Problem solving based physics learning strategy to enhance students’ higher order thinking skills

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Abstract. Higher order thinking skills (HOTS) in learning that would be needed in the 21st century. This study probed the effect of utilizing problem-solving strategy while learning physics. The sample of this study is two classes from the second year of Senior High School in Pontianak. Qualitative and quantitative research methods were applied to identify students’ HOTS, to analyze students’ score and acquire the effect of problem-solving strategy after students learning physics. The result shows that student’s physics HOTS who studied by problem-solving strategy is higher than students’ by rehearsal strategy. Thus indicates that problem-solving strategy can be effective to enhance students’ HOTS of physics. The pedagogical implication is discussed on the use of problem-solving strategy as an alternative strategy for physics teaching.

1. Introduction

Higher order thinking skills (HOTS) is an important skill that must student possess in the 21st century learning framework [1]. The thinking skills as a result of learning in the cognitive domain has a sequence that is hierarchical and consists of remembering, understand, apply, analyze, evaluate, and create [2]. HOTS is the higher capabilities [3], and according to Bloom’s taxonomy revision, HOTS are the last three aspects of human thinking skills [4].

Researchers in education research has been examined that the level of student’s HOTS still needs to be improved [5,6]. Problem-Based Learning [7], Critical Inquiry-Based Learning [8], Argumentation Based Inquiry [9], Geometrical Optics Process Image-Based Worksheets [10], Social Media [11] and problem-solving strategic [12] are the implementation of teaching to promote students’ HOTS.

Physics consists of facts, concepts, and principles that require analysis in solving a problem. The ability to use the right strategy in solving the problem is important in the success of students achievement must learner posses to solve the physics problem. Learning strategy is a method or technique that a person learning to objectives to be achieved [13].

In the implementation of the 2013 curriculum, the application of constructivism in learning is explicitly contained in curriculum documents. Constructivism is the study of how a student acquires his knowledge. The activity of building one’s own knowledge by students who are learning is an important implementation of constructivists in classroom learning [14, 15].

Obtaining scientific knowledge is represented by applying knowledge to other situations through the implementation of problem-solving skills that stimulate students to use their high-level thinking skills
in learning [16,17,18,19,20,21]. In physics education research, there are some ways to increase students' HOTS based constructivism. It is necessary to implement learning strategies that stimulate an increase in students' thinking skills like problem-solving strategy [12] to improve the ability of students’ HOTS in physics.

Problem-solving is an activity that requires the ability to find answers based on the combination of knowledge that has been learned before [22]. Stage in problem-solving consists of 1) understanding of the problem, 2) planning to solve the problem, 3) the implementation of problem-solving based on compiled plans and 4) re-verification [23]. Students who have been trained to use problem-solving strategy will have the ability to solve various problems they face [24].

2. Methodology
The study used an experimental method to test the effect of independent variables, referring to the opinion of Gall and Borg [25]. The study was conducted to examine the effect of problem solving strategies as independent variables. The independent variable that act as variable treatment is students’ HOTS. The research design used the pretest-posttest control group design.

The population in this study were MIA class XI student of SMAN 7 Pontianak with a sample of 46 students drawn by cluster random sampling. Random selection is to choose two classes MIA in SMAN 7 as learning groups, then through the draw elected the experimental group learned by implementing problem-solving strategy and the control group used rehearsal strategy. Data collection technique using 5 essay test to measure students’ HOTS with Aiken’s V validity index is 0.82 and reliability coefficient of 0.74 and 31 multiple-choice test to determine the ability of students beginning with validity index is 0.82 and the reliability coefficient of 0.82. The test instrument used in this study is the HOTS problem adopted from the development research on HOTS by Haratua Tiur Maria S [26]. A good HOTS test has a high level of validity and reliability, the level of difficulty of the question being medium or easy and the appropriate readability level with measured levels that correspond to test characteristics.

Survey data analysis used the t-test. Tests conducted after analysis meets the test requirements include: normality test for all groups associated with the treatment plan and homogeneity of variance. Research data were analyzed using SPSS 17.0.

3. Results And Discussion
The research data showed the results of student groups learning physics according to the treatment plan. The treatment group consisted of a group of students who learn by problem-solving strategies as an experiment group and who learn by rehearsal strategies as a control group. Recapitulation of students’ HOTS as given in table 1.

| Table 1. Recapitulation of Students Learning Outcomes Score |
|-------------------------------------------------------------|
| **HOTS Score Average** | Pretest | Posttest |
| Experiment Group    | 10.47   | 15.78   |
| Control Group       | 10.96   | 13.22   |

Based on hypothesis testing with t-test analysis seen that after taking into account students’ prior knowledge, learning outcomes of students problem-solving strategies is higher than rehearsal groups.

The results of this study indicate that students who use problem-solving strategies achieve higher HOTS as learning outcomes than Physics students who use rehearsal strategies, after controlling for students’ initial ability. The problem-solving strategy is a learning strategy that is implemented in the learning process of Physics by optimizing the thinking of students about what he did the physics learning process in the classroom. Thinking about what to do in planning, monitoring and evaluating learning, so it is expected to occur continuously reflection which can be led to improvements in students' learning strategies.
Problem-solving learning process on the path of learning physics as the process of solving problems in students activities, so that the process of knowledge formation begins with the presentation of an authentic physics problem or related to everyday life. The learning process is directed in accordance with the stages of problem-solving, which is understanding the problem, problem-solving plan, implement and evaluate the process of resolving the problem solving that has been done. To make it easier for students to understand the problem, some HOTS questions include pictures or diagram, and for the question without images, students are asked to present problems in the physics diagram or picture. The results of previous studies showed that students who drew pictures or sketch and also motion diagram in research achieved higher score than students who did not [27].

Problem-solving strategies is seen when the end of the lesson students was asked to reflect on the effectiveness of the plan and the implementation of the problem-solving process has been done. Reflection is often done is expected to bring positive habits for students to actively thinking about what they think and do in the learning process so that it will produce a physics problem-solving strategies that are most appropriate for themselves. This is in accordance with the research done by Sucipto, Mustaji & Maryono [28] that showed that the problem-solving is one of the learning strategies to increase students’ higher order thinking skills.

Rehearsal strategies familiarize students choose strategies that are considered effective for reading Physics teaching materials are provided. There are some learning strategies associated with reading comprehension, which underlines the important ideas in the passage, making marginal notes about important ideas or make a summary of the reading material.

Thinking about the effectiveness of the selected strategy and its implementation to encourage students to think about the learning process is performing.

4. Conclusion
Based on the research result, the study provided evidence that the students’HOTS on Physics students use problem-solving strategies is higher than on students’HOTS for Physics students use rehearsal strategies.

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