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Increasing junior students' learning outcome using systematic approach to problem solving

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ABSTRACT

A learning program not only aims to make students understand and master what and how things happen, but also provide an understanding of why it happened. Thus, a lesson that emphasizes problem-solving becomes very important to teach. One form of learning that emphasizes the problem solving is to apply systematic approach to problem solving. This is a guide to perform an action that serves to assist a person in solving a problem. Problem solving steps based on systematic approach to problem solving consists of four stages, namely problem analysis, problem solving process planning, calculation operations, and checking answers and interpretation of results. This study is a classroom action research that aims to see the inceasing of student learning outcomes after applied systematic approach to problem solving. The subject of this research is 25 students of class VIIIA MTs Salafiyah Syafi'iyah Tebuireng Jombang. Instruments in this study is a matter of student learning outcomes on the material wake up space. This research was conducted in two cycles because in the second cycle has reached the indicator of success that students achieve the minimal clarity of at least 75%. The results showed that student learning outcomes in the first cycle reached 36% classical completeness, and in the second cycle of classical completeness of 84%. This shows that the application of systematic approach to problem solving can increase student learning outcomes.

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1. INTRODUCTION

Good education is an education that not only prepares the students for particular profession or positions, but also prepares them to be able to solve daily problems [1]. The correlation between the ways teachers teach and the students' efforts in acquiring and developing the acquired insights is such a way to enhance the quality of education in schools and to attain students' successfulness in their learning process. The material that can not be separated from everyday life is mathematics.

Mathematics is one fundamental subject in science and, as a course; it is categorized into exact field, which needs more concentration on comprehension rather than memorizing. To understand a subject matter in mathematics, students need to master several mathematical concepts along with their relationship in order to solve problems they encounter. They need to comprehend the given concept and apply it to solve daily problems. So it can be said that the learning to solve problems related to everyday life will make students' ability to be better [2].

The purpose of learning mathematics since elementary and general grade is to make students able to use mathematics and mathematical thinking for their daily lives and for learning various disciplines. Learning mathematics emphasizes on students' capability to solve their daily problems. This capability is crucial.

Thus, students should drill, practice, and get used on it since early ages. Learning mathematics needs reasonable and mathematical thinking to solve existing problems and learn something new; hence, it is more than just counting [3]. The ability of these students depends on the success of the learning process by the teacher.

Basically, learning programs aim not only to understand and master on what and how something happens, but also to provide an understanding and mastery about "why it happens". Building on this notion, learning how to solve problems is crucial to teach. Based on the regulation of the Minister of Education and Culture about basic and secondary education content standards that problem solving is a part of the competence that must be possessed by students [4]. Problem solving plays an important role in the curriculum for several reasons: 1) can build new mathematical knowledge, 2) solve problems in other mathematical or context contexts, 3) be able to implement and adapt various problem solving strategies, 4) monitor and reflect problem solving process mathematics.

Problem solving is including situations where an individual in dealing with problems can not solve by routine or familiar procedures [5]. Mathematical problem solving is an activity that includes student involvement in various cognitive actions, including accessing, using knowledge, and prior experience [6]. Problem solving as a manifestation of mental activity consisting of various cognitive skills and actions [7]. Problem solving is a process that involves students in various cognitive actions such as abstracting, representing, integrating, and using prior knowledge. Further troubleshooting is intended in this study is an activity that involves students in solving problems to obtain solutions where this solution can not be done with routine procedures.

The success of students in solving problems is an important goal in learning mathematics and the success of students in solving problems is very dependent on problem-solving strategies. A problem-solving strategy is an action or method used by students to understand and solve a problem [8]. Problem solving strategies are 1) guessing and testing, 2) drawing, 3) using variables, 4) finding patterns, 5) making lists, 6) solving simpler problems, 7) drawing diagrams, 8) using direct reasoning, 9) using indirect reasoning, 10) using numerical properties, 11) solving equivalent problems, 12) work backward, 13) using cases, 14) solving equations, 15) looking for a formula, 16) doing a simulation, 17) using a model, 18) using dimensional analysis, 19) identifying sub purposes, 20) using coordinates, 21) using symmetry. These diverse problem-solving strategies can be an option for someone to succeed in solving problems [9].

To improve students' successfulness in solving a problem, Metter et al. [10] constructed a heuristic system set in Program of Action and Methods (PAM). This PAM is a general strategy applicable in more specific fields, that is, Systematic Approach to Problem-Solving. It is useful as a guideline to solve problems. So someone will go through the stages of systematic approach to problem solving in order to be able to solve problems well and find the right solution. There is little information in the standards document about how to implement problem solving in the school curriculum. There is now a mounting body of literature pointing to the fact that problem solving is still not implemented in mathematics classrooms in many parts of the world, or if implemented, then only certain routine approaches to heuristics are being adopted [11-15].

Someone will be able to go through the stages in systematic approach to solve the problem when they have good thinking skills. The problem-solving process allows the team to identify issues and implement action plans to reduce barriers and solve problems to meet predetermined objectives. Working together in a collaborative group is an important part of starting the process [16]. Be creative and open minded toward solutions are two matters individuals need to have when solving their problems. Using systematic approach to solve problems may accelerate the process of solving problems by students. Six procedures are identified for problem-solving, which involve: identifying the problem, analyzing it, identifying particular possible solutions, evaluating those possible solutions, elaborating the strategy of solving the problem, verifying the solutions whether or not they may address the problem [17].

Systematic approach to problem-solving has four procedures to address problems, which involve: analyzing the problem, constructing a strategy for problem-solving, having a counting operation, and checking the solutions along with its interpretation. The first procedure is analyzing problems, which asks students to carefully read the task and then note what they just identified and felt curious on along with possible solutions addressing that problem. Second, the students need to construct a strategy to solve the problem, in case that it has been standardized. However, when it is not standardized yet, they need to write down the formulation and check whether it corresponds to the problem they encounter. Furthermore, they need to translate the problem into the standardized one.

Third, counting operation is conducted through data distribution. The data was identified in standardized one and allowed to conduct a counting process. Students must be careful in doing the calculations so that the answers obtained are correct. Finally, checking the answers or solutions along with the interpretation of the result makes the students compare the counting result with the possible answer they have found in problem analysis. They need to check whether the answers correspond to the problems and

identify any mistakes they did. If the student finds a mistake in either the calculation or decision-making process, then the student should immediately justify the answer.

A systematic problem-solving approach is an approach that seeks a good and practical solution gradually. In practice, it is often easy to choose a systematic approach while also applying your creativity during certain stages. In addition to the systematic approach, there is also a creative approach. Both of these are not contradictory, they can be applied on the basis of the situation. A systematic and creative approach can be applied together to produce better problem solving [18].

The advantages of applying problem-solving learning among others are, 1) problem solving can make education in school become relevant with life, especially work world; 2) the learning process through problem solving can familiarize the students face and solve problems skillfully, if faced with problems in family life, society and work someday, a capability that is very meaningful for human life; 3) This strategy stimulates the development of students' creative thinking skills and comprehensively because in the learning process, students do a lot of trials by highlighting the problems from various facets in finding the solution [19] .

Several studies have been conducted related to student problem solving. The analysis result of this study found a positive relationship between teacher-students interaction and motivation, as well as the students' achievement. Thus, teacher's instruction that leads students to solve problems is necessary for students [20]. The procedures on the systematic approach to problem-solving and teacher's assistance are expected to help students in solving mathematics problems. Solving problems by steps and particular rules is best and helpful for students to solve problems.

Other study suggested that systematic approach to problem solving influenced the students' mathematics learning outcomes [21]. Learning outcomes is vital in learning process. It refers to patterns of actions, values, understandings, attitudes, appreciation, and skills [22]. The learning outcomes intended in this study points to the students' cognitive values after applying systematic approach to problem solving.

Several studies have been conducted but no research has been done to explain the increasing of student learning outcomes. This research is a research continuing previous research, this research aims to increase student learning outcomes by applying systematic approach to problem solving.

2. RESEARCH METHOD

Generally, this study aimed to see an improvement of the students' learning outcomes through the application of systematic approach to problem solving. Corresponding to this purpose, this study is a Classroom Action Research (CAR). Kunandar defined CAR as a scientific activity of a teacher, also acted as the researcher, in her/his class, either individually or collaboratively, by designing, executing, and reflecting the action in collaborative and participative manner aimed to improve or enhance the quality of teaching and learning process in class through particular treatment in a cycle [23].

This study was conducted with the students of MTs Salafi'iyah Tebuireng, particularly at class VIIIA. It is a private Islamic school in Jombang, East Java. This study was conducted in one class containing 25 students in order to see the improvement of the students' learning outcomes after a treatment –*Systematic Approach to Problem Solving*- was implemented. Geometry referring to cube and rectangular cuboid was selected as the learning material, which started from understanding the features of cube and cuboid, drawing the nets, up to determining the surface area and volume of those type of geometry. The key concept of Classroom Action Research, following Kurt Lewin, consisted of four components which included planning, acting, observing, and reflecting [24].

The instrument used in this study is test on students' learning outcomes. The test was in the form of essay about cube and rectangular cuboid. It was aimed to observe the students' understanding on those types of geometry (i.e., cube and rectangular cuboid) and, thus, see whether or not their learning outcomes was improved after a treatment - *Systematic Approach to Problem Solving*- was implemented. Before it was applied for data collection, it should be firstly validated by experts. Hence, the researcher asked a favor to an expert of mathematics and an expert of education to validate the instrument for this study.

The indicator of success in this study is the achievement of the percentage score of students learning outcomes that complete classical learning at least 75% after applied systematic approach to problem solving from cycle 1 to the next cycle. And students achieve the average learning completeness minimal mastery standard MTs Salafiyah Syafi'iyah Tebuireng that is 75 after applied learning by applying systematic approach to problem solving.

3. RESULTS AND ANALYSIS

3.1. Cycle 1

The first cycle run in two meetings. The former conducted the learning process by applying *Systematic Approach to Problem Solving*, and the latter conducted the test of students' learning outcomes. This cycle consisted of four procedures. First, *planning*. The researcher designed the teaching plan, the task for testing the students' learning outcomes, and the alternative test, and then validated the test. The researcher validates the instrument to a person skilled in mathematics.

Second, *acting*. The researcher did the teaching-learning process by applying *Systematic Approach to Problem Solving*. Understanding the features of cube and cuboid, drawing the nets, and determining the surface area and volume of those types of geometry were selected as the learning material. In this process, the researcher provided students with task and asked them to complete it using the systematic approach. This approach involved analyzing the problem, designing the strategy to solve the problem, conducting counting operation, and checking the answers followed by interpreting the results, respectively. At the implementation stage, the researcher helps students by giving worksheets. This has never been done in previous research. Students are able to work on the worksheet in accordance with the stages of systematic approach to problem solving. There is a small discussion process that is also visible when students have difficulty in solving problems

Third, *observing*. The researcher observed the students during the learning process. She assisted them who found difficulty in solving the problem, while observing and admonishing the others who seemed not focused on their learning in order to make sure that they all were able to understand the material well. The help given by the researcher to this student is referred to as scaffolding as revealed by vygotksy. Previous research has also revealed that the ability to understand the mathematical concepts of students learning with scaffolding approaches is better than the ability to understand the mathematical concept of students learning by using conventional learning [25]. The researcher acted as teacher observing the students solving the given problem by applying *Systematic Approach to Problem Solving*. After the process ended, the researcher provided them with a test on the next meeting in order to see their learning outcomes.

Based on the result, 16 of 25 students having the test reached their score less than 75 or under the minimal mastery standard the school had predetermined. It indicated that they did not complete their learning yet. The other 9 students had their score above 75, which indicated their complete learning. The students' average score was 67 with the classical completeness at 36%. Classically, it was not yet considered complete since it did not reach 75%.

Forth, *reflecting*. The researcher analyzed and evaluated the students' observed learning outcomes in order to see the successfulness of this study, respectively. The result of this stage was used for refinement to conduct Cycle 2. The students' learning outcomes only reached 36% classical completeness. It indicated that most of them did not comprehend *Systematic Approach to Problem Solving*. Hence, in the next cycle, the researcher -as teacher- should be more active to interact with the students and motivate them to ask what they did not know yet. The researcher should pay more attention on students who needed assistance to get out from the difficulty they might encounter in problem-solving. The students should be drilled to be familiar with *Systematic Approach to Problem Solving* in order to make them easier for problem-solving, and finally in turn, their classical completeness might reach more than 75%.

3.2. Cycle 2

This second cycle run in two meetings. The former conducted the learning process by applying *Systematic* Approach *to Problem Solving*, and the latter conducted the test of students' learning outcomes. Similar to the previous one, this cycle consisted of four procedures. First, *planning.* The researcher designed the teaching plan that corresponded to the reflection on Cycle 1. In addition, the researcher also designed the task for testing the students' learning outcomes and the alternative test for this second cycle, and then validated the test to the experts, respectively. After conducting validation and it was considered valid, the researcher collected the data.

Second, acting. The researcher acted as teacher conducting teaching-learning process by applying Systematic Approach to Problem *Solving*. The material continued to determining the surface area and the volume of cube and rectangular cuboid. The researcher provided the students with task containing related problems which pointed to *Systematic Approach to Problem Solving*. The researcher refined the learning process based on the reflection in Cycle 1. She made students more active in their learning process. She stressed more on problem-solving and asked the students to be more active in learning. She asked them to make questions for any difficulty they found. In addition, she motivated them to solve the problem well.

Third, *observing*. The researcher observed the students during the learning process. She led them to be more active and to make questions for any difficulty they found. Compared to Cycle 1, this current cycle was better. The students were more enthusiastic and encouraged to pay attention on the researcher, acting as

teacher. They were more likely to ask and interact with the teacher, since they were accustomed to the researcher acting as their teacher and it made them enjoy the learning. Additionally, they were more capable to apply *Systematic Approach to Problem Solving* and hence, more motivated to solve the problem. After the learning process ended, the researcher provided them with a test in order to see their learning outcomes.

Based on the result, 21 of 25 students reached their score more than 75 or more than the minimum criteria of successfulness (i.e. KKM) the school had set. It indicated that they had completed their learning. However, the other 4 students had their score less than 75, indicating their incompleteness in learning the subject matter. The students' average score was 85.5 with the classical completeness at 84%. It showed that the indicator of students' improvement in their learning outcomes had completed, and thus, the research completed in Cycle 2 as well.

Forth, *reflecting*. In this phase, the students' learning outcomes were analyzed in order to see the successfulness of this current study. The result of Cycle 2 showed that the students had successfully reached the classical completeness. Therefore, the study ended in Cycle 2 since it had matched the successful criteria. In addition, the students' learning activity in Cycle 2 was found better than the first one. They seemed more motivated to learn and more focused on the process of problem-solving.

4. CONCLUSION

The result concluded that applying *Systematic Approach to Problem Solving* enabled to improve the 8th students' learning outcomes, particularly in cube and rectangular cuboid. This improvement was found in the increasing results from Cycle 1 to Cycle 2. In Cycle 1, the students' average score was 67 with the classical completeness at 36%. In Cycle 2, however, the students' average score was 85.5 with the classical completeness at 84%. It indicated an improvement and completeness on students' classical learning outcomes since it reached over the criteria of successfulness which was predetermined at 75%, as the researcher set. The result of this study showed that the application of *Systematic Approach to Problem Solving* could be used as an option for teachers to teach problem-solving to their students.

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