KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Learning Obstacles of Junior High School Students on the Concept of Triangle

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Abstract.
Geometry is one of the important topics in school mathematics. Many people solve daily life problems using geometry, including the concept of triangles. However, many students still have obstacles in learning the concept of triangles. This study aims to analyze students' learning obstacles on the concept of triangle. A qualitative research along with a case study was conducted on 45 students of 9th grade, studying at one of the junior high schools in Majalengka, West Java, Indonesia. The data were collected using triangulation which included document analysis, test, and interview. The results showed that students experienced several types of learning obstacles, including students facing issues in incomplete or inadequate presentation of triangle material (didactical obstacle); their inability to use the triangle concept in the context of non-routine questions (epistemological obstacle); and their inability to follow the learning demands about the definition of triangle, the types of triangles, and the area of triangle (ontogenic obstacle), so that it is indicated that students have problems in understanding the concept of triangle. The results of this study can be used as a reference for developing a more optimal didactical design.

Keywords: junior high school, learning obstacles, triangle.

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Published: 26 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

1. INTRODUCTION

Geometry is an important component of learning mathematics. Geometry allows students to improve their analysis ability [1,2]. Geometry will always be used in solving problems both in mathematics itself and in everyday life [3]. One of the benefits of geometry in life is to help make buildings in various shapes [4].

One of the basic concepts in geometry is the triangle concept [5]. All plane are interrelated with each other, the concept of triangle is a prerequisite for learning the concepts of trapezoid, parallelogram, kite, and polygon If any type of plane is partitioned, it can become several triangles. Brousseau [6] stated that in learning the concept of the

triangle students should not experience a learning obstacle and the concept must be well understood by students in order to learn the next geometric concept.

In fact, there are still problems faced by students in learning geometry, including the concept of triangle. The average mathematical ability of Indonesian junior high school students in geometry is still low compared to other topics [7]. There are many previous study results that show the problems faced by students in learning the triangle concept, such as the students experienced difficulties in defining the area of a triangle, identifying types of triangles, and determining the base and high of triangle [8] Moreover, the study results of Sulistyowati and Sujadi [9] stated that the problems of students in learning the concept of triangle can be seen from the mistakes of students solving problems of angle, perimeter and area of triangle. The results of Yuwono's study [10] stated that students did not understand the concept of the base and height of a triangle. The results of Ozerem's study [1] stated that students forgot to divide the multiplication of the base and height in half when solving the problem of the area of a triangle. The results of Jupri's study [11] stated that the students' problem solving ability on non-routine questions about the triangle concept was still low.

The problems faced by students in learning the triangle concept do not just happen. There are many factors that cause these problems, one of which is the learning obstacle experienced by students when learning the concept of mathematics [6]. There is a need for research that reveals students' learning obstacle in learning a mathematics concept so that teachers can evaluate and develop more optimal didactical design [12]. Brousseau [6] stated that learning obstacles are classified into three types, namely didactical obstacles (related to the presentation / teaching stage of the material), epistemological obstacles (related to how students understand knowledge), and ontogenic obstacles (related to the development of students' cognitive abilities).

Therefore, this current study aims to analyze the learning obstacle experienced by junior high school students in learning the triangle concept. The results of the study might be used as a reference for further study regarding the development of didactical design triangle concept so that the learning obstacle identified in this study does not occur again in the future.

2. RESEARCH METHOD

The study used a qualitative research with a case study design, which is intended to obtain data about the learning obstacle of junior high school students on concept of triangle in natural conditions. This study involved forty-five 9th grade students who

study at one of junior high school in Majalengka, West Java, Indonesia. The class was chosen because the students had studied the concept of triangle.

The data were collected using triangulation techniques which included document analysis of the textbooks used by students, a diagnostic test to forty-five 9th grade students, and in-depth interview some students and a mathematics teacher. The main instrument of this study was the researcher itself and supported by a supporting instrument which was the diagnostic test instrument that has been validated by mathematician and mathematics teacher. The diagnostic test consists of five questions about the concept of triangle. Students take a diagnostic test in class for 60 minutes.

The data obtained were then analysed using qualitative data analysis techniques as follows: (1) processing the student diagnostic test results, interview results, and document analysis results; (2) collecting the important data about learning obstacles experienced by students; (3) analysing and classifying the identified learning obstacles; (4) presenting the data descriptively; (5) concluding the study results.

3. RESULTS AND DISCUSSION

The results of study showed that students experienced learning obstacles. These learning obstacles are classified into three types according to Brousseau [6], which will be discussed as follows.

3.1. Didactical Obstacle

The results showed that the textbook used by students to learn the triangle concept were incomplete in explaining the keywords that students had to understand in learning the definition of triangle and the process of finding formulas. In the context of the definition of triangle, there is a misrepresentation of the words used to define a triangle. This can be seen after analyzing documents on the textbook used by students, the textbook is written the definition of a triangle, namely “A triangle is a plane that is bounded by three sides and has three angles”. The choice of the word “bounded by” creates confusion over the students’ image of the triangle. Students interpret the definition of a triangle in the textbook as an area bounded by three sides, this is more directed at the area of the triangle. Selection of the word “bounded by” should be replaced with the word “has” or “consists of” or “with”. Joyce [13] defines a triangle as a plane with 3 sides.

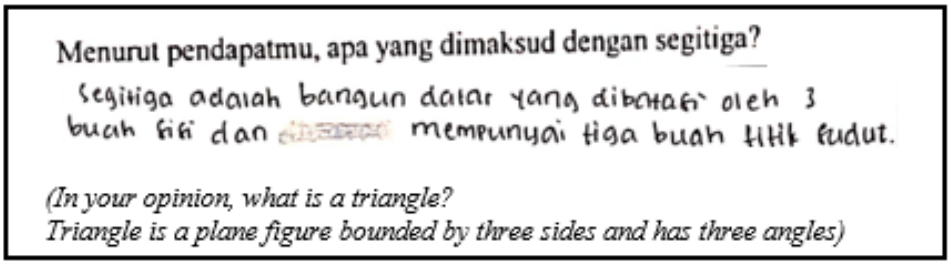

Figure 1: The student 1's answer to problem number 1.

In Figure 1, it can be seen that students really remember the definition of triangle in the textbook used by them. Then to trace the students' understanding of the triangle definition based on what he wrote, the researcher interviewed student 1.

P : Why do you define a triangle like this? (pointing to the student's answer)

S1 : Hmmm, that's what I remember from the textbook, Sir.

P : Do you understand the words in that sentence?

S1 : Yes, Sir.

P : Good... Then, what is meant by the word "bounded by"?

S1 : Hmmmm it's hard to explain. Can I just draw it, sir?

P : Sure, please.

S1 : (drawing a triangle and pointing to the area of the triangle) This means the word "bounded by"

P : Oh yeah, isn't that the area of the triangle?

S1 : Yes, that isn't Sir. The area that I know is 1/2 a .t

P : Where did 1/2 a .t come from?

S1 : That's what I memorized when my teacher told me the area of the triangle Sir.

From the students' answers, it can be seen that students experience obstcales in understanding the definition of a triangle which causes students cannot distinguish a triangle definition and the area of a triangle. Moreover, regarding the context of the formula for the area of a triangle, students only memorized the formula and did not get the opportunity to understand the formula's findings. Suryadi [14] stated that it can cause students to lose the meaning of the process (doing mathematics). These problems can cause new problems, such as students forgetting the formulas they memorized. This problem occurs when student 2 answers the diagnostic test questions.

In Figure 2, it can be seen that the students had errors in calculating the area of the triangle, the students considered the formula for the perimeter of the triangle as the area of the triangle. It was realized by students during in-depth interviews.

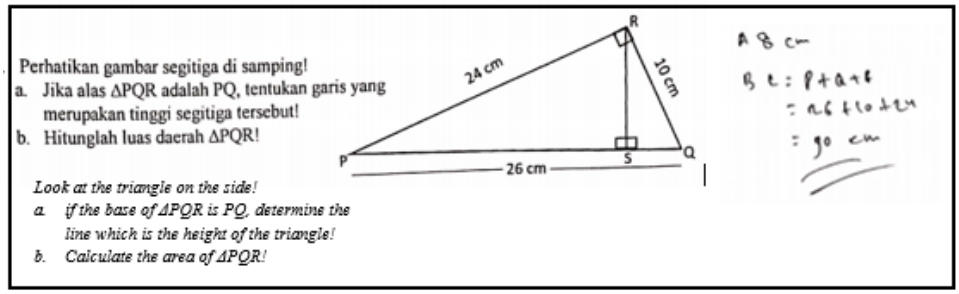

Figure 2: The student 2's answer to problem number 3.

P : What is L = P + Q + R? (pointing to the student's answer)

S2 : That's to find the area of the triangle, sir.

P : Is it not 1/2 a .t ?

S2 : Wait, Sir... I think I was wrong, Sir. I swapped the formula for the perimeter and area of a triangle.

P : Okay.. then, why did you answer "8cm" for part a?

S2 : I was guessing, Sir. That's because RS looks shorter than RQ.

P : So the height of the triangle is RS, right?

S2 : Yes, Sir.

P : If RP is the base, what is the height?

S2 : RS, Sir.

P : Are you sure?

S2 : Yes, because the height of the triangle is only one, while the sides of the triangle are three.

After conducting in-depth interviews, researchers analyzed the textbook used by students. In the textbook used by students, there is no explanation about the base and height of triangle which must be perpendicular to each other. This means that the presentation of the triangle concept in the textbook is incomplete or not in accordance with the needs of students and learning activities do not facilitate students to learn actively. It's not in accordance with Bruner's discovery learning theory, the learning process must facilitate active students to find their own knowledge so that learning is more meaningful [15]. Moreover, students tend not to experience the process of action, formulation, and validation [6].

According to Suryadi [15] didactical obstacles are learning obstacle that occur due to the mismatch between the stages of presenting the material and the needs of students. This means that the learning obstacles that have been described above include didactical obstacle, namely students are hampered by the presentation of

triangle material which is considered not well or not in accordance with the needs of students. Therefore, in developing didactical design, a teacher must prepare the stages of presenting the material according to the needs of students by positioning themselves as students when learning.

3.2. Epistemological Obstacle

In learning the triangle concept, students experience obstacles when faced with non-routine problems. This can be seen from student 3's answer to the diagnostic test questions.

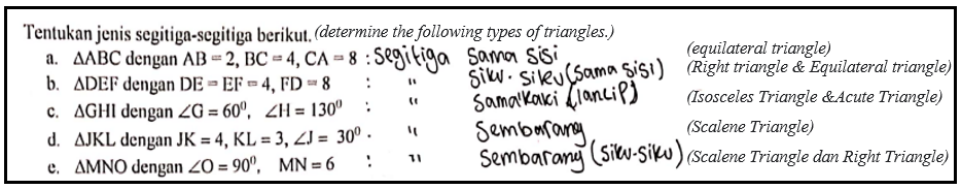

Figure 3: The student 3's answer to problem number 2.

Figure 3 shows students are just guessing in determining the type of some triangle conditions. In this question, students are not immediately given a triangular figure as usual but are given some information or conditions in order for students to know whether the triangles can be formed or not (non-routine problem). Then, some of the triangular conditions given are not like the usual triangular conditions, in that question a non-routine problem is given about the triangular condition where the three sides cannot form a closed curve because it does not match the triangle inequality theorem. This can be seen clearly from the answers of student 3 when interviewed in depth.

P : for point b, why is the answer right triangle and equilateral?

S3 : Wait, Sir. I think I was wrong. I mean it's an isosceles triangle, Sir.

P : Why is it isosceles?

S3 : Because there are two sides that are the same length.

P : Then, why is it a right triangle?

S3 : When I answer the question, I tried to draw the triangle. It has right angles.

P : Can you draw it again?

S3 : Yes, Sir. (drawing a isosceles right triangle)

P : How long is the side?

S3 : I just estimate, sir.

P : Try to follow according to the conditions in question. DE=EF=4 cm and FD=8 cm

S3 : Okay, sir. (redrawing the triangle). Sir, these conditions cannot form a triangle.

P : Do you remember the triangle inequality theorem?

S3 : No, Sir.

From the students' answers during the interview, it can be seen that students have been able to determine the characteristics of right and isosceles triangles but are not familiar with such non-routine questions. Students only estimate the triangle figure with the conditions in the problem, so that it causes students to have difficulty solving the problem. Suryadi [16] stated that epistemological obstacle are learning obstacle that occur due to the limited understanding of students who only understand a concept in a certain context. Based on that, when students already understand the characteristics of the type of triangle but experience difficulties when the context of the problem is linked to other concepts such as triangle inequality, it means that students experience epistemological obstacles. Therefore, didactical design should facilitate diverse contexts based on the relationship betwen concepts so that students can achieve relational understanding. Relational understanding is a complex knowledge structure that is interconnected from one concept to another [17].

3.3. Ontogenic Obstacle

Based on Figure 1, Figure 2, and Figure 3, students experience ontogenic obstacles, namely students are hampered by their inability to follow the learning demands about the definition of triangle, types of triangles, and the area of triangle. Figure 1 shows the students are wrong in understanding the definition of a triangle because the students have not been able to interpret word for word from the triangle definition. Furthermore, in Figure 2 and the results of the interviews related to the students' answers in Figure 2, it can be seen that students only memorized the formula for the perimeter or area of the triangle to be used directly in solving the problems given by the teacher and only assumed that the base of a triangle was always below. It causes students to be unable to solve the problem when the type of the question is different from the one given by their teacher. So, it indicates that students cannot follow the demands of learning about the area of a triangle just by memorizing the formula, but there must be a learning stage that facilitates students to understand the discovery of the formula for the area of the triangle so that students can understand the concept completely and meaningfully [15]. Last in Figure 3, the students seem to have understood the characteristics of a type of triangle, but students cannot follow the learning demands about the terms of forming a triangle. This causes students not to be able to visualize the triangle figure

for certain conditions which results in the students being mistaken in determining the types of triangles. Students should understand some prerequisite materials for learning the types of triangles, such as the concept of triangle inequality.

Suryadi [16] stated that the ontogenic obstacle is an obstacle experienced by students due to gaps in learning demands with the capacity or level of cognitive development of students. If students face stepping in the stages of understanding a learning material that is incompatible with students' cognitive development, students cannot participate optimally in learning activities. Based on the ontogenic obstacle found, students are not ready to learn because their cognitive abilities have not been able to adapt to the learning demands at the stage of presenting the material about definition of triangles, types of triangles, and the area of a triangle in the textbook used by students. The learning process should be carried out according to the cognitive development of students.

The results showed that students experienced all types of learning obstacles based on Brousseau [6], namely didactical obstacles, ontogenic obstacles, and epistemological obstacles. All the obstacles experienced by these students resulted in students not understanding the concept comprehensively. So teachers need to consider learning obstacles that students may experience and the needs of students in designing didactical designs [18]. Students are more optimal in achieving learning goals if the teacher develops a didactical design by considering learning obstacles [12].

4. CONCLUSION

According to the results and discussion of the study, it was found that in general there were learning obstacles on the triangle concept, namely (a) didactical obstacle: students are hampered by incomplete or inadequate presentation of triangle material; (b) epistemological obstacle: students are hampered by their inability to use triangle concept in the context of non-routine questions that are not the same as the context of questions given by their teacher; (c) ontogenic obstacle: students are hampered by their inability to follow the learning demands about the definition of triangle, the types of triangles, and the area of triangle. This study has not been accompanied by didactical design recommendatuions to overcome the identified learning obstacles. Therefore, the results of the study might be used as a reference for further study regarding the development of didactical design triangle concept that can minimize student learning obstacles for optimal learning.

Acknowledgments

I would like to thank students and mathematics teacher who have been involved in this study process.

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