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Analysis of Mathematical Problem Solving Ability of Students Viewed from Creative Thinking Stages in Problem-Based Learning Model

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Abstract

This study aims to analyze and determine the mathematical problem solving ability of students viewed from creative thinking stages in problem-based learning model and the indicators of student's mathematical problem-solving ability are understanding the problem, devising the problem solving, and solving problems, as well as creative thinking stages, including synthesizing idea, planning idea implementation, and implementing the idea. This research is a qualitative descriptive study. The subjects were 26 first-grade students of SMP Swasta Karya Bhakti Medan. The data analysis used is Miles and Huberman method. The results of this study show the analysis of mathematical problem solving ability of students viewed from creative thinking stages in problem-based learning model, namely: (1) in the high category of synthesizing idea stage, students completed three indicators of problem solving abilities. (2) in the medium category of planning idea implementation stage, students merely understood the problem and planned to solve the problem. (3) in the low category of implementing the idea stage, students only understood the problem.

Keywords: *Mathematical Problem Solving Ability; Creative Thinking Stages; Problem-Based Learning Model*

I. Introduction

The technology advancement in the modern era has transformed rapidly and sophisticatedly. The development is inseparable from the significance of mathematics. Mathematics is a universal science that is beneficial for daily life, underlies the development of modern technology, and has a vital role in various sciences, as well as promotes mindset [5]. It explains that mathematics subject aims to facilitate students in understanding mathematical concepts in problem solving. It indicates that mathematics is not only oriented towards improving student learning outcomes but is also oriented towards improving problem-solving ability.

The importance of problem solving ability as expressed by [2] is that problem solving ability is the core of mathematics. The problem solving ability has several indicators; (1) understanding the problem; (2) devising problem solving; and (3) solving problems.

One of the reasons for the students' low mathematical problem solving ability is that students could not solve problem solving questions adequately. Some students cannot understand the problems in the questions, cannot plan problem solving, and cannot solve the problems in questions. To answer problem solving questions, firstly, students need to understand the problem by writing what is given in the questions and what is asked in the questions so it is easier for students to employ mathematical formulas and complete the procedures in the questions.

Mathematical problem solving ability is associated with the creative thinking stage. According to [7], there are three stages of creative thinking in developing mathematics, comprising synthesizing the idea, planning idea implementation, and implementing the idea.

One of the efforts that can develop a student's mathematical problem-solving ability is using a problem-based learning model. Problem-based learning is learning that makes the problem the basis for students to learn. In line with the opinion [11] stated that problem-based learning is the learning model that utilizes real problems as a context for students to learn critical thinking and problem-solving skills, as well as to acquire knowledge and essential concepts from the respective subject.

The rationale behind choosing a problem-based learning model in improving problem solving and understanding students' concepts is because the problem-based learning model builds constructivism in which students focus more on developing thinking and problem-solving skills and communication and collaboration skills, as well as it arranges students' understanding of concepts in conducting investigations and social skills that require optimum reflection on group members' abilities. The role of teachers is as a facilitator and provide assistance to students.

This study attempts to describe the difficulties in mathematical problem solving that students encounter during the teaching-learning process so that teachers can understand and improve the factors causing these difficulties in the teaching-learning process.

II. Theoretical Framework

A. Problem-Solving

Mathematical problem solving is an individual process using one's prior knowledge, skills, and understanding to solve problems in unfamiliar situations [4]. This organized process contains methods, procedures, and strategies in solving mathematical problems [1]. Problem solving indicators are understanding the problem, devising the problem solving, and solving the problem. Understanding the problem is writing what is given and what is asked in the questions. Devising problem solving is creating a formula that will be used in the questions. Solving problem is organizing and implementing procedures to solve problems based on mathematical models, performing arithmetic operations correctly, and determining the results.

B. Creative Thinking Stages

Creative thinking is a thinking process that occurs in the mental activity of human beings and functions to formulate or solve problems [3]. Creative thinking in mathematics is a combination of logical thinking and divergent thinking based on intuition within the consciousness that considers flexibility,

fluency, and novelty [12]. Creative thinking contains three stages, synthesizing the idea, planning idea implementation, and implementing the idea [7]. The synthesizing idea stage is connecting or combining ideas owned which can be sourced from classroom learning and daily experiences. The planning idea implementation stage is choosing a specific idea to solve given problems. Implementing the idea stage is implementing or employing an organized idea to solve problems.

C. Problem-Based Learning

Problem-based learning is a learning model that uses a problem as the beginning of learning [10]. The objective of problem-based learning is to facilitate students in developing thinking ability or skills problem solving skill, and intellectual skills; teaches students to learn adult roles by getting involved in the real-life or simulation experiences; and shapes students into autonomous and independent learning. The problem-based learning model consists of five stages; orienting students to the problem, organizing students for learning, guiding individual and group investigations, and analyzing and evaluating the problem adjustment process [6].

III. Research Methods

This research is descriptive qualitative. This research was conducted at SMP Swasta Karya Bhakti Medan. The subjects in this study were 26 first-grade students of SMP. The subjects of the interview were selected based on the level of problem-solving ability, while the object of the study is students' problem-solving abilities and creative thinking stages. The mechanism used in this research includes three stages, including (1) the learning tools and research instruments; (2) learning tool validation and research instrument testing; and (3) the research implementation and data analysis. Each stage is designed accordingly to obtain valid data for research purposes. Meanwhile, the data analysis used is the Miles and Huberman method which consists of three interactive flows and continues to the end. Activities in data analysis are data reduction, data presentation, and drawing conclusions [8].

IV. *Results and Data Analysis*

a. Results

This research was conducted in a first-grade class at SMP Swasta Karya Bhakti Medan. The data from the research results were in the form of student learning outcomes and the data collection used a question instrument in the form of an essay consisting of four questions. The test data was obtained from the analysis of students' answers based on the scoring guideline of mathematical problem solving ability and the results of interviews were conducted with selected subjects based on the level of students' mathematical problem solving abilities; low, medium, and high. Each indicator of mathematical problem solving abilities includes understanding the problem, devising problem solving, and solving the problem [9]. Also, creative thinking consists of three stages, which are synthesizing the idea, planning idea implementation, and implementing idea [7].

Qualitatively, the level of students' mathematical problem solving abilities is displayed in Table 1 as follows:

Table 1. Levels of Students' Mathematical Problem Solving Abilities

No.	Score Interval	Number of Students	Percentage	Scoring Category
1.	$50 \leq$ SKPMM < 65	10	38,46%	Low
2.	$65 \leq$ SKPMM < 80	11	42,30%	Medium
3.	$80 \leq$ SKPMM ≤ 100	5	19,27%	High

Information: SKPMM = Score of Mathematical Problem Solving Ability

Based on the test results of students' mathematical problem solving abilities of 26 students, the level of students' mathematical problem solving abilities falls into three categories; 38.46% or 10 students had "low" category of mathematical problem solving ability, 42.30% or 11 students had "medium" abilities, 19.23% or 5 students had "high" abilities. Thus, it can be determined that the level of students' mathematical problem solving abilities after implementing problem-based learning is mostly shown by medium category.

However, it is also associated with creative thinking comprising of three stages, namely synthesizing the idea, planning idea implementation, and implementing the idea.

b. Data Analysis

Interviews were conducted with subjects in each classification of students' responses based on indicators (high, medium, and low). Data analysis from the results of students' mathematical problem-solving ability tests was triangulated by identifying the questions that students answered. Analysis of students' difficulties in mathematical problem solving was discovered correspond to the level of students' mathematical problem solving abilities (TPMM) comprising 3 stages of creative thinking; synthesizing the idea, planning idea implementation, and implementing ideas.

a. Analysis of Students' Difficulties in Mathematical Problem Solving of High-Ability Students through Synthesizing Ideas Stage

Based on the answer sheet of the problem solving ability test and by considering student's consent to be interviewed, S - 21 was selected as a student who was qualitatively analyzed from the high ability category. In the following, S - 21 answered question number 4 on the problem solving ability test and was interviewed to find the students' mathematical problem solving abilities.

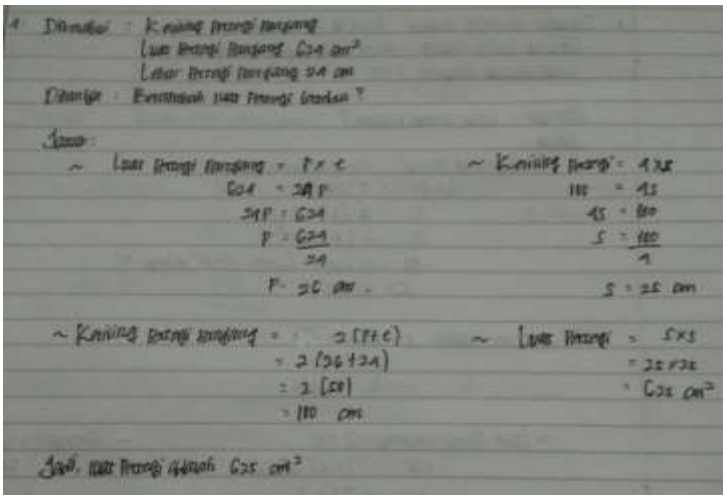

Figure 1.S-21 Answer Sheet on Question Number 4

Based on the results of the student's answer, it can be observed that the student answered question number 4 correctly and completely with the answer to the area of a square is 625 cm^2. From the answer, it shows that, based on the indicator of understanding the problem, students could write what was given and asked in the question precisely. On the indicators of devising problem solving, the student used formula being questioned. Lastly, on the indicators of answer the problem, the student could answer procedures in detail, correctly, and completely.

Based on the data triangulation obtained from the description of student answer sheet and the results of interviews with high category problem solving ability in the synthesizing idea stage, it can be determined that in the problem solving indicator, the student understood what was being answered and the student understood information from the problem and determined strategies and concepts to solve problems.

b. Analysis of Students' Difficulties in Mathematical Problem Solving of Medium-Ability Students through Planning Implementing Idea Stage

Based on the answer sheet of the problem solving ability test results and by considering student's consent to be interviewed, S-5 was selected as a student who was qualitatively analyzed from the medium ability category.

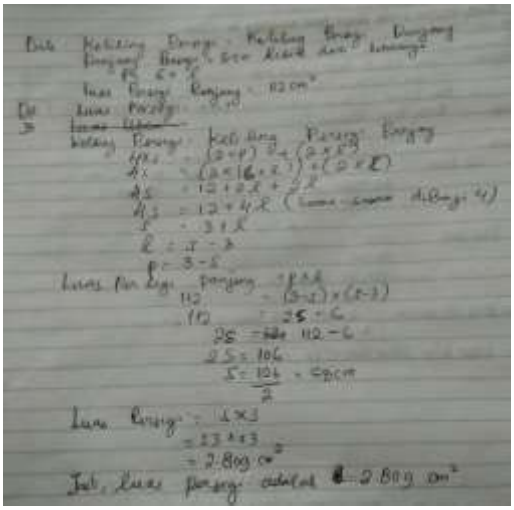

Figure 2.S-5 Answer Sheet on Question Number 1

Based on the answer sheet of S-5 in Figure 2, it can be observed that the student answered question number 1 correctly and completely. The student answered question number 1, the area of a square is 2,809 cm^2. From the answer, it displays that, based on the indicator of understanding the problem, the student could write was given and asked in the question properly and completely. In the indicator of devising problem solving (problem solving), the student could formulate a problem solving plan correctly and completely. In the indicator of solving the problem (answer the problem), the student could write the procedure correctly but miscalculate.

c. Analysis of Students' Difficulties in Mathematical Problem Solving of Low-Ability Students through Planning Idea Implementation Stage

Based on the answer sheet of the problem solving ability test results and by considering student's consent to be interviewed, S-24 was selected as a student who was qualitatively analyzed from low-ability students.

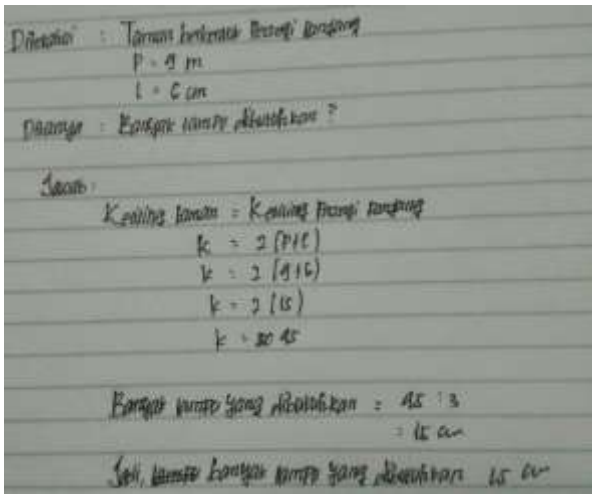

Figure 3. S-24 Answer Sheet on Question Number 2

Based on the S-24 answer sheet, it can be seen that the student answered question number 2, which is to determine the number of lights needed with the rectangular concept with the answer is 15 cm. From the answer, it discloses that, based on the indicator of understanding the problem, the student could write what was given and asked correctly but not completely. In the indicator of devising problem solving (solving the problem), the student could formulate problems but incomplete. In the indicator of solving the problem (answer the problem), the student could write the procedure correctly.

V. *Conclusion*

Based on the discussion above, it can be determined that the analysis of students' mathematical problem solving abilities viewed from creative thinking stages in problem-based learning model includes: (1) in the high category with synthesizing idea stage, students could answer problem solving indicators; (2) in the medium category with planning idea implementation stage, students could solve problems with indicators of understanding the problem and devising problem solving; and (3) in the low category with the implementing ideas stage, students could only solve problems with indicators of understanding the problem.

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