didactical and pedagogical anticipation (Suryadi, 2013). It is essentially a synthesis of the ideas of teachers based on the various possibilities that are predicted to occur in the learning event.

CONCLUSION AND SUGGESTION

In the learning process when the context is only used as an application, then the student can only imitate the procedure shown teacher and if students are exposed to different situations it is most likely the student is unable to answer or solve them, so that there arose the so called learning obstacles. Learning obstacles can be experienced by students with different levels of ability and any group that is made possible as a result of learning in the classroom. Knowledge of someone who is confined to the specific context called epistemological obstacles. In mathematics for the concept of operations on integer students experiencing epistemological obstacles aspects as follows:

1. Students are constrained in understanding the concept of the sum of the integers of different signs
2. Students are constrained in understanding the abstract meaning of negative numbers
3. Students are constrained to apply the concept of integer addition operations involving negative integers.

One of the teachers' efforts to improve the quality of learning is through reflection on the relationship of design and the learning process has been done. Suggestions based on epitemological obstacles examined in this article are as follows:

1. Teachers in preparing teaching materials integer operations, in order to pay attention to learning abstacles that may occur.
2. Teachers can prepare design of didactical situations that can minimize the obstacles to learning on integer operations that occur on student learning. Design of didactical situation is the first step before any learning to overcome learning obstacles that arise in the process of learning that are expected to lead students to the formation of a full understanding.
3. It should be further research on other obstacles that may arise.

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