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STUDENTS PROBLEM-SOLVING SKILLS ABILITY ON WORK AND ENERGY TOPICS WITH DIFFERENT SCIENCE PROCESS SKILLS USING A PROBLEM-BASED LEARNING MODEL

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Abstract: This study aims to: (1) determine the effect of the problem-based learning model on students' problem-solving abilities; (2) study the effect of science process skills on students' problem-solving abilities; (3) find the interaction between problem-based learning PBL models and science process skills on students' problem-solving abilities. The type of research is quasi-experimental research with Factorial Design 2 x 2. Population in research of all tenth-grade science students at senior high school SMA Negeri 1 Gunungsari in 2017/2018 academic years. Sampling in this study uses the cluster random sampling technique, in which the X MIA is an experiment class, and the X MIA 1 is a control class. The research instrument used was a description test taking into account the problem's validity, reliability, power difference, and level of difficulty and using observation sheets of science process skills. The data of this study were analyzed by two-way variance analysis with a 2 x 2 factorial design. Based on the result of the study, the average value of the post-test experimental class was 80.29, and the control class was 73.25. The normality and homogeneity tests showed that the two classes were normally distributed and homogeneous at a significant level of 0.05. Then proceed with hypothesis testing using a two-way ANOVA test. The result showed that: (1) $F_A > F_{table}$ that is 29.35>4.02 means that there is an influence of the PBL model on students' problem-solving abilities; (2) $F_B > F_{table}$, namely 29.35 > 4.02 means that there is an influence of science process skills on students' problem-solving abilities; (3) $F_{AB} < F_{table}$, is 3.93<4.02 means that there is no interaction between PBL models and science process skills on students' problem-solving abilities.

Keywords: *Problem-Based Learning, Science Process Skills, Problem-Solving Abilities.*

INTRODUCTION

Education is a program that involves several interrelated components to achieve the programmed goals. It is in line with the objectives of Indonesian National Education as stated in the National Education System Law No. 20 of 2003: to develop the potential of students to become human beings of faith and devotion to God almighty, noble, healthy, knowledgeable, capable, creative, independent and become citizens democratically, and responsible [1].

A teacher has an essential role in achieving educational goals; success or failure depends on how the process is designed and carried out professionally and optimally by a teacher. Subjects at each level, starting from the elementary and junior high school levels, are still general, while the subjects are special for the high school level. Science is a subject that students must obtain. Science is the study of the cause and effect of events occurring in nature. Science can also be interpreted as a systematic collection of knowledge of natural phenomena [2]. One example of science is physics.

Based on the results of observations made at SMAN 1 Gunungsari, it was found that the low physics learning outcomes of class X MIA students were supported by the average midterm score for physics subjects in semester 1 of the 2017/2018 academic year. The average midterm value has a small range of values with the Minimum Completeness Criteria. This range shows that the learning outcomes obtained are still relatively low. It is because at the time of the ongoing physics learning process is still dominated by learning that does not involve the active role of students. The learning is still teacher-centered and limited to the transfer of information, resulting in students being passive and not understanding the concept. The low learning outcomes of students are thought to occur due to a lack of conceptual understanding and problem-solving abilities.

Based on these problems, a learning model is needed to actively involve students so that learning becomes more meaningful. According to the researcher, the learning model that can be a solution is the Problem Based Learning (PBL) model. PBL is a learning model that challenges students to learn how to work in groups to find solutions to problems. PBL is a series of learning activities that emphasize the process of solving problems faced scientifically. During the learning process with the PBL model, students are not expected just to listen, take notes and then memorize the subject matter, but with the PBL model, students actively think, communicate, search, process data, and conclude [3].

The PBL model is student-centered, so students become active during the learning process. It is in line with Abdullah et al. [4]; the PBL model is one of the learning approaches with scientific spending characteristics. It requires active students to get concepts that can be applied by solving problems; students will explore the concepts

themselves. That they must master, and students are enabled to ask questions and argue through discussion, hone investigative skills, and carry out other scientific work procedures. PBL prepares students to think critically and analytically and find appropriate learning resources [5].

In addition, this is also reinforced by the results of research conducted by Khaeruddin et al. [6], which said that the PBL model could improve students' physics problem-solving abilities. It is inseparable from the advantages of the PBL model, namely helping students understand the course of a learning process. There are five syntaxes used in the PBL model: student orientation to problems, organizing students to learn, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating problem-solving processes [7].

In addition to using the PBL model, students are expected to find it easier to solve problems if students' science process skills can be measured as well. Meanwhile, process skills can be interpreted as an insight into the rules for developing intellectual, social, and physical skills originating from basic abilities that, in principle, already exist in students [8].

Science process skills are very important to develop students' scientific attitudes that are creative, critical, open, innovative, and competitive in the global competition in society [9]. In addition, science process skills need to be instilled and trained to seek, find knowledge, and solve problems [10].

It is in line with the results of research conducted by Hikmawati, science process skills are very necessary because, with science process skills, students can solve problems faced in life and provide students with provisions to form their concepts by how to learn something [11]. Some indicators of science process skills students must possess are the ability to observe, interpret, predict, apply, plan research and communicate [12].

Problem-solving ability is the process of eliminating existing problems, in which relationships or concepts are obtained in solving problems. Meanwhile, problem-solving ability in physics subjects is the ability to use a method to complete many tasks in physics lessons.

RESEARCH METHODS

This quasi-experimental research uses a 2 x 2 factorial. Factorial design is used when the researcher considers the influence of other independent variables (usually moderator variables) in his research [13]. The population and samples studied were all students of class X MIA SMAN 1 Gunungsari. MIA1 is the control class, and MIA2 is the experimental class. This research was conducted at SMAN 1 Gunungsari class X from September 2017 to July 2018.

The sampling technique used in this study was random cluster sampling. In this study, the dependent variable is problem-solving ability. The independent variable is the problem-based learning model, the moderator variable is science process skills, and the control variable is the length of treatment time, the meter's depth, and the instrument used. The experimental class was treated with the PBL model, and the control class was treated with the conventional model.

The problem-solving ability test instrument used is a matter of description, and the science process skills test instrument is an observation sheet. The description questions consist of 10 questions with problem-solving ability indicators that were tested on 22 class XII students and then analyzed to determine validity, reliability, difficulty level analysis, and discriminatory analysis. In contrast, the observation instrument test used an observation sheet consisting of 6 skills to measure students' science process skills.

Prerequisites of hypothesis testing analysis, namely normality test with Chi-Square test and homogeneity test with F test. Analysis of hypothesis testing through two-way ANOVA test.

RESULTS AND DISCUSSION

A two-way ANOVA test was used to determine the effect of learning models, science process skills, and the interaction between learning models and science process skills on problem-solving abilities. A two-way ANOVA test was calculated with a significance level of 5%. The results of the hypothesis testing analysis using two-way ANOVA can be seen in Table 1.

To determine the research hypothesis, H0 is accepted if Fcount < Ftable while H0 is rejected if Fcount Ftable. Based on Table 1, the results of hypothesis testing are as follows:

Table 1. Results of Two Way ANOVA Hypothesis Testing

Source	JK	Dk	RK	F_{obs}	F_{α}
Models (A)	631.19	1	631.19	29.35	4.02
Science process skills (B)	631.19	1	631.19	29.35	4.02
Interaction (AB)	80.74	1	80.74	3.93	4.02

Problem Based Learning (PBL) Model on Students' Problem-Solving Ability

Based on Table 1, it is obtained that Fcount = 29.35 while Ftable = 4.02. It shows that Fcount > Ftable, thus, H01 is rejected and Ha1 is accepted, meaning that the PBL model affects students' problem-solving abilities. Several factors cause the PBL model to affect students' physics problem-solving abilities, including the PBL model involving students actively in understanding the concepts and principles of a material because the characteristics of the PBL model are submitting problems to students. The problems given can train students in problem-solving habits that will affect their high-level abilities of students. The positive effect of the PBL model on students' problem-solving skills is because the PBL model is based on the principle that students not only acquire knowledge but also know how to apply that knowledge in real situations [14].

These factors can be seen based on the activities researchers in the experimental class have carried out during the learning process. The first syntax is the orientation of students to problems. It aims to raise problems for students by involving students directly in conducting demonstrations so that students play an active role and it is easier to understand the existing problems. The second syntax organizes students to learn, where the researcher coordinates the students to carry out experimental activities after giving problems to the students in the first syntax. The third syntax guides the investigation, where the researcher gives students directions in answering the worksheet and conducts experimental activities in groups so that from the results of the experiments they have done, they can solve the problems given and help students have real and active learning experiences.

Furthermore, the fifth syntax is developing and presenting the work results, where each group presents the results of experiments carried out in front of the class. Other groups respond if there are differences in the results of the discussions presented. It causes the learning process to be more student-centered. The last syntax is to analyze and evaluate the problem-solving process. The researcher evaluates the results of problem-solving that has been carried out by each group, aiming to avoid errors in understanding the students' concepts. After evaluating at each meeting, the researcher gave awards to students and groups who played an active role and had the right answers in solving problems, thereby increasing students' enthusiasm to participate in learning.

These results align with the research conducted by Khaeruddin et al. that the PBL model can improve students' physics problem-solving abilities. It is inseparable from the advantages of the PBL model, namely helping students clearly understand the course of a learning process. Suardani et al. [15] stated that the achievement of problem-solving skills in the PBL model was better than in the direct teaching model. Then Markus et al. [16] stated that there was a significant effect of the PBL model on students' problem-solving abilities.

Different Science Process Skills on Students' Problem-Solving Ability

Table 1 shows that Fcount = 29.35 while Ftable = 4.02. It shows that Fcount > Ftable, thus, H02 is rejected and Ha2 is accepted, meaning that science process skills influence students' problem-solving abilities. The results of the observation sheet in the experimental class show that the syntax of the PBL model can accommodate all aspects of students' KPS. One of the activities that show science process skills the most is the activity of experimenting or practicing. It is supported by the opinion of Barba, which states that the science process skills experiment is a process that includes all basic and combined scientific processes [17].

The skills in the experimental class were measured during the third syntax, namely guiding the investigation, and during the fourth syntax, namely developing and presenting the work. Each group is given a worksheet containing a problem when conducting experimental activities. All student activities are accommodated in the worksheet. Students gain knowledge from problems and questions in the worksheet. The results of research by Desi et al. The use of worksheets can improve students' science process skills because the questions in the worksheet require students to think about solving problems and doing an activity [18].

Several factors cause science process skills to affect students' problem-solving abilities, including science process skills, which are procedures used by students to seek, acquire, and process knowledge according to the scientific method. Science process skills are the basis for solving problems in science [10]. Then, applying existing abilities in scientific process skills such as observing, interpreting observations, predicting, applying concepts, planning research, and communicating causes students to understand the material, principles, concepts, and laws of physics—an influence of science process skills on students' problem-solving abilities [10].

Interaction of PBL Models and Different Science Process Skills on Students' Problem-Solving Ability

Table 1 shows that Fcount = 3.93 while Ftable = 4.02. It shows that Fcount < Ftable, thus, H03 is accepted and Ha3 is rejected, meaning that there is no interaction between the PBL model and science process skills on students' problem-solving abilities. There was no interaction between the two

treatments on problem-solving abilities because both treatments were given simultaneously during the learning process. It causes the two treatments to have an impact on the problem-solving abilities of students. The study results show that the independent variable, namely the PBL model, has more influence on the physics problem-solving ability of students in the experimental class compared to the control class using direct teaching. It can happen because the PBL model involves students actively in solving problems. It is in line with Ayu et al. Applying the PBL model encourages students to look active in the learning process [19].

The results also show that the moderator variable, namely science process skills, impacts students' problem-solving abilities. It can be seen from the problem-solving abilities of students with high science process skills obtaining a better average than those with low science process skills in the experimental class with the PBL model and the control class with the direct teaching model. Science process skills can be mastered if students acquire higher-order thinking skills, while higher-order thinking skills can be obtained through learning with the PBL model [20].

CONCLUSION

Based on the results of research, data analysis, and discussion, it can be concluded that the PBL model has an effect on students' problem-solving abilities. There is an influence of science process skills on students' problem-solving abilities. And there is no interaction between the PBL model and science process skills on students' problem-solving abilities. The suggestion that the author can give is for physics teachers, teachers in the teaching process can apply this PBL model because it can activate students in learning activities.

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