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THE INFLUENCE OF PROBLEM-BASED LEARNING MODEL ON HEAT AND ITS TRANSFER TOPIC TOWARD JUNIOR HIGH SCHOOL STUDENTS' PROBLEM-SOLVING SKILLS

A. V. Aprilia[1], P. Parmin[2], I. U. Wusqo[✉3]

[1,2,3] Integrated Sciences Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Indonesia

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Abstract

This study intends to reveal the influence of PBL on heat and its transfer topic toward the students' problem-solving skills and scientific attitudes. The design of this study was quasi-experimental with the nonequivalent control group. The samples consisted of the students of VII A (experimental class) and VII B (control class) selected using a purposive sampling technique. Data were collected through observation and tests. The results showed that the value of the correlation coefficient obtained based on the posttest of students' problem-solving skills was $r = 0.728$. Moreover, the t-test analysis on the value of the correlation coefficient of problem solving skill scored t count = 6.58, which indicated the existence of a dependent influence or relationship. The significance of the effect was seen from the coefficient of determination score of 56.25%. Besides, there were 75% of the students gave a positive response to the learning process. Thus, it concludes that the PBL on heat and its transfer topic has affected the students' problem-solving skills.

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✉Corresponding author:
Indah Urwatin Wusqo
[3]Universitas Negeri Semarang
E-mail: urwatin@mail.unnes.ac.id

INTRODUCTION

Law No. 20 of 2003 has explained that education must be oriented to students to generate active learners. Based on the Law, science learning should not only place students as a listener but a doer. They must directly involve the teaching and learning process. This student-centered learning must be packaged attractively to avoid students' boredom and encourage their participation. For that reason, teachers must create a learning atmosphere that is both fun and effective to achieve the goals (Parmin & Sudarmin, 2013). Science is one of the subjects that require students to be active as it comprises four main elements: (1) attitude, which includes curiosity about objects, natural phenomena, and living things, as well as causal relationships that generate new problems for solved through correct procedures; (2) process, consisting of problem-solving procedures through scientific methods, including the preparation of hypotheses, the design of experiments, evaluation, measurement, and concluding; (3) product, comprising facts, principles, theories, and laws; and (4) application, including the implementation of scientific methods and concepts in everyday life (Parmin and Sudarmin, 2013).

Problem-solving skills are required not only to answer the school's question items but also everyday problems (Dwi, et al., 2012). Nevertheless, students of SMPN 8 Pati have faced difficulties on heat and its transfer topic although the phenomena are commonly found in daily life. The students' lacking of problem-solving was presumably caused by the teacher-centered learning method applied in the class. They were doubtful in giving a solution to a problem; in addition to their lack of understanding of the materials and the problems given. These conditions resulted in low learning outcomes, as evidenced by the final semester test score, which was 40% of them scored below mastery learning.

Students generally see science as a difficult subject since it contains numerous concepts that need the effort to understand. As stated by Umah *et al.* (2014), students' direct involvement in the science learning process is intended to foster their ability to think, work, and behave scientifically. For that reason, scientific attitudes have to be instilled in each student. As the scientific attitude grows; their problem-solving skills would also improve.

Logic and systematic thinking would have an impact on the ability to apply scientific methods in solving all existing problems related to science and everyday life (Wijayanti, 2014). One of the learning models that can provide students the opportunity to solve problems and scientific attitudes is the Problem-Based Learning (PBL) model. The selection of the PBL model is in accordance with the results of Khoiriyah & Husamah study (2018) which revealed that the PBL model could (1) improve conceptual understanding; (2) enhance problem-solving skills; (3) increase the ability to apply concepts; (4) enhance students' positive attitudes; and (5) improve students' critical thinking skills. Besides, student-centered learning could also be applied in this model (Saidah *et al.*, 2014). Furthermore, a study by Argaw, et al. (2016) explained that the PBL model could enhance students' scientific attitudes and provide experience on scientific attitudes required during the learning process. With this in mind, the purpose of this study is to determine the effect of the problem-based learning model on problem-solving skills and scientific attitudes.

METHODS

The sample was selected using a purposive sampling technique considering the science scores in the odd semester, and the average grade of the class tended to be almost the same. Class VII A served as the experimental class and class VII B acted as the control class. The independent variable in this study was the problem-based learning model, while the dependent variable was the problem-solving skills and scientific attitudes. Problem solving skill was measured by problem-solving skills test items (Hidayat, et al., 2018) Data analysis was performed quantitatively for validity, reliability, distinguishing power, and item difficulty level, two variances analysis test (homogeneity of sample classes), normality test (the post-test value of problem-solving skills), test for the presence or absence of influence using Biserial Correlation (post-test data that is normally distributed), test for the significance of the effect caused by variables using the coefficient of determination, and descriptive analysis (problem-solving skills and scientific attitudes).

RESULT AND DISCUSSION

Based on data collection 2017 academic year, the following results were obtained . The results of the first analysis test conducted were homogeneity tests of report cards. It was found that in the experimental and control class, which consisted of 30 students each, the F_{count} obtained was 1.29. Because the significance level was 5% and dk = n-1, the F_{table} was 1.82, so $F_{count} < F_{table}$, which means that the data had the same variance and is called homogeneous.

The final stage of data analysis was performed to answer the hypotheses that have been put forward. In this stage, the data used included problem-solving skills and scientific attitudes. The students' problem-solving skills were analyzed from the post-test scores using the normality test. If the data are normally distributed, then the statistics used are parametric, whereas if the data are not normally distributed, the nonparametric statistics are applied. Then, the analysis of the treatment effect on the post-test value was carried out using the coefficient of determination.

Based on the analysis results of the post-test's normality, the X^2count of the experimental class was 9.00, and the control class was 9.49. It can be seen that the X^2count <X^2table for the value of X^2table = 11.1. Moreover, dk = k-1 and α = 5%; thus, the H0 is rejected, and Ha is accepted. This means that the post-test data were normally distributed; hence, the next test employed the parametric statistical test. The parametric statistical test used to analyze the presence or absence of influence between variables was Biserial Correlation. Before the correlation analysis or the test of the guided inquiry model's influence on students' scientific attitudes, a descriptive analysis of scientific attitudes was carried out in both classes. The descriptive analysis aimed to determine the increase in the results of scientific attitudes after the implementation of the guided inquiry model in the experimental class and the direct learning model in the control class.

The calculation of the post-test value showed that the biserial coefficient (rb) was 0.728. Based on the guidelines for the interpretation of biserial coefficient criteria, the results of the analysis indicated that the influence of the PBL model was in the range of 0.60 - 0.799; thus, the effect was included in the strong category.

The contribution of the independent variable to the dependent variable was calculated using the coefficient of determination. Based on the calculation results obtained by the significance of the biserial correlation coefficient (rb) of 0.728; thus, the significance of the coefficient of determination (CD) was 52.98%. Therefore, it can be concluded that the effect of the PBL model on problem-solving skills was 52.98%.

Figure 1 presents the students' early and final state of problem-solving skills seen from the pre-test and post-test of the experimental and control class.

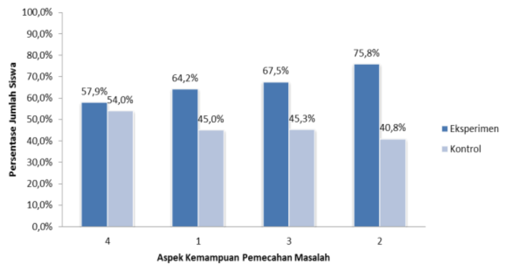

Figure 1. The Students' Problem-Solving Skills

The first aspect of problem-solving skills is problem recognition. The indicator includes possessing a clearer problem understanding. The percentage of the experimental class was 64.2%, while the control class was 45.0%. This aspect is related to the orientation of problems which helps the students develop thinking skills and motivates them to actively involve in finding problems as well as cooperation in problem-solving activities to the questions given during the learning activities. This is similar to what Leak, et al., (2017) studied that the process of recognizing problems requires collaboration, critical thinking, and curiosity. Hence, it will become increasingly important as a group to choose solutions to problems.

The second aspect of problem-solving skills is strategic planning in which the indicator consists of composing work procedures to solve problems. The percentage of the experimental class was 75.8%, while the control class was 40.8%. The activity included organizing students for the inquiry stage to find solutions independently or in groups. According to Moreau & Engeset (2016) strategic planning can be developed independently so that it would establish the students' mindset in answering questions.

The third aspect of problem-solving skills is strategic implementation. The indicator covers the suitability of the problem-solving stage with the strategic plan. The percentage obtained by the experimental class was 67.5%, while the control class was 45.3%. These results were obtained while the students were developing and presenting results. The aspect was reflected when the students could explain strategies in answering the questions in the worksheets. Strategies owned by the groups were poured when answering the reasoned multiple choice according to the established strategy. This is in line with Leak, et al., (2017) that a problem should be solved by applying strategies that reflect the mindset of the solution to the problem.

The fourth aspect of problem-solving skills is evaluating solutions, in which the indicator includes result evaluation. The percentage obtained by the experimental class was 57.9%, while the control class was 54.0% in analyzing and evaluating the problem-solving process. The students expressed their opinions to each other and provided feedback on the group presentations. The students paid attention to each other group's opinions and were willing to provide responses and input to group presentations so that the mastery of the materials increased and developed. However, Moallem & Web (2016) argued that learners tended to be a bit careless in evaluating solutions. According to Karatas & Baki (2013) (2013), evaluating other's solutions is a way of reflecting on one's problem-solving. The behavior adopted by a person when facing a problem is significant in designing a plan for a solution. Moreover, Aslan (2012) asserted that the development of problem-solving skills is aimed more at rational thinking and decision-making processes rather than classic courses.

As stated by Etherington (2011), also based on the research conducted, the advantage of problem-based science learning is the students' experience in proving the experimental results as they could deduce the data obtained through searching for information from various sources, implement, and report the research results. In other words, the PBL model emphasizes cognitive and affective aspects. Some students also gave suggestions so that the students could do more experiments. In addition to advantages, the use of the PBL learning model in science learning also has shortcomings, that is the difficulties in transforming the students' learning patterns as it clashes with the students' learning habits. Thus, a preliminary explanation about the learning implementation should be done. Each aspect of student response was scored between 75% - 92%. This is following Mahrani, et al., (2017) research that the problem-based learning model influences problem solving ability and critical thinking skills. This means that the application of the PBL learning model gets positive responses from students.

CONCLUSION

The use of the PBL model on the topic of heat and its transfer significantly influences the students' problem-solving skills (52.98%). The students' responded positively to the applied PBL model with 75%-92% at the ‘excellent’ and ‘good’ category.

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