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Enhancing Junior High School Students' Science Process Skills in Science Learning

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ABSTRAK

This study aims to determine the effect of the problem-based learning model on science process skills in the topic of planetary characteristics. The research design used is a Pre-Experimental Design with the One Group Pretest-Posttest Design. This study was conducted at a junior high school in Lamongan with a sample of 77 seventh-grade students selected using simple random sampling. The research data was obtained from instruments in the form of learning tools and science process skills tests. The data analysis technique used is quantitative analysis. The results of the study show that the implementation of the problem-based learning model has a significant effect and improves students' science process skills, as evidenced by an N-Gain score of 0.48. The conclusion of this study is that there is an effect of implementing the problem-based learning model on science process skills in the topic of the solar system.

Keywords: Science Process Skills; Problem-Based Learning

INTRODUCTION

The development of science learning is progressing alongside the implementation of the Merdeka Curriculum, directing students to achieve the competencies needed in the 21st century, one of which is science process skills (Mardianti et al., 2020). It is essential for 21st-century teachers to have the capability to adapt to environmental developments to develop learning strategies and approaches that meet students' needs. As facilitators, teachers must provide a learning system that allows students to connect knowledge and skills (Latif, 2020). Knowledge and process skills in the Merdeka Curriculum are two integrated aspects.

Science process skills refer to students' abilities to understand, develop scientific concepts, and make scientific discoveries by applying the scientific method (Hartati et al., 2022). These skills are crucial for students as a foundation for applying the scientific method in the development of scientific knowledge, enabling them to expand existing knowledge or acquire new knowledge. Science process skills involve several necessary aspects: observation, interpreting observations (interpretation), classifying, predicting, communicating, hypothesizing, planning experiments or investigations, applying principles or concepts, and asking questions (Rustaman, 2005). Science process skills do not focus solely on teacher-centered learning but emphasize students' active involvement in independently building and developing knowledge continuously.

Based on field studies at SMPN 2 Lamongan, particularly in class VII in January 2023, it was found that students' science process skills are still in the developmental stage. This is further supported by the results of a science process skills test, which showed the highest score of 85 and the lowest score of 40 out of a total score of 100. These results indicate that students still face difficulties in aspects of science process skills such as formulating hypotheses, solving problems, drawing conclusions, and applying concepts. The weak performance of students in science is also reflected in the Trends in Mathematics and Science Study (TIMSS) survey by the International Association for the Evaluation of Educational Achievement (IEA) in 2015, where Indonesia ranked 44th out of 47 countries with an average score of 397 (Martin *et al*., 2016). Indonesian students' science skills are below the average (500) and generally at the lowest stage (low international benchmark).

Interviews with two science teachers at SMPN 2 Lamongan on October 23, 2023, revealed that students pay less attention during lessons due to lack of control, low interest and motivation in learning, insufficient concentration, lack of scientific attitudes, passivity, and lack of attention to the teacher.

Additionally, there is a lack of question-and-answer activities between teachers and students, and the use of learning media such as PowerPoint and videos is still rare. Science material is still considered boring due to the many theories that need to be learned and the abstract nature of the material, making it difficult for students to understand, thus affecting test results that do not meet the KKTP score, which is within the interval of undeveloped scores from the school's set value. Based on these observations and interviews, it can be concluded that learning is still teacher-centered, resulting in underdeveloped science process skills in students.

Given these issues, schools need a learning model that can make the learning atmosphere more engaging, conducive, enjoyable, and capable of training students' science process skills. A learning model that can train and enhance science process skills in each learning syntax is one that promotes active student involvement, such as the problem-based learning model. In problem-based learning, students are trained to learn independently to solve a problem by developing their ability to analyze and manage the information they have acquired. Problem-based learning is a model that can stimulate students to think critically in solving authentic problems.

The characteristics of planets are a relevant and interesting science topic for students, motivating them to learn more. The problem-based learning model enables students to solve real and authentic problems related to planet exploration.

The use of problem-based learning models has been applied by several previous researchers. Putri (2020) found that the use of problem-based learning models can improve students' science process skills on environmental pollution material (Putri et al., 2020). Another study by Hartati (2022) also stated that science process skills are influenced by the use of problem-based learning models, as shown by the difference in categories between the control and experimental classes, where the science process skills of the experimental class students were higher at 72.82%, categorized as good, compared to the control class's percentage of 56.31%, categorized as sufficient. Previous studies indicate that learning through problem-based learning models has a positive impact on students' science process skills. The researcher intends to conduct a study aimed at determining the effect of the problem-based learning model on science process skills in the material on the characteristics of planets.

RESEARCH METHODS

This type of research is pre-experimental with a One Group Pretest-Posttest design, where there is only one group without a control or comparison group (Sugiyono, 2019). The results are assessed by comparing the pre-test and post-test results. The research design can be seen in Figure 1.

Figure 1. Research Design One Group Pre-Test Post-Test

Keterangan:
O_1 : Pre-Test
X : Treatment using PBL learning model
O_2 : Post-Test

The variables in this study are reviewed based on their roles, consisting of the independent variable, which is the problem-based learning model, the dependent variable being science process skills, and the control variable being the material used in the study, which is the characteristics of planets. This study was conducted in the even semester, March of the 2023/2024 academic year, at one of the junior high schools in Lamongan Regency, specifically at SMPN 2 Lamongan.

Targets/objectives

This study aims to determine the effect of the problem-based learning model on the science process skills of junior high school students in science learning about the characteristics of planets by measuring the changes that occur between the pre-test and post-test results in the group being studied.

Research subjects

The subjects of this study were seventh-grade students at one of the junior high schools in Lamongan Regency, with a population of 326 students. The sampling technique used was simple random sampling, which means selecting a sample without considering the strata in the population. The sample size was determined using the Slovin formula with a 10% margin of error, resulting in a sample of 77 students.

Procedures

The steps in this study involve three stages: the initial stage, the implementation stage, and the final stage. The initial stage involves conducting interviews and observations to identify problems at the research location. Next, a study on the science process skills to be used is conducted, followed by the preparation of learning tools and research instruments, and validation of the research instruments by expert validators. The implementation stage includes initial measurement (Pre-Test) to determine the initial condition of students' science process skills before treatment. Subsequently, the group is given treatment by applying the problem-based learning model. After the treatment, a final measurement (post-test) is conducted to observe the impact and improvement in students' science process skills. The final stage involves processing the data obtained from the pre-test and post-test, then comparing it to analyze the effect of the problem-based learning model on science process skills and drawing conclusions.

Data and instruments

Data in this study were collected through two stages of measurement, pre-test and post-test. The instruments used to collect data include a science process skills test consisting of written tests and learning tools and research instruments. The science skills test instrument consists of 15 essay questions. Written tests are chosen to measure science process skills as they can include questions that assess skills in observation, prediction, questioning, processing investigation results, and communication. The science process skills test is used to examine how students' science process skills are before and after using the problem-based learning model.

Quantitative descriptive analysis is the technique used in this study to analyze the collected data to draw conclusions from the study's results. Statistical tests such as prerequisite tests, including normality and homogeneity tests, are conducted before testing for influence. The normality test is performed to determine whether the data to be analyzed are normally distributed (Widana & Muliani, 2020). The Kolmogorov-Smirnov test is used for normality testing because the sample size is more than 40 (Biu et al., 2020). The homogeneity test is used to ensure that two or more groups of sample data taken from the population have comparable variance (homogeneous). The Levene test is chosen to test data homogeneity. After the prerequisite tests are conducted and the data are normally distributed, an influence test is conducted to examine whether there is an effect of the problem-based learning model on students' science process skills. The paired t-test is used, comparing the average data from the sample group. The influence test and prerequisite tests are performed using SPSS 26 for Windows. To determine the improvement in science process skills before and after applying the problem-based learning model, the N-Gain test is used, with the score criteria referring to Sukarelawan et al., 2024, as follows:

Table 4. N-Gain Score Criteria

Skor	Kategori
$-1{,}00 \leq g < 0{,}00$	Decrease
$g = 0{,}00$	No Increase
$0{,}00 < g < 0{,}30$	Low
$0{,}30 \leq g < 0{,}70$	Medium
$0{,}70 \leq g \leq 1{,}00$	High

RESULTS AND DISCUSSION

This study implements the problem-based learning model on students' science process skills in the topic of planet characteristics. The results and discussion of this study are as follows:

Result

The pre-test and post-test data on students' science process skills were analyzed using normality and homogeneity tests to determine whether the data were normally distributed and homogeneous. The data were then analyzed using the paired t-test and N-Gain test.

The normality test for the pre-test data of classes B, D, and E yielded significance values of 0.115, 0.200, and 0.050, respectively, while the post-test data for each class obtained significance values of 0.127, 0.092, and 0.118. The pre-test and post-test data for all classes were normally distributed, as the data obtained were >0.05.(Sugiyono, 2019). After confirming data normality, hypothesis testing and the measurement of science process skills improvement were conducted using the t-test and N-Gain test.

The results of the paired sample t-test for pre-test and post-test data on science process skills showed a significance value (2-tailed) of 0.000 < 0.05. Therefore, the study concluded that the problem-based learning model affects students' science process skills in the topic of planet characteristics, meaning Ha is accepted and H0 is rejected. The N-Gain test result was 0.48. Based on the N-Gain score criteria in Table 4, the value ($0.30 \leq 0.48 < 0.70$) indicates that the improvement in science process skills for the three classes is in the medium category.

Table 6. N-Gain Test Result

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
NGain_score	77	.20	.73	.4848	.10232
NGain_Persen	77	20.00	73.13	48.4775	10.23211
Valid N (listwise)	77				

Discussion

Scientific process skills are the students' abilities to understand, develop scientific concepts, and acquire knowledge through the application of the scientific method (Ariyansyah & Nurfathurrahmah, 2022). Scientific process skills require students to think systematically in an effort to solve problems (Kelana et al., 2020), providing a more meaningful learning experience and supporting the development of higher-order thinking skills. Scientific learning necessitates a process that can stimulate students to learn through real-world problems connected to previously acquired knowledge. To enhance students' scientific process skills, a learning model encompassing these skills is needed, one of which is the problem-based learning model. This is because each syntax of the problem-based learning model is relevant to scientific process skills. Problem-based learning is a learning model that presents authentic problems and asks students to solve them. The scientific process skills practiced in this study are listed in Table 1.

The scientific process skills test was conducted with an essay-type written test given during the pre-test and post-test. The choice of a written test to measure students' scientific process skills is due to the essay format, which allows for evaluating the scientific process skills used in this study. Students can be asked to explain how they collected and analyzed data about the planets. Furthermore, essay tests provide space for students to answer in the way they understand best, allowing for various perspectives and approaches in explaining the characteristics of planets.

The significance value obtained from the pre-test and post-test data analysis of students' scientific process skills using SPSS 26 for Windows was 0.000, which means 0.000 < 0.05, based on the paired sample t-test results in Table 5. This indicates that H0 is rejected and Ha is accepted, or in other words, there is a significant effect of implementing the problem-based learning model on students' scientific process skills in the topic of scientific process skills.

The results of the pre-test and post-test data analysis of students' scientific process skills before and after the implementation of the problem-based learning model were conducted using the N-gain test and obtained an average N-gain score for classes B, D, and E of 0.48. The N-gain values for the three classes are in the medium category.

The learning process was carried out by applying the syntax of the problem-based learning model. Students solved problems provided by the teacher related to the characteristics of planets. In solving the problems, students were given problem-based learning worksheets. Students were divided into several groups, each consisting of 5-6 students. Students discussed with their group members to solve the problems.

The improvement in students' scientific process skills through the problem-based learning model can be seen from each indicator measured in the study. The first indicator, observing, increased from 69.13 to 91.23. The second indicator, predicting, also increased from 37.73 to 70.88. The third indicator, asking questions, rose from 42.26 to 79.61. The fourth indicator, planning and conducting investigations, showed an increase from 33.97 to 51.63. The fifth indicator, processing and analyzing data and information, increased from 52.58 to 93.70. The sixth indicator, communicating, also increased from 52.13 to 73.03. These improvements can be seen in Figure 4.

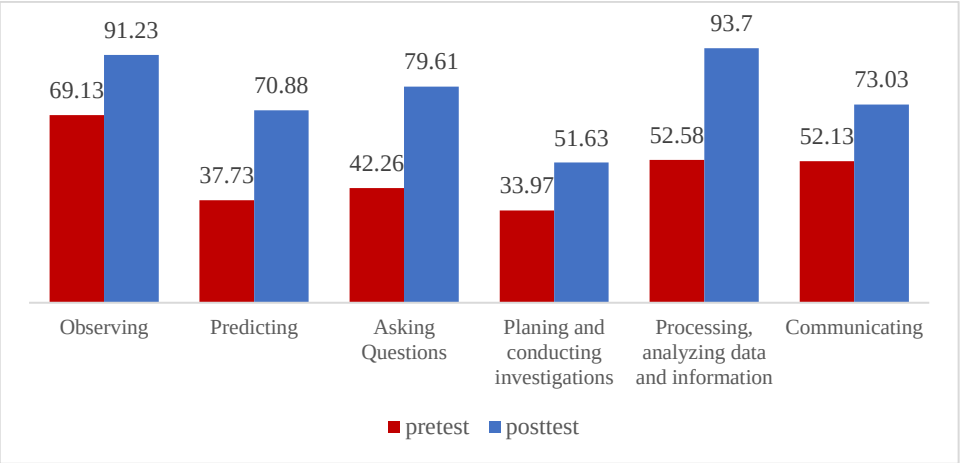

Figure 4. Results of the Improvement in Science Process Skills

Figure 4 shows that each aspect of scientific process skills (SPS) has different average achievements. The SPS aspects with the highest achievements are observing and processing and analyzing data and information. Conversely, the SPS aspects with the lowest achievements are planning and conducting investigations, and communicating.

These results are likely due to the frequent integration of observing and analyzing data and information activities into daily learning processes. Students tend to be more accustomed to and trained in observing and analyzing data and information provided by the teacher or found in learning resources. Therefore, when learning using the problem-based learning model, students can easily observe and analyze data and information about the characteristics of planets, as this information is presented in an engaging and interactive manner. On the other hand, planning and conducting investigations and communicating have the lowest achievements because these activities require more complex skills and need more guidance and time. The communication aspect requires more practice in group discussions. The aspects of predicting and asking questions require students to think more critically about the characteristics of planets, such as asking questions and predicting "whether there are other planets that can be inhabited by living beings from Earth." The correlation between the aspects of scientific process skills and the problem-based learning model is presented in Table 7.

Table 7. Correlation of Scientific Process Skills Aspects with Problem-Based Learning Model

SPS Indicators	PBL
Observing	Students observe the planets displayed together at the beginning of the lesson.
Predicting	Students predict the outcomes of the investigation on the given problem, such as "Are there any other planets that can be inhabited by living beings besides Earth?"

SPS Indicators	PBL
Asking Questions	Students actively seek information during the problem-solving process.
Conducting Investigations	Through organized learning, students plan and conduct investigations in groups to solve the given problems.
Processing, Analyzing Data and Information	Students process and analyze data obtained from the conducted investigations.

The research conducted by Putri (2020) supports this study, showing that the problem-based learning model can enhance students' scientific process skills (Putri et al., 2020). The aspects of scientific process skills used by Putri (2020) include observing, classifying, interpreting observations, predicting, communicating, formulating hypotheses, and designing experiments.

Another supporting study is by Hartati (2022), which explains that the scientific process skills in the experimental class were higher, at 72.82%, categorized as good, compared to the control class, which had a percentage of 56.31%, categorized as fair (Hartati et al., 2022). The aspects of scientific process skills used by Hartati (2022) also differ from this study, where the aspects include asking questions, hypothesizing, planning experiments, observing, interpreting, and communicating. Although previous studies by Putri (2020) and Hartati (2022) support this research, there are differences in the aspects of scientific process skills used. The aspects used by the researcher align with the learning outcomes categorized in the Merdeka Curriculum, namely observing, predicting, asking questions, conducting investigations, processing, analyzing data and information, and communicating. Another difference lies in the science subjects used; previous studies focused on environmental pollution and biology, while this study focuses on the characteristics of planets.

CONCLUSIONS

Based on the data obtained, it is evident that the problem-based learning model can significantly impact students' science process skills. The significant effect between the problem-based learning model and science process skills is demonstrated by an N-gain increase of 0.48 for classes B, D, and E, which falls into the moderate category.

Recommendations from this study include paying attention to the time allocated for the learning process to ensure its effectiveness, as activities involving science process skills typically require a relatively long duration. Materials that are suitable for implementing the problem-based learning model to enhance science process skills include those closely related to everyday life, such as environmental pollution, heat and its transfer, and so on.

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