**THE IMPLEMENTATION OF PROBLEM BASED LEARNING TO IMPROVE STUDENTS’ FORMAL REASONING AND PHYSICS PROBLEM SOLVING ABILITY**

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Abstract

The aim of this study was to describe the results of implementation problem based learning. The study was pre-experimental design by using one group pre-test and post-test design. The participants included students from grade X MIA 6 as experimental class, X MIA 7 and X MIA 8 as replications class. Data was collected by observation and test. Data was analyzed using learning activities analysis, assessment of test result analysis with descriptive analysis, paired t-test, n-gain score and correlation analysis. The result showed that: (1) the implementation of problem based learning carried out very well, (2) students’ formal reasoning ability improved from initial formal level towards formal level, (3) students’ problem solving ability improved significantly with n-gain score which categorized as moderate level, (4) the correlation between students’ formal reasoning and problem solving ability was in moderate positive correlation. Based on the results, it can be concluded that the implementation of problem based learning can improve students’ formal reasoning and physics problem solving.

**Keywords**: problem based learning, formal reasoning ability, problem solving ability

**INTRODUCTION**

Physics is a science obtained and developed based on experiment to find answers about natural phenomena. Physics learning is expected to improve students’ thinking skills that are useful to solve real life problems. Understanding, reasoning and mastery of the concept needed to focus on solving real problems (Fakhrudin et al, 2013).

Reasoning is individual cognitive ability. According to Piaget, each stage of individual cognitive development describes their level of reasoning. Piaget'stheory consists of four stagesof cognitive development: the sensorimotor, preoperational, concrete operational and formal operational period (Arends, 2012). These stages is hierarchical, given a certain sequence and no one can learn something beyond their cognitive stage. At the upper secondary school, students’ cognitive development is at the formal operational stage. At this stage, students can think symbolically and abstractly to solve problem. This ability is closely related to formal reasoning (Miller, 2007).

Formal reasoning is ability to perform formal procedures consist of control of variables, proportional, probabilistic, correlational, and combinatorial reasoning (Lawson, 1978). Reasoning ability is related to problem solving ability because some form of it is an element of problem solving. Students’ high reasoning ability will have an impact on their ability to solve problems (Steinberg & Cormier, 2013). Where problem solving ability have four aspects, that is understanding the problem, devising a plan, carrying out the plan and looking back (Polya, 1973). For that reason, to improve problem solving ability, students should more often use their reasoning ability (Supriyadi et al, 2016).

Based on the preliminary research conducted at SMAN 1 Taman, it showed that 6.45% of students was at the level of concrete reasoning, 22.58% of students was at the level of transition reasoning, 38.71% of students was at the level of initial formal reasoning, and 32.26 % of students was at the level of formal reasoning with the average level of reasoning students was at the initial formal. It can be concluded that students' reasoning ability was at the low level.

From the result data above, it can be analyzed that students’ reasoning ability was at the low level. It is indicated that students’ problem solving ability was at the low level too. For that reason, one learning model is needed to improve students’ formal reasoning and problem solving ability, that is problem based learning model. On this model, it is possible to develop students’ ability (reasoning) in solving problem because in each stage students will be trained all of this ability (Rusman, 229). Based on this, researcher conducted a research entitled “The Implementation of Problem Based Learning Model to Improve Students’ Formal Reasoning and Physics Problem Solving Ability”.

**METHOD**

This study is pre-experiment design by using one group pre-test and post-test design. A class subject was given a pre-test to diagnose the prior knowledge. After obtaining the data, the teacher gave treatment in the form of delivering the simple harmonic motion material by using problem based learning model. At the end of the learning the students were given a post-test.

This research was conducted in SMAN 1 Taman Sidoarjo in the even semester of academic year 2017/2018. This study used purposive sampling, which is a technique of determining the sample with certain considerations (Sugiyono, 2010). The subject that was observed were three classes, X MIPA 6 as experimental class, X MIPA 7 and X MIPA 8 as replications class in SMAN 1 Taman Sidoarjo. The research design used is in Figure 1.

|  |  |  |
| --- | --- | --- |
| Pre-test | Treatment | Post-test |
| O1 | X | O2 |

**Fig 1**. Research Design

Information:

O1 : Pre-test score before treatment

X : Treatment

O2 : Pos-test score after treatment

Data was collected from observation and test. In this study, there were two types of given tests that is formal reasoning test and the other is physics problem solving test. Formal reasoning test consist of ten questions, while the question was adapted from Test of Logical Thinking (TOLT) by Tobin & Capie (1981). Physics problem solving test consist of seven questions. Data was analyzed using learning activities analysis, assessment of test result analysis with descriptive analysis, paired t-test, n-gain score and correlation analysis.

**RESULT AND DISCUSSION**

The result of this study is the implementation of learning, improvement of formal reasoning and problem solving ability. From the result of normality test, for each class is obtained *χ* 2calc < *χ* 2table, so the samples are normally distributed at a significant level of 0,05. The homogenity test in all populations obtained *χ* 2calc < *χ* 2table, so it was homogeneous.

The analysis of the learning implementation by two observers showed an average percentage of 92%, which is very good.

From the descriptive analysis, obtained the reasoning level result both from pre-test and post-test as in Table 1.

**Table 1**. Pre-test Result of Formal Reasoninf Level

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Class | Average Score of Formal Reasoning | | | |
| Pre-test | Category | Post-test | Category |
| Experiment | 4 | I | 7 | F |
| Replication I | 4 | I | 7 | F |
| Replication II | 6 | F | 9 | F |

Information:

I : Initial Formal

F : Formal

Based on Table 1, known that the average score of students’ formal reasoning level from the pre-test result is at the initial formal level. Meanwhile the average score of students’ formal reasoning level from the post-test result is at the formal level. So, the students’ formal reasoning improved from initial formal level towards formal level.

From the result of paired t-test, for each class is obtained tcalc > ttable, so there was significant difference between the pre-test and post-test after problem based learning model was applied, with a better post-test score than the pre-test score.

From the gain score analysis, obtained the result as in Table 2.

**Table 2**. The Result of Gain Score Analysis

|  |  |  |
| --- | --- | --- |
| Class | n-gain | Category |
| Experiment | 0,64 | Moderate |
| Replication I | 0,64 | Moderate |
| Replication II | 0,74 | High |

Based on Table 2, obtained that the average of gain score is in moderate category. The result suggested that the implementation of problem based-learning model has an impact on the improvement of students’ physics problem solving ability.

The following data is gain score of each aspect of problem solving. The aspects include understanding the problem, devising a plan, carrying out the plan and looking back.

**Fig 2**. Index Gain For Each Ascpect

Based on Figure 2, known that all aspects of problem solving ability in three classes is improve. Aspect of understanding the problem is in the highest category of all aspects. In this case, the problem relates to real life problem, so the students can understanding the problem and can answer the questions correctly.

From the correlation analysis, obtained the correlation between students’ formal reasoning and problem solving ability as follow

**Table 3**. The Result of Gain Score Analysis

| Class | Coefficient of Correlation | Degree of Correlation |
| --- | --- | --- |
| Experiment | 0,45 | Moderate |
| Replication I | 0,23 | Weak |
| Replication II | 0,53 | Moderate |

Based on Table 3, the average correlation between students’ formal reasoning and problem solving ability is in moderate positive correlation. It is means that students with the higher formal reasoning is, the higher problem solving ability.

Students’ formal reasoning and problem solving ability can improve because in each stage of problem based learning, students is trained all of this ability. In addition, students through a process such as: finding problems, defining problems, gathering information, making hypothesis, experimenting, stating problems in other forms, presenting options and giving solutions. So, students’ formal reasoning and problem solving ability can improve significantly.

It is also relates to previous research from Nurhayati (2016) found out that there was correlation between reasoning and problem solving ability. The correlation between these two variables is at a very strong correlation.

**CLOSING**

**Conclusion**

The implementation of problem based learning carried out very well. Students’ formal reasoning ability improved from initial formal level towards formal level. Students’ problem solving ability improved significantly with n-gain score which categorized as moderate level. The correlation between students’ formal reasoning and problem solving ability was in moderate positive correlation.

**Suggestion**

Students should first be given science skills training, so student will not find some difficulty to carry out the worksheet. And also select research subjects with middle to upper ability in order to get good results.

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