Students’ metacognition on mathematical problem solving through ethnomathematics in Rejang Lebong, Indonesia

D Herawaty, W Widada, T Novita, L Waroka, and A N M T Lubis
Universities Bengkulu, Jl. W.R. Supratman, Bengkulu 38371 Indonesia

E-mail: dherawaty@unib.ac.id

Abstract. The structure of knowledge consists of a development scheme of facts. Mathematical activities are based on situations arising from experiences. This study aimed to describe the metacognition of students in solving problems using mathematics problem-based learning in Rejang Lebong ethnomathematics. This research was the preliminary phase of a research and development. This preliminary research was conducted through in-depth interviews, involved six students of a Junior High School in Rejang Lebong, Bengkulu province, Indonesia. The research instrument consisted of an interview guide on problem solving and understanding of mathematical concepts. Data were analyzed qualitatively. The results showed that students could develop the ability to solve problems through self-reflection on planning, monitoring and evaluating the implementation of thinking processes. Students could combine pieces of information about the parts of the traditional house of Rejang Lebong that have similar properties to the mathematical 3-dimensional figures such as pyramids, prisms, rectangular prism, and cubes.

1. Introduction

In mathematics learning process, students often have the misconception. One of the ways to reduce the misconception is by requiring students to explain the way and the results of their thinking, which is widely known as metacognition. Metacognition refers to a strategy of learning, planning, and validation of the learning process [1]. Widada stated that a variety of mental and physical activity undertaken by students could be seen as a collection of structure or model of the students’ metacognition [2]. The physical and mental activities of metacognition involve an explicit description of how mathematical concepts/principles of mathematics are developed in students’ minds.

In mathematics learning, metacognition has an important role in solving mathematics problems. A development scheme of facts forms the structure of mathematical knowledge, and mathematical activities are based on situations arising from someone’s experiences [3]. To obtain optimal results in learning mathematics, solving mathematical problems should involve the well-organized steps. The steps include understanding the problem, making a plan for settlement, implementing the settlement plan, and re-examining solutions that have been resolved. According to Widada, the starting point was the issue of contextual learning mathematics which can enhance students’ mathematical abilities to solve mathematical problems successfully [5]. Solving the problem itself was a mental activity which requires an individual’s effort to overcome or find the correct solution to a problem. The person needs to manage his thoughts well, take advantage of prior knowledge, control and reflect on their thinking processes and results, to help in resolving a problem. The awareness of the thinking processes was called one of the components of metacognition.
According to Flavell, metacognition was also crucial in other areas, such as communication, reading comprehension, learning, social metacognition, attention, self-checking, memory, self-study, writing and problem-solving [6]. Research carried out by Aini showed that metacognition training could improve mathematical competence and be useful for learners who had difficulties in learning mathematics [7]. According to Herawaty, the students’ activities during the implementation of the realistic mathematics teaching model were effective [8]. The ability to understand the concept and troubleshooting results from a class experiment with realistic mathematics learning was better than in control classes that were assigned to conventional mathematics lesson.

The utilization of contextual learning media is appropriate to improve students’ abilities to understand and master the concepts and principles of mathematics [9]. Contextual learning could relate the learning activities to local cultures. Meanwhile, the mathematics culture can be applied and used to analyze the innovations. Thus, mathematics can be used as a tool to develop a winning culture. In addition, consciously or not, humans have used mathematics in solving problems.

Mathematical properties tend to be linear and rigid, but when they are integrated to culture, then the properties are flexible, for example, in the architecture area. The building structure involves mathematical principles as well as the aesthetic principles. When thinking about building structures, it not only requires the concept of geometrical shapes (two-dimensional and three-dimensional geometry) but also involves the aesthetic sense. Various cultural products of Rejang Lebong have many heritage and artistic creativity that include mathematical principles. For example, in Rejang Lebong, the design woven cloth forms two-dimensional geometry, ornamental carvings and architectural structures in houses contains geometric patterns. The attribution of mathematics into a culture is better known as ethnomathematics. Therefore, the process of students’ metacognition is found in the concept of geometry with problems relating to ethnomathematics becomes important.

Many experts defined the term metacognition in different ways. According to Livingston, metacognition refers to the thinking process about one’s thought (thinking about thought) or a person’s knowledge about the process of thinking [10]. O’Neil & Brown defines metacognition as a process of how a person thinks about thought to develop a strategy to solve the problem [11]. Wellman stated that "metacognition was a form of cognition, a second or higher order thinking process control, which involved cognitive activity process. It can be simply defined as someone’s thinking about thought or as a person’s cognition about cognition" [12]. Accordingly, metacognition is the process of thinking two levels or more that involve the control of cognitive activities. Blakey [13] found "metacognition means thinking about thought, as well as knowing what we know and what we do not know", which means that metacognition was awareness of what known, and what unknown. Thus, it can be seen that metacognition was knowledge, awareness, and control of one's thinking process and results. Huit [14] defined metacognition as one's knowledge of the cognitive system, thinking about thought, and essential skills of a person in "learning to learn ". Moreover, Huit sets out the two components included in metacognition, namely what we know or do not know, and the regulation of how we learn. Therefore, in this research, metacognition refers to the process when someone thinks about the way he thinks about what he has done.

Metacognition has two components, namely the knowledge of metacognition, and the mechanism of self-control, and monitoring of cognitive [11]. The components of metacognition in this research refer to the knowledge of metacognition. Anderson [15] stated that knowledge of metacognition is generally similar to someone's awareness and knowledge of metacognition because metacognition is awareness of what is known and what is unknown. The reasonable cognitive strategies refer to the ways to increase awareness about the process of thinking and learning that are applied when consciousness is true, and then one can guard the mind by designing, monitoring and assessing what he learned.

According to Pierce [16], to improve the ability of metacognition, students should have three types of knowledge, namely: declarative knowledge, procedural knowledge, and conditional knowledge. Declarative knowledge is factual information that someone understood and expressed orally or in writing. Declarative knowledge was the ability to describe the thinking strategies, procedural
knowledge includes knowledge of how to use the strategies, and conditional knowledge was knowledge about the right time to use them [17]. Procedural knowledge is knowledge about how to do things and how to do the steps in a process. Conditional knowledge is the knowledge of when to use a procedure, skill or strategy and when not to use it, why the procedure can be used and under what conditions and why such as a procedure were better than the other.

In this research, metacognition refers to three types of knowledge, namely: declarative knowledge, that refers to knowledge of facts and concepts or factors that affect thinking and attention in solving the problem, procedural knowledge, that is knowledge of how to do things, how to do the steps or strategies in a problem-solving process, conditional knowledge, that refers to a person's awareness of the conditions that affect him in solving the problem is: when a strategy should be implemented, why to implement a strategy and when the strategy used in solving problems. Thus, the problem of this research was how the process of students' metacognition in problem-solving geometry based on the traditional housing ethnomathematics in Rejang Lebong.

2. Method
This research was a development research by Plomp [22], which included only preliminary research conducted by in-depth interviews. The interviews included six junior high school students in Rejang Lebong. The research instrument consists of an interview protocol on problem solving and understanding of mathematical concepts. The researcher was the main instrument. Data were analyzed qualitatively to explain the metacognition of students in finding the concepts and principles of geometry (two-dimensional and three-dimensional geometric figures) based on ethnomathematics in Rejang Lebong.

3. Results and discussion
The traditional house of Rejang Lebong is known as Cut Umeak Jang, in which umeak means house, Cut means artificial, and Jang means Rejang. Thus, literally, Umeak Cut Jang means artificial Rejang house. Moreover, the traditional house of Bengkulu is also commonly known as Umeak-An, that means old or older house. Here ethnomathematics traditional house of Rejang Lebong:

![Figure 1. Traditional house Rejang Lebong](image)

The process of students' metacognition based on society ethnomathematics Rejang Lebong as the horizontal mathematical process. Mathematics activities that developed students’ thinking about the geometrical concepts were related to traditional house culture Rejang Lebong. Students devoted their mind and stated that the traditional houses in Rejang Lebong had been implementing the concept and principles of geometry in the construction of parts of the building traditional houses. The concepts and principles found by other students were geometrical models, including a triangular prism, quadrilateral pyramid, cubes, and blocks.
3.1. Concepts and principles prism build space triangle

![Figure 2. Prism triangle ABC.DEF.](image)

A triangular prism was waking three-dimensional space limited by the base and lid were identical triangular-3 and the sides of the square-shaped upright. Here's the formula volume and surface area of prisms:

\[
\text{Volume} = \text{the area of the base} \times \text{high from the prism}
\]
\[
\text{Surface area} = (2 \times \text{the area of the base of the prism}) + (\text{around the triangle} \times \text{high from the prism})
\]

3.2. Concepts and principles build pace rectangular space prism

![Figure 3. Rectangular prism EFGH.KLMN.](image)

Rectangular prism was waking up three-dimensional space formed by three pairs of square or rectangular, with at least one pair of which were sized differently. Here's the formula volume and surface area of the beam:

\[
\text{Volume} = \text{length} \times \text{width} \times \text{height}
\]
\[
\text{Surface area} = (2 \times l \times w) + (2 \times l \times h) + (2 \times w \times h)
\]
\[
= 2(lw + lh + wh)
\]

3.3. Concepts and principles build space rectangular pyramid

![Figure 4. Limas quadrilateral T.ABCD.](image)

Limas was a wake bounded by a rectangle as a base and four triangular fields that meet at a peak.

\[
\text{Volume} = \frac{1}{3} \times \text{the area of the base} \times \text{height}
\]
\[
\text{Surface area} = \text{the area of the base} + L. \ TBC + L. \ TCD + L. \ TAD + L. \ TAB
\]
3.4. Concepts and principles build space cube.

Figure 5. Cube ABCD.EFGH.

Cube was waking three-dimensional space bounded by six areas congruent sides of a square. The cube has six sides, 12 ribs, and 8 vertexes. Here’s the formula volume and surface area of the cube:

\[
\text{Volume} = s \times s \times s = s^3 \\
\text{Area} = 6 \times s^2
\]

According to Woolfolk [18], cognitive strategies include planning, monitoring, and evaluating processes. NCTM suggested three basic elements of metacognition include to develop an action plan, to monitor the action plan, and to evaluate action plans. In this research, these basic elements were found by students when they related the forms of some elements of traditional house in Rejang Lebong to geometric figures.

Any problems always need to solve. Therefore, the problem solvers should have a contextual understanding. Widada [19] suggested that someone has no understanding of a problem conceptually when the person does not utilize the concepts that have been learned or failed to implement the concept that has been known to solve the given problem. Troubleshooting was an attempt to find the solution to a problem. Polya mentioned that in solving a problem, there were four stages that must be made, including to understand the problem, to plan problem-solving process, to implement the plan of, and to re-check the solution obtained [4]. Santrock [20] stated that solving the problem can be done by finding and developing problems, developing strategies to solve the problem, evaluating the solution, and thinking and redefining the problem and the solution. According to Schoenfeld [21], there are five stages in solving the problem, namely reading, analysis, exploration, planning/implementation, and verification. Arzt & Armor-Thomas has developed step-by-step troubleshooting of Schoenfeld, becoming reading, understanding, analysis, exploration, planning, implementation, and verification [21]. In this research, the students used these steps during their metacognition process to validate the formulas of the 2-dimensional and 3-dimensional geometric figures, including the surface area and volume of pyramids, prisms, rectangular prism, and cubes.

4. Conclusion

Students solved mathematical problems through mathematization process based on ethnomathematics. Students were aware that Rejang Lebong's ethnomathematics was the starting point of horizontal mathematical activity. Just like the traditional house, the culture was a real problem to achieve geometric concepts, such as 2-dimensional and 3-dimensional geometric figures. In particular, students can discover about the surface area and volume of pyramids, prisms, rectangular prism, and cubes. The students’ metacognition was used to validate the correctness of the formulas.

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