Problem-based learning model to improve mathematical reasoning ability

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Abstract. Reasoning ability is very important to note because it is able to train students' thinking activities to be able to solve mathematical problems. This ability is also a benchmark in determining student achievement in the field of mathematics, one of which is in the international event TIMSS and PISA. However, the competitiveness of Indonesian students is still very low compared to other countries. This can be caused by the lack of giving questions that practice the ability of reasoning by the teacher. Therefore, there is a need for improvement in the process of learning mathematics. In the learning process, students should be given the opportunity to explore all their potential. The teacher can offer problems that are able to train and develop mathematical reasoning abilities. Problem-based learning is problem-centered learning. Problems given can be related to real-life students and can practice the ability to reason and solve mathematical problems.

1. Introduction

Mathematics is taught to equip students with the ability to think logically, analytically, systematically, critically and creatively. Globally the aims of learning mathematics include learning to reason (think logically and analytically). This ability is needed so that students have competitiveness and are able to follow the development of science and technology that often changes along with the times. However, students' competitiveness Indonesia is still very low compared to other countries.

This can be seen from the results of international standardized tests, which are the results of PISA in 2015, namely Indonesia ranked 62 out of 72 countries [1]. TIMSS results in 2015, Indonesia ranks 45th out of 50 countries [2]. One of the abilities tested at the event is the ability of mathematical reasoning. This illustrates that the mathematical reasoning ability of Indonesian students is still very low. This can be due to the lack of giving questions that are practicing reasoning skills so students cannot develop these abilities. This illustrates that the mathematical reasoning ability of Indonesian students is still very low.

Therefore, improvement is needed in learning mathematics. In the learning process, teachers can offer problems that are able to train and develop mathematical reasoning abilities. Problem-based learning is problem-based learning. Problems generally occur because of the gap between the expected conditions and real conditions. Problem-based learning can be interpreted as a series of learning that emphasizes the process of solving problems faced scientifically. According to Trianto [3], the problem-based learning model is a learning model that is based on the many problems that need authentic investigation, that is, investigations must in real resolution of problems [4]. Problem-based
learning model is a learning model that can help students to be active and independent in developing thinking skills to solve problems through data search so that rational and authentic solutions are obtained.

2. Methods
This research is a development research or development research type formative research [5,6]. Research and development according is "a process used to develop and validate educational products" (research and development is a process for developing and validating educational products). This study developed a Student Worksheet based on valid and practical problem based learning in mathematics learning for grade VIII SMP. This research was conducted in two stages, namely the preliminary or preparatory stage and the formative evaluation stage. The formative evaluation stage includes: 1) Self evaluation consists of: a) analysis and b) design, 2) Prototyping (validation, evaluation and revision) consists of: a) expert review and one-to-one, b) small group, and 3) Field test.

3. Results and discussion
3.1. Problem-based learning model
According to Slameto [7], problem-based learning is: "A learning model that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills, as well as to gain knowledge and concepts that are essential from the subject. In terms of these students are involved in investigations for problem-solving which integrate skills and concepts from various contents of the subject". Suyatno [8] says, "Problem-based learning models can present authentic and meaningful problems so students can investigate and find out for themselves". And the problem-based learning model according to Suradijono [9] is a learning method that uses problems as a first step in collecting data and integrating new knowledge ".

The opinions of Bern and Erickson [7]. problem-based learning are Learning models that involve students in solving problems by integrating various concepts and skills from various disciplines. This strategy includes gathering and uniting information, and presenting findings. The opinion of Riyanto [4] said, "Problem-based learning is a learning model that is designed and developed to develop students' ability to solve problems". According to Arends [3]. problem-based learning is A learning model where students work on authentic problems with a view to compiling their own knowledge, developing inquiry and higher-order thinking skills, developing independence and self-confidence.

Some definitions according to the experts above can be concluded by the writer that the problem-based learning model is one of the learning strategies used by teachers in the process of learning activities by using problems as a step to gather knowledge, so that it can stimulate students to think critically and learn individually or in groups. Small until finding a solution to the problem. The teacher's role in the problem learning model is as a facilitator and proving assumptions as well as listening to existing perspectives on students so that those who play an active role in the classroom during learning are students.

According to Arends [10]. the most important features of the problem-based learning model area: a. Submitting questions or problems: 1) Authentic, i.e. the problem must be rooted in the real world life of students; 2) Clearly, i.e. the problem is clearly formulated, does not cause new problems; 3) Easy to understand, i.e. the problem given is adjusted to the level of student development; 4) Broad and proper learning objectives; 5) Useful, namely the problem is beneficial for students; b. Focusing on the interconnectedness between disciplines. Although problem-based learning is aimed at a particular field of science but in solving real problems, students can investigate from various sciences. c. Authentic inquiry (real), in the investigation of students, to analyze and formulate problems, develop and predict hypotheses, collect and analyze information, conduct experiments, make conclusions and describe the last results. d. Producing products and exhibiting them Students are tasked with compiling their learning outcomes in the form of work and displaying their work; e. Collaborative Learning tasks in the form of problems are solved jointly between students.
Based on Arendts opinion about the characteristics of problem-based learning models the writer can draw conclusions problem-based learning models in the learning process activities begin by giving clear problems to students rooted in real-world life, then students must collect data, gather information, conduct experiments and draw conclusions in groups, so students play an active role in learning activities and the teacher as a facilitator also pays attention to students' questioning skills.

Arends [10] suggests the syntax of problem-based learning, namely: a. Student orientation to problems The teacher conveys learning objectives explains the logistics (materials and tools) needed for problem-solving and provides motivation for students to pay attention to problem-solving activities. b. Organizing students. The teacher helps students define and organize learning so that it is relevant to problem-solving. c. Guiding individuals and group investigations The teacher encourages students to search for proper information, conduct experiments, and look for explanations and problem-solving. d. Develop and present results. The teacher helps students in the planning and realization of the results in accordance with the given task; e. Analyze and check the process and results of problem-solving. The teacher helps students to show on the results of their investigations and the learning processes that have been carried out.

The conclusion drawn from the opinion of Arends about the steps of problem-based learning according to the author is that in the first steps of learning students must be able to formulate the problem to be solved and studied, and the teacher is tasked with guiding students, then students must be able to analyze the problem from various points of view, after the students find the cause and effect to be solved or resolved, to solve existing problems students must gather information or data from various relevant sources, then students hypothesize to produce the data needed and draw conclusions.

3.2. Mathematical reasoning ability
The reasoning is a thought process that seeks to connect known facts or evidence to a conclusion [11]. In addition, Sobur [12] states that reasoning is an activity of thinking to get a conclusion from known premises. Surtasumantri [13] states the characteristics of reasoning as follows: (1) the existence of a pattern of thinking that can broadly be called logic, logic is a formal thinking system in which there is a set of rules for drawing conclusions, the reasoning is a process of logical thinking, where logical thinking is defined as the activity of thinking according to a certain pattern or certain logic, (2) analytical nature of the thought process, the reasoning is an analytical activity that uses scientific logic, an analysis is an activity of thinking based on certain steps, broadly speaking, reasoning can be divided into two, namely as follows: (a) inductive reasoning; inductive reasoning is defined as a thought process to draw conclusions from specific things to general things, (b) deductive reasoning; deductive reasoning means the thought process to draw conclusions based on agreed rules or general matters leading to specific things.

In learning mathematics, deductive reasoning is more widely used than inductive reasoning. This is because the process of drawing conclusions is based on statements that have been believed to be true such as definitions, axioms or theorems.

Based on the description above, it is concluded that the ability of mathematical reasoning is the ability to carry out logical and analytical thinking processes to get conclusions both deductively and inductively.

According to Sumarmo [14] mathematical reasoning includes: (1) drawing logical conclusions, (2) providing explanations using models, facts, traits and relationships, (3) estimating answers and solution processes, (4) using patterns and relationships to analyze mathematical situations, (5) construct and test conjectures, (6) formulate counterexamples, (7) follow the rules of inference; checking the validity of arguments, (8) constructing valid arguments, and (9) constructing direct evidence and using mathematical induction.

Regulation of the Director-General of Primary and Secondary Education No. 506 / C / PP / 2004 (MONE, 2004) states the reasoning indicators that must be achieved by students. Indicators that show reasoning include: (a) the ability to present mathematical statements verbally, in writing, pictures, and
diagrams, (b) ability to give conjectures, (c) the ability to do mathematical manipulation, (d) the ability to compile evidence, give reasons/evidence for the correctness of the solution, (e) the ability to draw conclusions from statements, (f) the ability to check the validity of an argument, (g) find patterns or properties of mathematical symptoms to make generalizations.

4. Conclusion
The ability of mathematical reasoning is the ability to carry out logical and analytical thinking processes to get conclusions both deductively and inductively. So to increase the ability of mathematical reasoning, it is necessary to apply a learning model that can help students to be active and independent in developing thinking skills to solve problems through data search to get rational and authentic solutions. Problem-Based Learning is a learning model that requires students to think about solving problems.

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