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The Implementation of Physics Problem Solving Strategy Combined with Concept Map in General Physics Course

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Abstract. This paper aims to provide a description of the implementation of Physic Problem Solving strategy combined with concept maps in General Physics learning at Department of Physics, Universitas Negeri Padang. Action research has been conducted in two cycles where each end of the cycle is reflected and improved for the next cycle. Implementation of Physics Problem Solving strategy combined with concept map can increase student activity in solving general physics problem with an average increase of 15% and can improve student learning outcomes from 42,7 in the cycle I become 62,7 in cycle II in general physics at the Universitas Negeri Padang. In the future, the implementation of Physic Problem Solving strategy combined with concept maps will need to be considered in Physics courses.

1. Introduction

Recently, research in physics education has made some major advances by adopting important findings from research on expert-beginner relationships and cognitive science [1]. These findings lead to the ability of students to solve physics problems with high-level thinking and can help students become like an expert in solving physics problems. To achieve this goal, a problem solving strategy in physics is needed to transform the student into an expert in solving physics.

There are two factors that can help a student to have better problem solving physics skills, namely: First, students must know and understand the principles of physics. Secondly, students should have a strategy to apply these physics principles to new situations where physics can help [2]. Thus, the given learning needs to apply a physics problem-solving, learning strategy to help students have better physics problem solving abilities.

The problem solving, learning strategy is part of the inquiry learning strategy. This learning strategy, emphasizes the completion of a problem by reason. Why is the importance of a problem-solving learning strategy? The reason, because in principle learning is a process of interaction between humans with the environment, which takes place gradually, ranging from receiving stimulus from the environment, to give the right response to it.

Problem solving is an individual or group effort to find answers based on knowledge, understanding, skills that have been previously held in order to meet the demands of unusual situations [3]. Meanwhile, Martinez [4] says that problem solving is "... the process of working towards a goal without a script and this is the cognitive passport to the future ...." Thus problem-solving learning is indispensable in developing student skills to solve problems in everyday life.

Research on problem solving strategies has been applied in several disciplines such as physics, medical diagnosis, engineering, design and computer programming. In Physics learning, this strategy

has been done with various methods and levels of education. Heller and Hollabaugh [5] develop problem solving strategies in cooperative learning that can improve students' problem solving physics skills. Gonen and Basaran [6] use a problem solving strategy combined with a Course Management System (CMS) in distance physics learning via the internet. It effectively improves students' problem solving skills in physics. Chi and VanLehn [7] found that when high school students are trained to identify and understand the concept of the problem, the gap between good problem solvers and weak problem solvers can be minimized.

In Indonesia, the application of problem solving strategy in physics learning has also been done by several researchers. Asma and Ramli [8] developed a model of learning to improve the ability to solve high school physics problems. Sriyanti [9] apply Heuristic method in solving basic physics problems I so that can increase activity and result of student learning in subject of Basic Physics I.

Problem solving skills is one of the six competency indicators of students who have guaranteed 71.7% satisfaction from stakeholders [10]. The six indicators are: computer skills, application in major, oral comunication, problem solving skills, thinking / reasoning and writing skills.

Based on the experience of teaching the subjects of General Physics and discussions with some lecturers of General Physics subjects, the author observes that students have difficulties in understanding abstract physics concepts, and students tend to understand the physics concepts separately. In addition, there are still many students who only understand the learning materials, but are not able to solve the problems given. As a result, when the examination, the value obtained by students is still low. When given any exercise, it turns out that only a small percentage of students can do it well, most students do not know what to do. In order for students to be able to solve the problems of physics, needed mastery of physics concepts and strategies problem solving physics is good.

Based on detailed interviews with some students and a team of General Physics lecturer, author concludes that the concerns expressed in this General Physics learning, among others:

- Students have difficulty connecting physics concepts.
- Students have less problem solving skills in solving general physics problems.

Consequently, the learning process needs to be carried out with problem solving strategies combined with concept maps, to improve students' ability to solve general physics problems.

At the beginning, researchers have not used the strategy of Minnesota Physics Problem Solving, so the ability of students to solve the problem of General Physics, is still low. Further Researchers take action that is the implementation of Minnesota Physics Problem Solving strategy as much as two cycles. In the first cycle of learning using the strategy of Minnesota Physics Problem Solving, and continued in cycle II using the strategy of Minnesota Physics Problem Solving combined with concept maps so that the expected end-ability of students in solving the problem of General Physics, increased. The diagram of the framework of thinking is shown in Figure 1.

Problem-solving strategies can be divided into major steps and minor steps. Heler and Heler [11] divide the problem solving strategies in physics into five steps: Focus on the Problem, Physics Description, Plan a Solution, Execute the Plan, and Evaluate the Solution.

The five steps of the problem solving strategy above are an effective way to generate problem solutions based on a physics understanding. The quality of the solution depends on the knowledge students use in obtaining solutions. The use of strategy also makes it easier to look back through the solutions that have been made. The above strategy is called the minnesota problem solving strategy. This strategy can be used to organize abilities in order to develop students' problem solving skils, and become one of the important tools in physics learning.

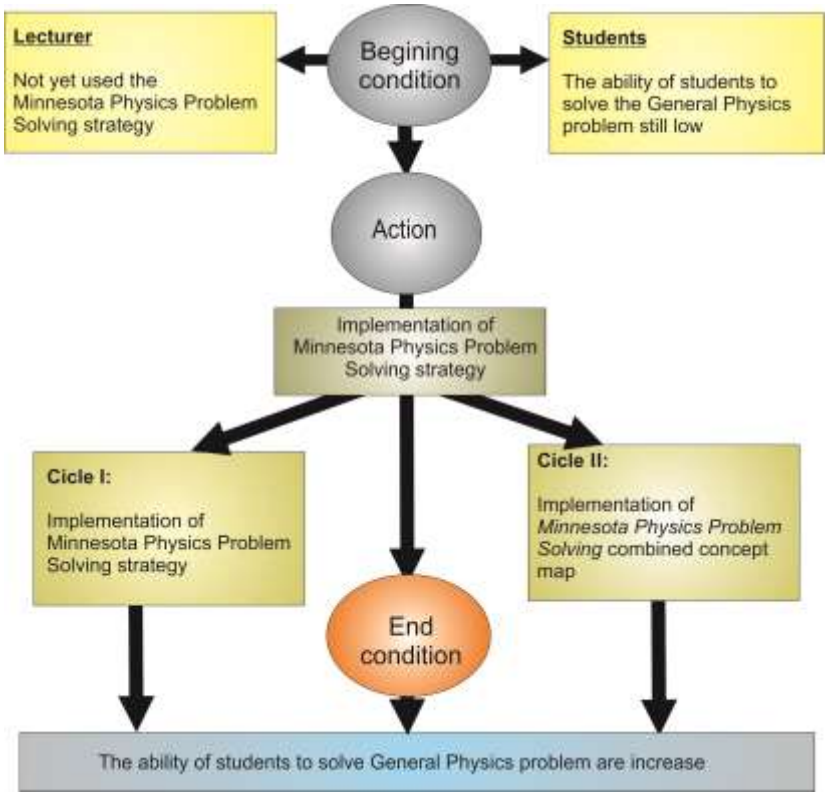

Figure 1. Framework of thinking

2. Research Methods

The type of research is Classroom Action Research. The design of each cycle consists of four stages: action planning, action implementation, observation/evaluation and reflection. The data of learning result is collected through test which its implementation is done at the end of each cycle. Meanwhile, student activeness data was collected by observation sheet. Research subjects were 46 first year students who took the General Physics course.

The steps of research activities and class actions that have been done are:

1. Preparation of Action: Preparation of action is as follows: drafting of Minnesota Physics Problem Solving strategy guidance, drafting concept maps, assessment formats, evaluation tools and questionnaires.
2. Implementation of Action: (1) The researcher prepares the lesson material, (2) The researcher explains the material and gives some examples of how to work the problem using 5 steps in Minnesota Physics Problem Solving strategy: Focus on the Problem, Physics Description, Plan a Solution , Execute the Plan, and Evaluate the Solution. At the end of the cycle / recovery researchers give tests to determine the ability of learning/learning outcomes.
3. Observation and Evaluation: During the learning activity the researcher monitors the learning process on the learning outcomes and understanding the student concept in each cycle. Observation of student learning outcomes is done at the end of each cycle by providing a written test.
4. Reflection: The results of observation / evaluation of the action is done to see if there is a stage that has not been optimal, so it needs re-diagnostic to the implementation of action in the first cycle. These diagnostic results are used to plan and implement actions in the second cycle.

3. Results and Discussion

The student activity when doing General Physics problems using Minnesota Physics Problem Solving strategy in cycle I is shown in Figure 2. It shows that focus the problem activity, has the highest value compared with other activities. This is possible because this activity is related to drawing diagrams and writing down known information from reading questions.

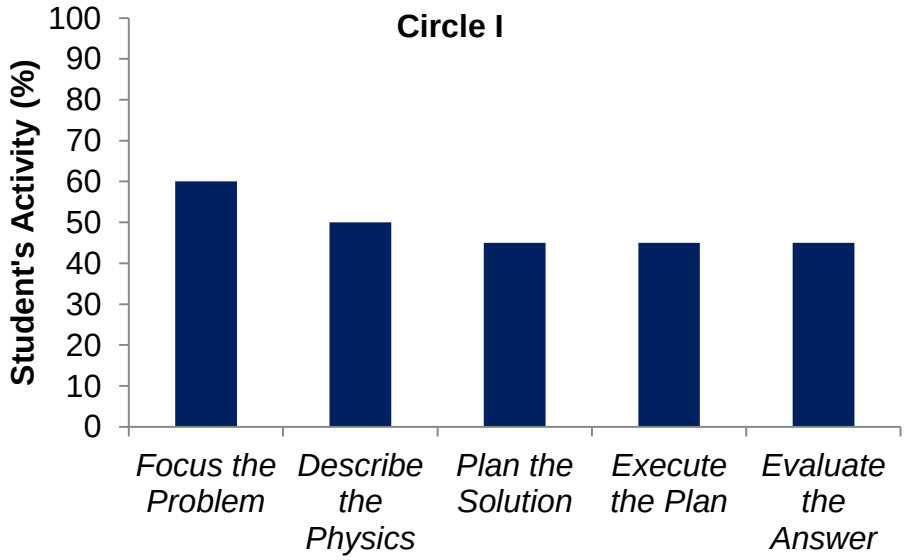

Figure 2. The average activity of students in the application of physics problem solving strategy in cycle I.

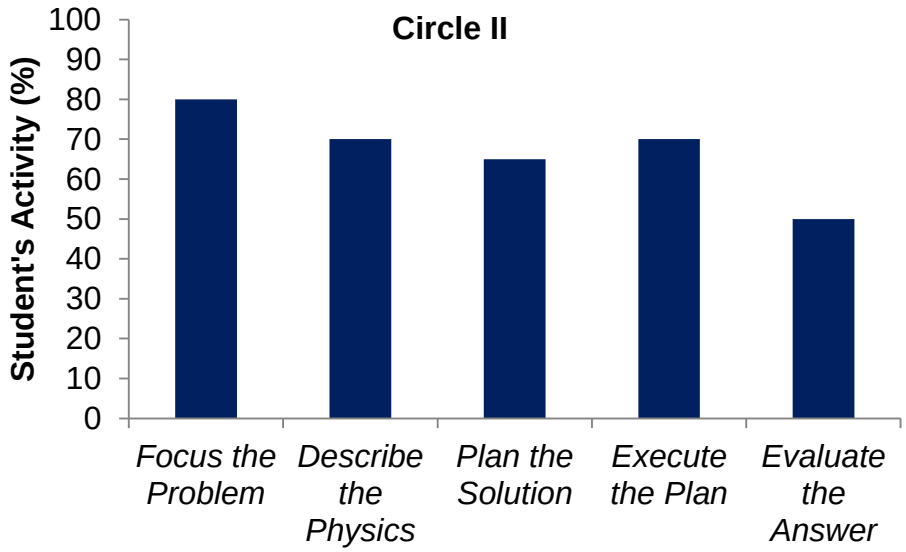

Figure 3. The average activity of students in the application of physics problem solving strategy in cycle II.

After the reflection on the results of cycle I, then in the second cycle is applied the application of physics problem solving strategy combined with concept map. The results show that the average

student activity has increased, as in Figure 3. This happens because concept maps add students' understanding in solving general physics problems. In addition, the concept map is a representation of the relationship between one concept with another concept that students have [12, 13]. Comparison of student activity in applying physics problem solving strategy between cycle I and cycle II is shown in Figure 4

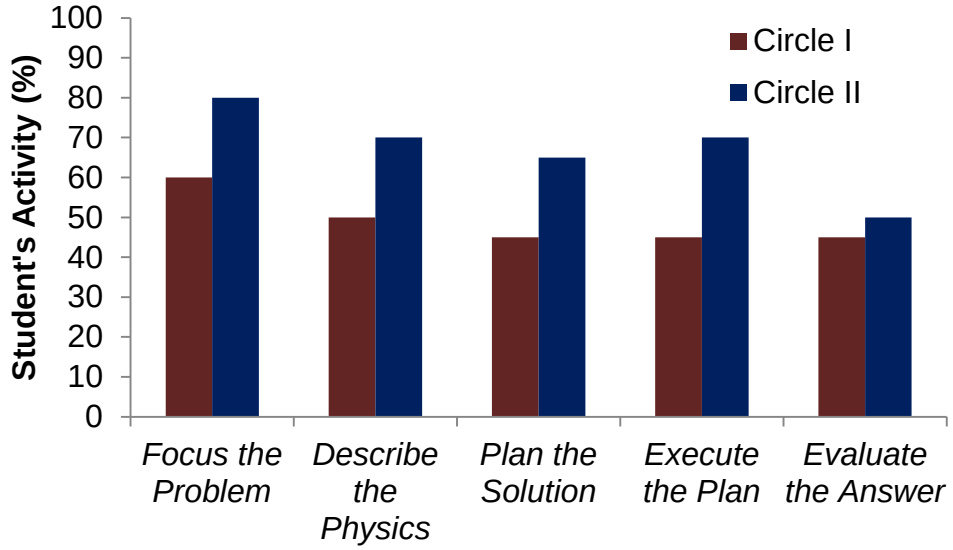

Figure 4. Comparison between student's average activity in applying physics problem solving strategy at every cycle..

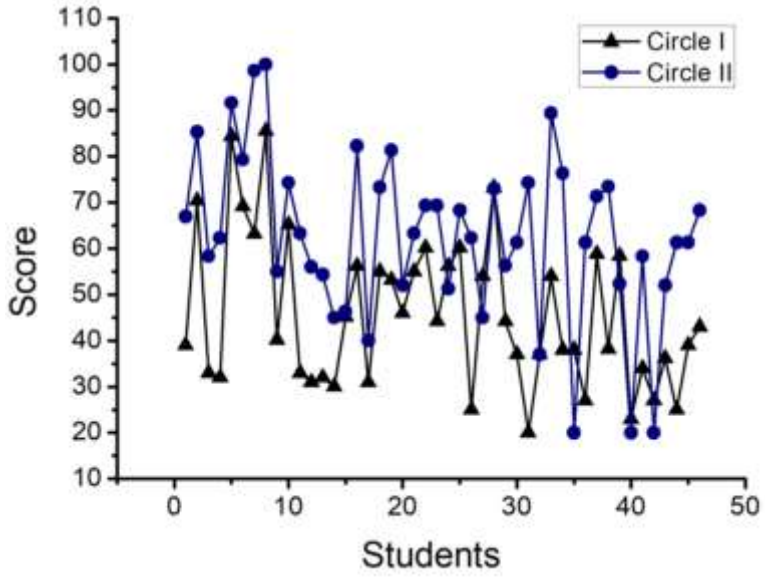

Figure 5. Distribution of student scores on cycle I and cycle II..

Meanwhile, the result of student learning as a result of application of physics problem solving strategy for cycle I and cycle II is shown in Figure 5. It can be seen that the average of student learning

outcomes has increased from 42.7 in cycle I to 62,7 in cycle II. The improvement of this learning result happened because in cycle II, the students have better comprehended the strategy of solving the problems of General Physics, as can be seen from their activity in the application of physics problem solving strategy in cycle II. This results are consistent with Gok & Silai's research results [2], that learning with problem-solving strategies influences student achievement, student attitudes toward problem solving and student motivation positively.

4. Conclusion

Based on the results obtained from the actions taken during the two cycles, it can be concluded:

1. Implementation of Physics Problem Solving strategy combined with concept map can improve students' activity to solve the problem in General Physics course with an average increase of 15%.
2. Implementation of Physics Problem Solving strategy that combined concept map can improve student learning outcomes in General Physics course from 42,7 in cycle I to 62,7 in cycle II.

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