

Mathematical Reasoning

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Mathematical reasoning in problem-solving in three dimensions

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Abstract. This research is a qualitative study, where the purpose of this study is to describe the form of student reasoning in solving three-dimensional problems. To establish a research class, namely students of class XI-IPA who have studied Geometry material, especially Dimension Three, then conducts an analyzed test to determine the subject to be selected in the study. The number of research subjects to be selected are 3 people (high-ability subjects (ST), medium-capable subjects (SS), and low-ability subjects (SR). The research process followed the stages: Reasoning students in solving three dimensional problems with the indicators are: 1) Understanding the Problem; 2) Devising a Plan; 3) Carrying Out the Plan; 4) Looking Back.

1. Introduction

Mathematics is a universal science that underlies the development of modern technology, has an important role in various scientific disciplines and advances human thinking. mathematics is a science that is the basis for practicing logical and creative thinking skills [1]. Mathematics is the study of patterns abstracted from the world around us, so anything we learn in maths has literally thousands of applications, in arts, sciences, finance, health and leisure. In other words, Mathematics has a very essential role for other sciences, especially for science and technology [2].

National Council of Teachers of Mathematics is mention that there are five basic mathematical abilities that are standard processes namely reasoning, reasoning and proof, communication, connections and representation. By referring to the five NCTM capability standards, in the air learning mathematics according to the 2006 National Education Standards Agency (BSNP) namely that students have the ability to: (1) understand mathematical concepts, explain the interrelationships between concepts and use these concepts in completing problem or problem; (2) using reasoning, manipulating, and compiling evidence; (3) solving problems such as being able to understand problems, design mathematical models, solve models, and interpret solutions; (4) presents mathematical ideas with symbols, tables, diagrams, or other media; (5) has an attitude of appreciating the usefulness of mathematics in life [3]. Reasoning is very important in learning, in addition to helping students understand the subject matter, it also improves their thinking abilities. This is supported by Brodie that if students are given the opportunity to use their reasoning skills to make predictions based on their own experiences, then students will more easily understand them. Suppose students are given problems using real objects, students are asked to see patterns that are already known and evaluate them so that the results obtained are more informative. This further helps students in understanding the processes that have been prepared by doing mathematics and mathematics exploration [4].



One of the goals of mathematics learning that must be achieved by students is the reasoning ability contained in NCTM which is the basic ability of mathematics. But in learning mathematics that happens nowadays, it is not directly proportional to what is the guidance of the world. Mathematics learning in schools now pays little attention to the activeness of students and their learning processes, and is not subject to events that occur in the student environment or is unrealistic. So that what is taught by educators or education staff is now less meaningful for students. Jerome Bruner in his theory states that learning mathematics will succeed if the teaching process is directed to concepts and structures made in subjects that start with concrete objects intuitively, then at higher stages (according to students' abilities) this concept is taught in an abstract form using notations that are more commonly used in mathematics.

Reasoning is one of the events of the thought process. Limitation about thinking (thinking) is a series of mental activities that are many kinds such as recalling a thing, fantasizing, memorizing, counting, connecting some understanding, creating a concept or estimating various possibilities [5]. Reasoning is a process or activity of thinking to draw conclusions or make a new statement that is true based on several statements that were known beforehand using a logical method [6]. Based on the researchers' experience for geometry material, the underlying problem of students in addition to the abstract is that students' long-term memories are not embedded in their minds in solving problems regarding the three dimensions, this is due to the large number of abstract drawings or spaces that require strong reasoning so that the material they can just pass. According to Putri, Sulianto & Azizah students who have good reasoning skills will easily understand mathematical material and conversely students who have low mathematical reasoning abilities will find it difficult to understand mathematical material [7].

From some of the notions of mathematical reasoning it can be seen that what students must have in doing mathematical reasoning is the ability to carry out mathematical problem solving procedures and the ability to explain or give reasons for resolutions carried out. According to Polya interpreting problem solving as an effort to find a way out of a difficulty in order to achieve a goal that is not so easy to achieve immediately [8].

Based on the above background, the focus of this study is: Reasoning students in solving three dimensional problems with the indicators are: 1) Understanding the Problem; 2) Devising a Plan; 3) Carrying Out the Plan; 4) Looking Back.

2. Method

This research is a qualitative descriptive study with the aim to find out information about student reasoning in solving geometry problems, especially in the discussion of three-dimensional material.

Research Subjects are students of class XI-IPA who have studied Geometry material, especially Dimension Three. Taking research subjects by looking at the results of general mathematics tests and the consideration of teachers. The chosen study subjects are 3 people (1 high ability, 1 medium ability, 1 low ability).

The process of collecting data in this study will be done through interviews based on Mathematical problem solving tasks, where subjects are given paper and pens to do some assignments, then subjects are asked to describe in detail their understanding of solving circle problems. Interviews and observations are then carried out to explore the reasons for doing the mistakes and other possible solutions that can be done.

3. Result and Discussion

As for the results of research and discussion of the subject's mathematical reasoning process in solving problems one of the three dimensional problems at each stage of problem solving as follows:

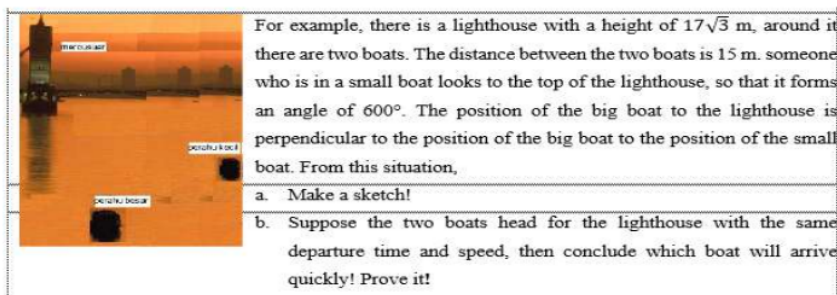


Figure 1. Three dimensional problems

Following is the explanation of data analysis about the reasoning of high-ability subjects (ST), medium-ability subjects (SS) and low-ability subjects (SR) in solving mathematical problems, especially in the third dimension:

a. Understanding the Problem

High-ability subjects (ST) explicitly understand the problem in the problem of TPMM, but when viewed from the results of problem solving, high-ability subjects (ST) do not write down what is known and what is asked at the given problem. Highly capable subjects know the steps that will be taken to be able to solve the problem. High-ability subjects (ST) use long-term memory, ST tries to connect a concept that has been obtained and then applied to the problem. However, highly capable subjects (ST) are less able to communicate the knowledge possessed to others.

Medium-capable subjects (SS) explicitly do not understand the problem, but are implicitly able to write what is known in the problem. In understanding the problem of moderately capable (SS) subjects, sometimes they are not able to manage the information that has been obtained and relate it to new things that actually have in common. Medium-capable (SS) subjects are more accustomed to relying on themselves, so mistakes often occur when solving problems both schoolwork and homework.

Low-ability subjects (SR) have in common with medium-capable subjects in understanding the problem. Low-ability subjects tend to be accustomed to describing things based on what they see and hear, without managing the information first. High-ability subjects (ST), medium-capable subjects (SS), and low-ability subjects are both doing reasoning that is presenting mathematical statements verbally, in writing, or drawing. However, high-ability subjects (ST) in understanding the problem also use their reasoning abilities, namely presenting allegations, compiling evidence and giving reasons for the truth of the solution and drawing conclusions from statements.

b. Devising a Plan

The highly capable subject (ST) in planning the solution explicitly made the initial guess by making a sketch to make it easier to determine the steps to be taken. Highly capable subjects (ST) remember mathematical concepts related to the problem. While subjects with moderate ability (SR) and subjects with low ability (SR) in planning a solution are still in doubt. This doubt is based on the lack of student experience in solving similar problems.

Based on this, it can be concluded that subjects with medium ability (SS) and subjects with low ability (SR) do not use reasoning as limited to procedural. While highly capable subjects (ST) use a parallelization that is submitting guesses, doing mathematical manipulation, and drawing conclusions from statements.

c. Carrying Out the Plan

High-ability subjects (ST) in carrying out the completion plan that is by using mathematical concepts that have previously been obtained. Subjects have the ability to manage or carry out mathematical manipulations based on things that are already known to both the problem and based on concepts that have existed on the subject. While the subjects of medium ability (SS) and low

ability subjects (SR) in carrying out the settlement plan can be said to be just trial and error. This can be seen from the method of completion and explanation given at the interview.

The subject of high ability in carrying out the plan of completion involves an indicator of reasoning that is mathematical manipulation, compiling evidence and giving reasons for the truth of the solution, and drawing conclusions from statements.

d. Looking back

At this stage high-capable subjects (ST), medium-capable subjects (SS), and low-ability subjects (SR) do not reason but only use procedural abilities in analyzing work that has been written on the answer sheets of mathematical problem solving tasks.

Based on data exposure and valid data the results of mathematical problem solving tasks with high-ability subjects (ST), medium-capable subjects (SS) and low-ability subjects (SR) in solving three-dimensional problems can be compared where the reasoning difference lies.

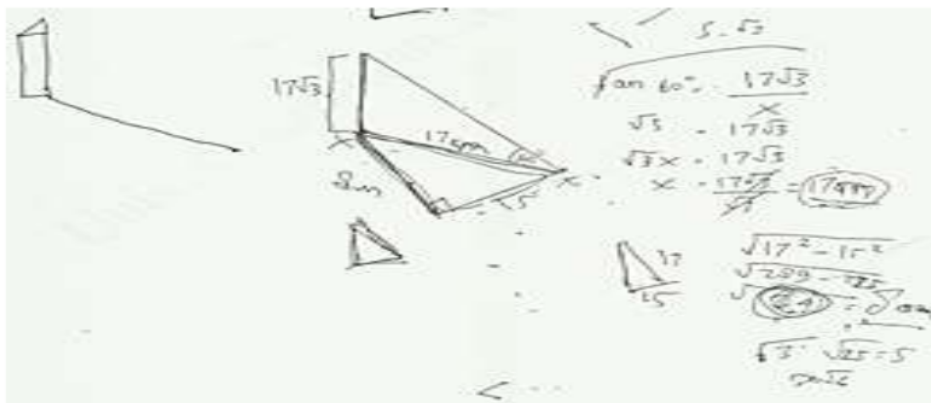


Figure 2. high-ability subjects (ST)

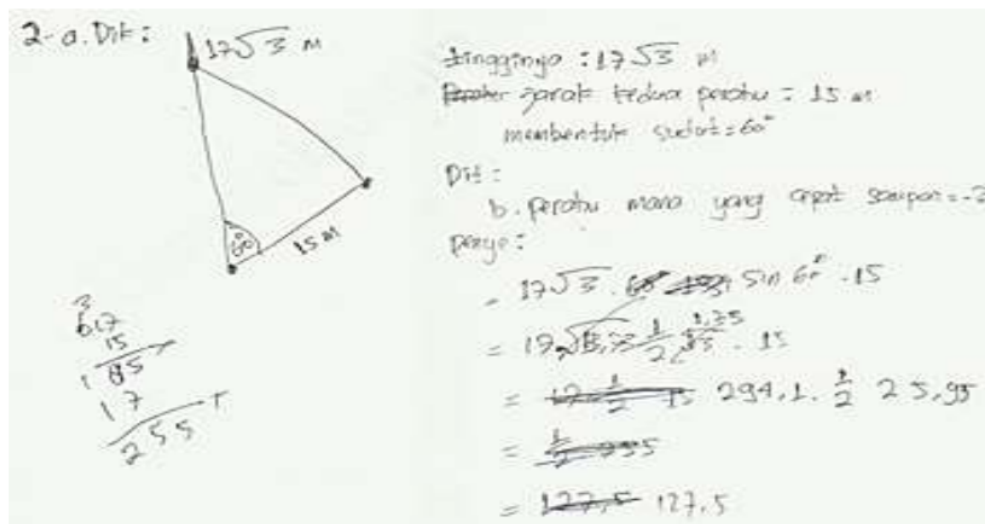


Figure 3. medium-ability subjects (SS)

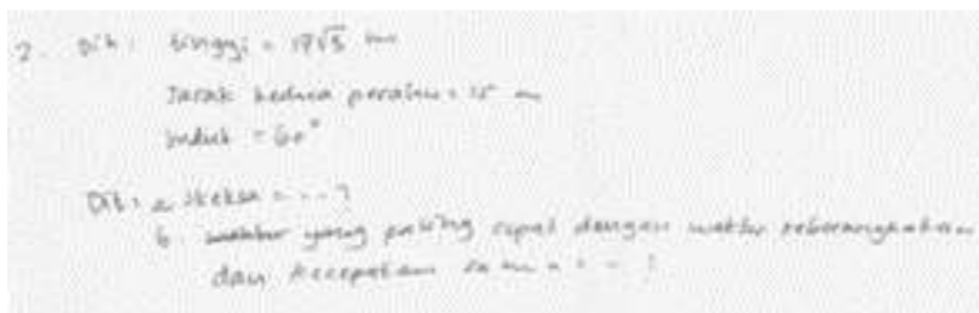


Figure 4. low-ability subjects (SR)

Highly capable subjects (ST) in understanding problems and planning the completion of the third dimension by using guesses in starting or starting solving a problem in this case solving three dimensional problems and finding patterns to plan solutions through mental activity and subject observation. If it is associated with the initial stage of solving the problem, the highly capable subject (ST) makes the initial observation in solving the problem, then from the observation results a conclusion that is associated with the knowledge and experience stored in its long-term memory. Activities carried out by subcells (ST) a characteristic of reasoning, it is in accordance with what is conveyed by Asrawati, that there is a mindset called logical. In this case it can be said that the activity of reasoning is a process of logical thinking. Logical thinking can be interpreted as thinking according to a certain pattern or according to certain logic; 2) the thought process is analytic. Reasoning is an activity that relies on an analytic, within the framework of thinking needed for a particular analytic. While subjects with medium ability (SS) and subjects with low ability in performing problem-solving steps, cannot use their reasoning abilities. Both subjects are only able to give a small picture of the problem [9].

4. Conclusion

There are several factors that cause the subject or student to be weak in reasoning, including: (1) students are less or not accustomed to expressing ideas. This is clearly seen both in high-ability subjects (ST), moderate-ability subjects (SS), and low-ability subjects (SR) who are less able to communicate what is in their minds into written or oral form. The highly capable subject states that he is incapable if asked to explain something, but to make himself understand, he can. Unlike the case with a moderately capable subject, in terms of expressing opinions or ideas he has a high enough confidence, even though what he puts forward is not necessarily true. While low-ability subjects (SR) in expressing their opinions or ideas still lack confidence or doubt. When viewed from the results of problem solving and interview results, it appears that subjects with low women (SR) are accustomed to accepting things without making a judgment; (2) the teacher has difficulty in guiding students to formulate a conjecture (conjecture) from existing data).

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