Semiotic Reasoning in Solving Plane Figure Area

Christine Wulandari Suryaningrum, Purwanto, Subanji, Hery Susanto

Abstract: ***Semiotics is an activity involving three components of signs, objects and interpretants. This study aimed to identify and analyze the results of student work on a plane figure area. Students' work results were analyzed using Peirce's semiotic theory of what objects are identified by the students on the questions, the marks can be made by the students, how the students' interpretations in understanding the problem and how the students solve the problem. This is a qualitative descriptive research with 3 research subjects from one private junior high school in Jember, Indonesia. Subjects were given one plane figure area problem to be done individually and completed within 15 minutes then interviewed. From the results of research, after the three research subjects understood the problem, the three subjects found five different objects. Of the three research subjects, only one subject made a new mark in an image. To solve one problem, from the three subjects there are three different interpretations.***

Keywords: Semiotic, Peirce Semiotic Theory, Plane Figure Area

I. INTRODUCTION

The reasoning is a thought process to solve problems and make conclusions. Reasoning students must be able to make valid conclusions through structured evidence and can make decisions based on the right reasons. Reasoning is a process of drawing logical conclusions based on relevant statements, facts, and information [1]–[3]. By reasoning, students are expected to be able to make decisions about how to determine a problem solving strategy, be able to solve problems correctly and finally be able to draw conclusions [4], [5].

Semiotics is the study of the production of signs and symbols to communicate information. Semiotic is an activity involving three components namely signs, objects and interpretations [6]–[8]. Semiotics and representation are important in mathematics [9]. Because, in mathematical activity we need signs and representations. signs are used to represent abstract mathematical concepts to be clearer, so that signs and sign transformations that appear in each activity of learning activities can develop mathematical knowledge [9], [10]. On the one hand, signs mean to think about the relationships of mathematics and objects, and on the other hand signs are the result of thought to produce new signs.

The concept of logic which focuses on the knowledge of human thinking process is resembled to what is to be called as semiotics [11]. A person thinks through signs, allowing them to communicate with each other and give whatever meaning is in their environment. The basic principle of Peirce's theory is that everything can be a sign, provided it has the ability to represent something according to the interpretation and thinking of people [12]–[14]. Peirce's theory of signs focuses on three dimensions or triadic and tracheotomy systems.

Peirce classifies into three aspects, namely signs, objects, and interpretations. Signs or representamens are physical things that can be captured by the five human senses and are things that refer other things outside the sign itself [12]. The sign acts as a mediator between objects with the knowledge and meaning of the sign [15]. The object referred to by the sign is the reality or whatever is assumed to exist. This means that objects do not have to be concrete, they do not have to be things that can be seen by the eye or as empirical relations, but can also be other abstract entities [16]. Interpretation or sign user is a concept of thought from a person who uses a sign and lowers it to a certain meaning or meaning that is in a person's mind about the object referred to by a sign [17]. Related reasoning abilities with symbols called semiotic reasoning [18].

Semiotic reasoning in solving plane figure area problem is a process of thinking of students in identifying objects that exist in the problem. The objects in the problem are the information identified in the problem and considered important to help solve the problem. To make it easier for students to understand the objects in the problem, students can make a mark of the object. An object can be represented in a variety of different signs [7], [19], [20]. In order to solve the problem correctly, the student must be able to interpret the alerts already made. Signs can be interpreted in several different ways. Interpretation is the response to the object through the interpretation of the sign [21].

Research on semiotics in problem-solving has been done by researchers. Mathematical tasks involving dynamic solution methods such as formula derivations can strengthen mathematical proficiency for secondary level students through exposure to adaptive and strategic reasoning [2]. When elementary students are given the 8060 number, there are two different interpretations, that is the first interpretation indicates that the text is read as a sign/representation for the two-digit object, which is 80 and 60, the second interpretation of the two students looks at the "one digit four digits" object, which is 8060 [20]. There is a semiotic list for geometry diagrams and shows that the list can be used as an empirical learning in textbook geometry

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diagrams [22]. semiotic conflicts arising from prospective teachers are confusion between simple probabilities and probabilities of an event, confusion between mathematical objects (eg probability and frequency), difficulty in reading two-way tables and confusion in using formulas [23].

The main question in this research is how is the students' semiotic reasoning in solving plane figure area problem?. Plane figure area is the number of square units that cover the area. Plane figure area is a very important material to be studied because the material of plane figure area is widely used to solve real-life problems. However, based on observations in one high school in Jember district, 82% of students have difficulty in solving plane figure area problem. Students have difficulty in understanding the problem, so students are not able to solve the problem correctly. The purpose of this article is to describe objects identified in the problem, signs made by students based on objects identified and students' interpretations that appear to solve problems.

II. METHOD

This research is qualitative descriptive research. Students who are the subject of research are private junior high school students in Jember District. 45 students were given a problem of reasoning. From the answers derived from the 45 students, they were grouped by object, sign and interpretation. The answers of students who had similar characteristics were included in one group. Each group of students answered in a single student who became the subject of research, thus obtained 3 students as subjects. The instruments used in this research were worksheets and interview guides. The subject was given a problem of plane figure area reasoning that must be done individually. The solving a problem students should work individually [3], [12], the time given to solve the problem was 15 minutes. Problem given to students are as follows.

After the students' work has been collected, semi-structured interviews was conducted. The main purpose of the interview was to complete the data. Based on the results of student work then conducted an in-depth interview. This was done to obtain important information not presented in student work. Interviews were related to what objects can be identified from the problem, what signs can be made, how the students interpretation of the problem, and how students solved the problem.

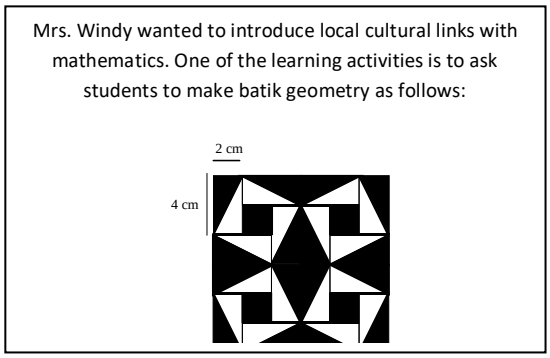

Fig 1: Problem given to students

Data collected in this study include data on student outcomes in solving problem solving problems and data on interviews. After the data was collected, analysis was done with qualitative analysis techniques. Stage analysis was chosen to analyze the data [24], [25]. Data analysis stages include data reduction, data categorization, synthesis, and ends with the preparation of working hypotheses [24].

Besides using Creswell's analysis, researchers also analyze students' work results used analysis based on Peirce's semiotic theory. There is a signaling relationship called triadic Peirce [25]. The triadic sign of Peirce consists of three relations of the semiotic element: representament, object, interpretant [9], [20], [26]. Triadic Peirce relationships can be described as follows.

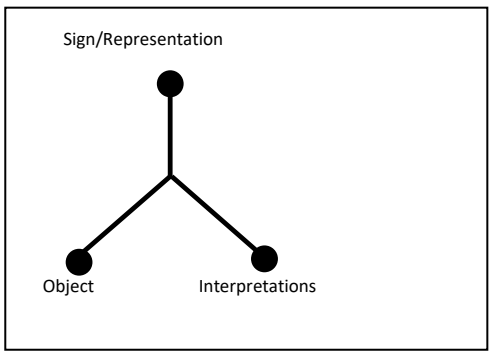

Fig. 2. Relations of triadic signs, objects and interpretations

Signs or representatives are something that represents something else in some way or capacitys [9], [20], [27]. It shows that in one's mind there is another equivalent sign. Interpretation is another representation referred to the same object [13]. In semiotic theories suggest learning should emphasize freedom of interpretation [28]. In one's mind there will grow the interpretation of the activities of others relating to the object. The object is something that represents the resulting interpretation [6]. An object is the reality or whatever is considered to exist. It means the object does not have to be concrete, it should not be a thing that can be seen by the eye or as an empirical relativity, but it can also be other abstract entities.

Compared with Saussure and Lacan semiotic analysis, Peirce's semiotic theory further integrates individual interpretation [6]. The advantages of semiotics by Peirce which analyzes the complete object, representamen and interpretation [14], [29]. In addition, Peirce's semiotic theory divides the mark into three parts: icons, indexes and symbols. More specifically, Peirce's semiotic theory classifies icons into three forms: images, diagrams and metaphors [9], [20]. This is important for semiotic reasoning in solving plane figure area problem, because in solving plane figure area problem, there are some objects that can be identified by the student. These objects can be represented in various symbols such as images, tables, and diagrams. Student's interpretation of the marks may vary depending on how the students interpret the sign.

III. RESULT

The result of this research is student's answer in solving the problem which was analyzed based on Peirce semiotic theory. Semiotic analysis was performed to determine the identified object, the sign made, the interpretation of the sign and how to solve the problem. Furthermore, interviews were conducted on the results of student answers, this was done to explore the way students find objects, signs and interpretations that can finally solve the problem.

Based on the result of subject 1 (S1) answer the object found is a large square with 12 cm side, 16 white colored triangle with base 2cm and height 4cm. In solving the problem, S1 did not create a new sign. To help solve the problem, S1 used the image provided in the problem. The initial step of solving the problem, S1 looked for a large square area of L = s x s = 12 x 12 = 144. Here is the answer found ofS1 in finding the large square are

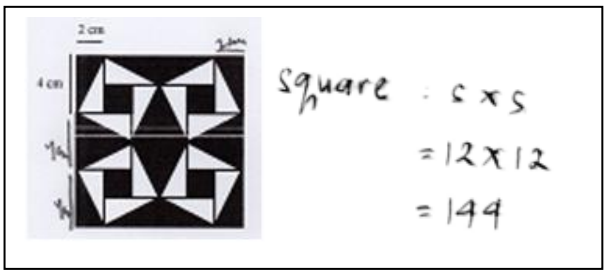

Fig. 3: The answer of S1

Then looked for the area of white triangle which is L = ½ xaxt = ½ x 2 x 4 = 4. Since there were 16 white triangles, then S1 multiplied 16 by the area of triangle with 16 to obtain L = 16 x 4 = 64. Because the black colored area was the one tried to be solved, S1 searched for a square wide area with a total area of a white triangle, thus S1 can find the area of black which is L = 144 - 64 = 80. Here is the answer obtained by S1 when completing plane figure area problem.

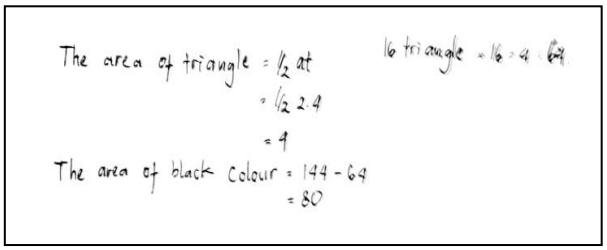

Fig. 4: The answer of S1 in completing plane figure area problem

The answer of S2 was different from S1 answer. The objects identified in the problem were also different. However, to solve the problems S1 and S2 equally did not make a new sign. They made use of the images already provided. Based on the result of the answer of subject 2 (S2) object found is 16 triangle with black color with 2cm base and 4cm height and 4 square black color with 2cm side. In solving the problem, S2 did not make a new mark, S2 understood the problem by utilizing the images already provided. The first step in solving the problem, S2 looked for the area of each figure by looking for the area of the right triangle colored black which is L = ½ x a x t = ½ x 2 x 4 = 4. Because there were 16 right triangles colored black, S2 multiplied triangle area with 16 to obtain the total area of the black right triangle which is L = 16 x 4 = 64. The answer S2 in finding the area of triangle

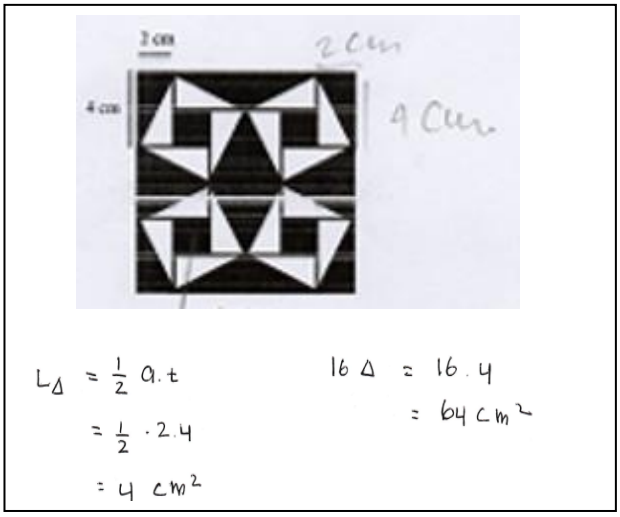

Fig. 5: The answer of S2 in finding the area of triangle

The next stage S2 looked for the square area of black color which is L = s x s = 2 x 2 = 4. Since there were 4 small rectangles, then S2 multiplied 4 with the black square area then obtained L = 4 x 4 = 16. To find the area of the black colored area S2 added the total area of the black triangle with black square area then obtained L = 64 + 16 = 80. Here is S2 answer when solving the plane figure area problem

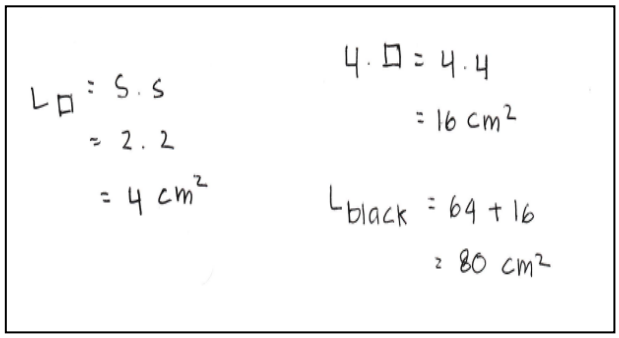

Fig. 6: The answer of S2 in solving the plane figure area problem

In contrast with the previous two subject answers, in the work done by S3, objects found were different from those found in S1 and S2. To understand and solve the problem, S3 created a new sign used to help solve the problem. Based on the result of the 3 subject responses (S3) the object found is 16 rectangles with length 4cm and width 2cm, the rectangle is divided into two equal branches to form a right triangle. One of the right triangles is shaded black. Another object that S3 found was 4 small black squares with 2cm sides.

To understand the problem, S3 made a new sign which is a rectangle with a length of 4cm and width of 2cm. the rectangle is divided into two equal parts producing two right triangles shaded black and one white and square black with

2cm sides. To solve the problem, the first step done by S3 was to look for the area of the rectangle L = pxl = 4 x 2 = 8. To find the area of the black right triangle, the area of the rectangle is divided by 2 ie L = 8: 2 = 4. Since there are 16 black right triangles then S3 multiplied the area of a black triangle with 16 to obtain the total area of the black right triangle which is L = 16 x 4 = 64.

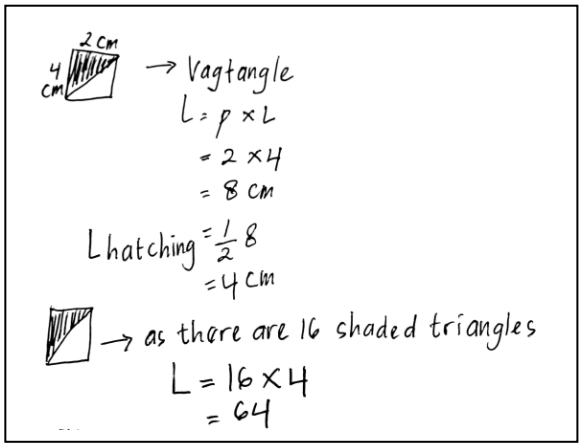

Fig. 7: The answer S3 to find total area of the black right triangle

The next step is to find the black square area of L = s x s = 2 x 2 = 4. Since there are 4 black squares then S3 multiplied the black square with 4 thus the total square area of black is L = 4 x 4 = 16. In the final stage, S3 added the total area of the black triangle with the total square area of black so that the total area of black is L = 64 + 16 = 80. Here is the answer by S2 when solving the plane figure area problem

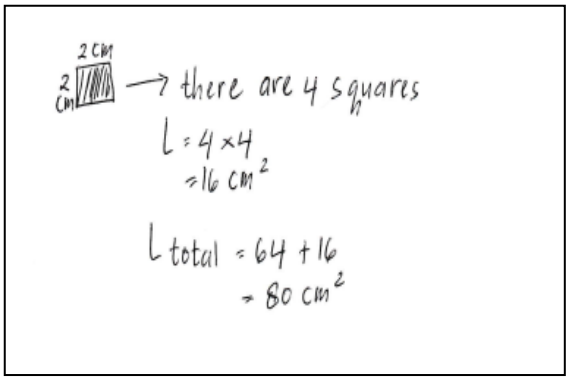

Fig. 8. The answer of S2 in solving the plane figure area problem

IV. DISCUSSION

Problem solving is an important part in mathematics learning. Problem solving is not only related to understanding mathematical concepts but also related to their application in daily life [30]. From the results of research, obtained information that in solving one problem, the object found the three subjects of different research.

Based on the interview with S1 the object seen on the problem is a black square with 12 cm side, 16 white colored triangle with base of 2cm and height 4cm. S1 did not make a new mark, S1 utilized the existing image provided. After looking at the picture, it appeared S1 interpretation was to solve the problem, S1 calculated the area of the black square and the area of the white triangle then calculated the total area of the white triangle. In the final stage, S1 subtracted the large square area with a total area of white triangle. Here are the results of interviews with S1.

P : after reading the question, what information do you get?

S1 : I found the size of triangle and square (while plucking into big square)

P : where did you get the square size?

S1 : emmmm ... (pause) I sum up the side of the known triangle (while looking at the picture on the problem)

P : To solve the problem, don't you need to create a new image?

S1 : no ma'am ... because the picture available in the question is clear

P : how do you solve the problem?

S1 : from the image provided, I see a black square (while pointing at image) with 12 cm sides and white triangle in total of ... (counting the number of triangles of color of the white) is 16. To find the area of black color, I calculated the area of the black square and the area of the white triangle. Since the area of the white triangle is 16, then I multiplied the area of the white triangle by 16. Then I subtracted the area of the black square with the whole area of the white triangle.

Objects found in S2 are different from objects found by S1. Based on the results of interviews with S2 the object seen in the problem is 16 triangles colored black with a base of 2cm and 4cm height and 4 square black color which has 2cm side. to understand the object that has been identified in the problem, S2 used the available image in question.

After looking at the picture, S2 used its interpretation to solve the problem. The initial step to solve the problem, S2 found the total area of the black triangle and the total square area colored black. Then S2 added up the total area of the square and the triangle already found. Here is the results of the researchers' interviews with S2

P : after reading the question, what information do you get?

S2 : I found the size of triangle and square (while pointing a small square)

P : To solve the problem, don't you need to create a new image?

S2 : no (while shaking head) I used the image that is on question

P : how do you solve the problem?

S2 : from the picture on the problem, I see there are 16 right triangles colored black with base 2cm and height 4cm. there is also a black square (pointing to a small square) whose side is 2cm. First I looked for triangle area. Since there are 16 triangles, then I multiplied the area of the triangle by 16. Then I searched the square area (while pointing to the picture), then I multiplied the square area by 4, because the square is 4. Then I added up the whole area of triangle with square

Subject 3 finds different objects with S1 and S2.Based on the results of interviews with S3, the object found in the problem is 16 rectangles divided into two equal branches to form a right triangle. One of the right triangles is shaded black. Another object that S3 found is 4 square black color with 2cm side. After finding the object in question, S3 made a new sign that is the rectangle and divided into two parts of the right triangle black and white triangle and black square. After viewing the image, an interpretation of S is used to solve the problem. S3 searched the area of the rectangle, then divided the two extents of the rectangle and multiplied by 16. The final stage was to add up to the total area of the small square. Here is the result of interview with S3

P : after reading the question, what information do you get?

S3 : I found the size of rectangle and square

Q : How do you solve the problem?

S3 : first I created a rectangle image

Q : what is the image of the rectangle for?

S3 : to find the area of a triangle, is ½ of the area of the rectangle. Once found area of the triangle, I multiplied the area of the triangle by 16, because the triangle was 16. Then I made a square image

P : what is square image for?

S3 :because I wanted to find the square area which is side multiplied by the side. Because there are 4 rectangulars then I multiplied the square area by 4. Then I sum up the area of the triangle with the square area

From the results of the work of three research subjects found different data. This is in accordance with the results of research conducted by [14], [20] who reported that when students are given a sign it will appear several objects and interpretations. Differences of objects identified by students are influenced by the ability of students in understanding the problem. The ability of students in understanding the problem is influenced by the experience of students in solving a problem. Students can easily solve problems if students have experience and thinking skills to solve problems. This is in accordance with the results of previous studies which stated that experience, motivation, ability to understand problems, and thinking skills have a positive effect on students' mathematical problem solving skills [31], [32].

From the work of the three research subjects, a subject that made a new sign is the image. From the work of three research subjects, the subject that made a new sign was a picture. this result is in line with the statement that the sign is divided into three types of icons, indices and symbols, while icons can be grouped into three forms of images, diagrams or metaphors [11]. This statement is in accordance with the results of previous studies which reported that after seeing the sign s, there are two different interpretations [12], [20].

V. CONCLUSION

Based on the results and the discussion it can be concluded that in understanding the problem there are five different objects, namely a large rectangle with 12cm side, black square with 2cm side, white colored triangle with base 2cm and height 4cm, black right triangle with pedestal 2cm and height 4cm, and rectangle with display 4cm and width 2cm. The rectangle is divided into two equal parts that form a right triangle. While the sign made by the subject is a picture. Of the three subjects there are three different interpretations to solve one plane figure area problem. These three interpretations appear based on the object found and the sign made to solve the problem. Interpretation will appear in the mind of the student if the student can find the object in the problem and can make a new mark. Interpretations made by students can be new objects for other students who have different interpretations.

The results of this study might be very useful in learning, especially learning mathematics. By analyzing the results of the students' work in solving plane figure area problem, the researcher knows the students' interpretation thus the students can solve the problem in their own way. For further research, it is expected to develop a learning tool or model of combustion that can give students the opportunity to generate interpretation. Further research is conducted to characterize semiotic students in solving plane figure area problem.

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