The Effect of Project Based Learning (PjBL) - STEM in Improving Students' Science Literacy Skills on Topic of Alternative Energy

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Received: 17th May 2024; **Accepted**: 4th June 2024; **Published**: 15th June 2024
DOI: https://dx.doi.org/10.29303/jpft.v10i1.6896

Abstract *- Science literacy skills are one of the abilities in understanding scientific knowledge to solve problems in everyday life. However, science literacy in Indonesia is still classified as low. So that in the independent curriculum currently used in education, science literacy is one of the competencies that is very important and also needed by Pancasila students. The purpose of this study is to analyze the improvement of science literacy skills as a result of PjBL - STEM learning in class X in one of Bandung State High School on alternative energy material. The sampling consisted of 32 students and the sampling technique was taken using convenience sampling technique. Data collection used is by formative test description of science literacy skills. The test instruments used were 2 questions identifying scientific issues, 2 questions explaining scientific evidence, and 3 questions explaining scientific evidence. The method used in this research is pre-experiment method using one group pre-test - post-test research design. The data that has been obtained is analyzed using the N-Gain value and effect size. The results showed that the value of students' science literacy skills increased with an average post-test score of 83.16 and the overall N-Gain value obtained was 0.57 and included in the moderate category, then the increase in students' science literacy in each indicator, namely in identifying problem issues, explaining scientific phenomena, and explaining scientific evidence has a moderate category. However, of the three indicators, the indicator of identifying scientific issues has the smallest N-Gain of 0.51. The calculation of the effect size value is carried out to determine how much influence learning using the PjBL-STEM model has in improving science literacy skills, so that in the research that has been done it is found that the effect size is 3.23 and is included in the "high" category. Thus, learning with the PjBL-STEM model has an effect in improving students' science literacy skills.*

Keywords*: Science Literacy; PjBL; STEM; Physics; Alternative Energy*

INTRODUCTION

The development of modern times makes all information from various aspects spread so quickly, one of which is in the field of education which is required to be able to adjust to the changes that have occurred, especially in the ability of science literacy which is one of the competencies that are indispensable for the Pancasila Student Profile (P3) (Kemdikbudristek, 2023). Developments in the field of education make teaching methods more technologically innovative with various online learning platforms, such as e-learning which provides great accessibility for students. The relationship between science and technology is inseparable, especially during the modern era. The use of technology helps learners in finding various learning resources that involve various sciences such as science, math and engineering. Therefore, technology is related to science which emphasizes understanding, knowledge, and scientific phenomena. The development of technology and science can never be separated from the development of science learning in schools. Science literacy skills are able to make students use their knowledge to solve problems in everyday life (Jufrida et al., 2019).

Science literacy is defined as scientific knowledge and skills so that learners are able to identify questions, acquire new knowledge, explain scientific phenomena,

and draw conclusions based on facts, understand the characteristics of science, awareness of science and technology in the natural, intellectual and cultural environment. Science literacy is one of the knowledge and skills that is very important for learners to master, so that individuals have the ability to engage and care about science-related issues in people's lives.

Science literacy skills are also defined as an understanding of science and its application to people's lives. Science literacy in society is very important because there are many problems related to science and technology. Improving science literacy through science education is developing various abilities by utilizing the creativity of learners' knowledge and skills based on scientific evidence used to solve scientific problems. Especially in physics learning that is able to explain all phenomena that occur in nature, so that problems related to physics are often seen in everyday life and students can solve a problem to analyze data and be able to make decisions from the problems studied. Thus, physics learning can train students to be able to master knowledge, concepts, principles of physics, and scientific skills (Yunieka et al., 2015).

Based on the results of preliminary studies in physics learning that have been carried out through observations and interviews with physics teachers in one of the public high schools in Bandung City, it is found that during physics learning activities in class X the situation is quite conducive because the learning methods used by physics teachers are demonstration, inquiry-discovery, cooperative, and collaborative methods. So that the response of students during physics learning takes place quite well, especially when doing practicum. However, in the interview the teacher also mentioned that science literacy skills are still not applied in class X during physics learning activities. When learning takes place, students only focus on the material explained by the teacher. Then students when given discourse questions students still cannot give the right answer. Then, the teacher also mentioned that students still failed to answer questions with science literacy indicators, and the practice questions given by the teacher were more questions in the form of concepts, so that students were still less trained in solving a problem.

Project-based learning (PjBL) is a thinking activity that can improve students' higher-order thinking skills (Rahayu et al., 2017). Project-based learning improves learning habits and can motivate learners to think in solving a problem in real life. Project-based learning is a learning model that tries to link technology with problems in everyday life or also with projects given at school. Learning activities with project-based models can also be integrated through the STEM (Science, Technology, Engineering, and Mathematics) approach. The STEM approach is one of the integrated approaches to improve the ability to solve problems by involving learners in systematic investigations that link knowledge and skills (Hong, Lin, Chen B, 2019; Fiteriani et al., (2021)). Thus, learning with the STEM-based PjBL model can improve students' science literacy skills. Previous research shows that learning using the PjBL-STEM model has better science literacy with a medium category, while learning conducted without the PjBL-STEM model has an average with a low category. So that in this study for students learning using the PjBL-STEM model is considered interesting, then it can build students' creativity and be able to make students more aware of the importance of protecting the environment (Afriana et al., 2016).

STEM should be integrated in the education process that focuses on solving real-life problems. Learning using a STEM-based approach can create a cohesive learning system because the four aspects of STEM are needed simultaneously for students to solve problems. According to Bakri et al., (2021), with the STEM-based PjBL model in science learning, students can hone cognitive abilities, design, utilize technology, and apply knowledge. Through learning with the STEM-based PjBL model, students are able to have science and technology literacy knowledge to read, search for information, and observe (Mayasari et al., 2014).

The problems that have been described, it is determined that this study provides a solution with the learning process, the science literacy skills provided can be obtained by students using a project-based learning approach or model (PjBL) - STEM (Science, Technology, Engineering, and Mathematics). This is in line with previous research that the PjBL-STEM model applied in learning can train student-centered learning in developing and improving aspects of knowledge and science owned by students, and can help students in understanding teaching materials and also form students' creative attitudes (Sari et al., 2021). Therefore, the author is interested in conducting research on a learning model that focuses on students, namely project-based learning (PjBL) - STEM which is carried out to optimize the improvement of students' science literacy skills by collaborating students' knowledge, process skills, and technology to solve problems in everyday life.

RESEARCH METHODS

The research method used in this research is pre-experiment with the research design form one group pre-test post-test, this is because the research only uses one group of subjects and is carried out without a comparison group. then the implementation of physics learning is only carried out in one class with a duration of 3 x 45 minutes. Data collection is done by giving a pre-test (O_1) to students before learning with the PjBL-STEM approach is implemented, and giving a post-test (O_2) to students after learning with the PjBL-STEM approach is implemented (X). The description of the research design of one group pre-test post-test design is as follows.

Table 1. One-group pre-test post-test Research Design

Pre-test	Treatment	Post-test
O_1	X	O_2

In this study, students who became the population were 32 grade X students in one of the Bandung State High Schools. Sampling was done using convenience sampling technique. The instruments used are teaching modules, learning implementation sheets, science literacy skills test questions using Google Form. The science literacy skills test instrument used has 3 indicators including identifying scientific issues, explaining scientific phenomena, and using scientific evidence. The science literacy skills test instrument on the 3 indicators is in the form of a description test which contains in accordance with the discussion on alternative energy material, students are expected to be able to answer the description test which contains aspects of understanding, determining and identifying a problem. The pre-test and post-test data that has been obtained can then be analyzed using N-Gain and effect size. This was done to determine the increase in science literacy skills possessed by students and the effect of learning with the PjBL-STEM model in

improving students' science literacy skills through pre-test and post-test activities after being given the PjBL-STEM learning treatment. Learning activities with the PjBL-STEM model which were carried out in 3 meetings using an observation sheet had an implementation percentage score of 100% at each meeting, so it can be interpreted that the learning activities were carried out very well. The implementation score that has been obtained is to determine whether the implementation of learning is going well or not.

RESULTS AND DISCUSSION

Results

The results of pre-test and post-test data on science literacy skills that have been given to class X students are then analyzed to determine the increase in students' science literacy skills before and after learning with the PjBL-STEM model using N-Gain data analysis. The results of the pre-test and post-test analysis of students' science literacy skills using N-Gain can be seen in table 2 as follows.

Table 2. Results of Overall N-Gain Data Analysis

Average Score			
Average Score pre-test	**Average Score post-test**	**N-Gain <g>**	**category**
60,44	83,16	0,57	Medium

Table 2 above shows the average pre-test score of students of 60.44 and the average post-test score of 83.16. The overall N-Gain result is 0.57 which is included in the moderate category. So, from the N-Gain results that have been obtained, it can be interpreted that the science literacy skills of students have increased. This is in accordance with the normalized gain criteria as follows.

Table 3. Normalized Gain Criteria

Gain	Description
G > 0,7	high
0,3 ≤g≥0,7	medium
g≤0,3	low

(Hake, 1998)

After analyzing the overall improvement of students' science literacy skills, then N-Gain analysis was carried out on each indicator of science literacy skills with the aim of knowing the difference in the average score of students on each indicator of science literacy skills before and after learning activities with the PjBL-STEM model and the criteria obtained on each indicator. The results of the analysis obtained based on the indicators of students' science literacy skills can be seen in the table below.

Table 4. N-Gain Test Results for Each Indicator of Students' Science Literacy Skills

Science Literacy Skill Indicator	Average Value		Gain	Criteria
	Pre-Test	Post-Test		
Identifying Issues/Problems	61,72	81,25	0,51	Medium
Explaining Scientific Phenomena	64,06	84,38	0,57	Medium
Using Scientific Evidence	57,29	83,33	0,61	Medium

Based on the data in table 4 above, it is known that the results of the N-Gain test that has been carried out on all indicators of the results of the N-Gain test conducted on all indicators of science literacy skills, namely (1) identifying problem issues, (2) explaining scientific phenomena, (3) and using scientific evidence have “medium” criteria with each indicator of science literacy skills having an N-Gain of 0.51, 0.57, and 0.61. The N-Gain value obtained is different because of the difference in pre-test

and post-test improvement in each indicator of science literacy skills after treatment.

Discussion

Analysis of the improvement of students' science literacy based on indicators of science literacy skills can be seen in the average value of the post-test on each indicator of students' science literacy skills that have increased after learning with the PjBL - STEM model in learning as shown in table 4. It can be seen in the table that the indicator explaining scientific phenomena experienced a higher increase among other indicators with an average post-test score of 84.38. The indicator of identifying scientific issues has the lowest average post-test score of 81.25 and the indicator of using scientific evidence is at an average post-test score of 83.33.

The increase that occurs in the indicator of explaining scientific phenomena can also be seen by using LKPD that has been done by students when learning using the PjBL-STEM model takes place. Learners are able to answer questions given on LKPD activity 1 related to scientific phenomena regarding how heat energy changes occur. Then, students are able to explain the scientific phenomenon (changes in heat energy) based on facts. In the practicum activities carried out, students also work on LKPD 2 with questions related to science literacy skills indicators, especially one of which is the indicator of explaining scientific phenomena. Practical activities through the STEM approach are able to make students build new knowledge in solving a problem contained in the LKPD given and through the process of designing products. So, this shows that when working on LKPD students can answer problems related to indicators of explaining scientific phenomena. Then on the indicators of problem issues and scientific evidence, students can also provide explanations in answering the questions given. The following are students' answers to questions contained in 3 indicators of science literacy skills. Item number 2 with an indicator of identifying scientific issues can be seen in Figure 1.

Figure 1. Science Literacy Test Instrument Items Identifying Problem Issues

Item number 2 begins with an infographic about alternative energy that has a deficit in petroleum supply. The question on this indicator helps learners to bring up C2 cognitive abilities. The science literacy indicator tested in this question is that learners can identify scientific issues or scientific information. The keyword contained in the question is the petroleum supply deficit. Learners' understanding of these keywords will help learners answer the questions given. However, in this indicator there are still many learners who have not been able to answer correctly. However, after being given treatment through the PjBL-STEM model, students can find learning resources, so they are able to analyze a problem. In addition to using

images as information, science literacy skills can also be explored using images seen in Figure 2.

Figure 2. Science Literacy Test Instrument Item Identifying explaining scientific phenomena

Figure 2 is Item 10 which is contained in the indicator of explaining scientific phenomena in determining, this relates to the cognitive ability of C3 (Applying) learners. In science literacy skills, learners are required to be able to explain scientific phenomena that occur, namely determining and explaining energy changes that occur in flashlights. Furthermore, the form of the question is in the form of text, as shown in Figure 3 below.

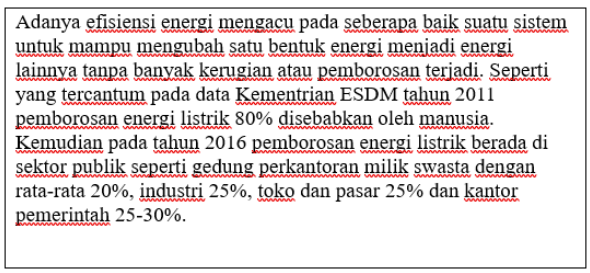

Figure 3. Science Literacy Test Instrument Item Identifying explain scientific evidence

Item number 8 in Figure 3 above begins with text about energy efficiency. The text provided helps learners in analyzing which is related to the cognitive ability of C4 (analyzing) learners. The science literacy required from this question is explaining scientific evidence and drawing conclusions from the data provided.

The average value contained in the literacy skills question above is on item number 2, the indicator of identifying problem issues, the average value obtained is 53.91 and the post-test is 77.34. Then, on item number 4 the indicator explaining scientific phenomena has an average pre-test value of 67.97 and a post-test of 85.16. In the last science literacy skill indicator found in item number 6, namely explaining scientific evidence, the average post-test value is 58.59 and in the post-test is 80.47. So, this can be interpreted that learning with the PjBL - STEM model can improve the science literacy of students, as based on the acquisition of the N-Gain value seen in table 2. In research conducted by Rahmadyah (2020) shows that the science literacy of students with PjBL-STEM learning has a higher average of 7.29 than the use of guided inquiry models with an average of 6.58. In addition, learning using the PjBL-STEM model can help students develop science literacy in both cognitive and affective aspects (Lutfi et al., (2018); Diana & Sukma, 2021). So, it can be explained that learning with the PjBL-STEM model can improve students' science literacy skills and build students' creativity.

Science literacy is closely related to the ability of learners to understand the environment and problems that occur around the scope of modern society which is highly dependent on technology and the development of science or science (Bybee, 2011). Learning by using the PjBL - STEM model in learning activities in addition to

increasing science literacy for students, can also improve skills in problem solving and communication skills trained through the use of digital media technology (Bakri et al., 2023).

Based on the N-Gain that has been obtained as shown in table 2, it can be said that PjBL-STEM learning can improve students' science literacy skills. The acquisition data that has been obtained in the study is tested for normality and hypothesis. Hypothesis testing that has been done gets a sig value. (2-talled) <0.05 which means that Ho is rejected and Ha is accepted, so it can be concluded that when Ha is accepted it means that there is a difference or influence on science literacy skills when learning with the PjBL - STEM model is used.

Then, the calculation of effectiveness using effect size was carried out to determine how much effect the STEM-based Project Based Learning model has on science literacy skills. The calculation of the effect size value carried out using Cohen's d results obtained was 3.13 and included in the high category. So, it can be concluded that learning with the PjBL-STEM model has a good influence in improving students' science literacy skills.

CONCLUSION

Based on the findings and discussion, it is concluded that using the STEM-based PjBL learning model can improve the science literacy skills of grade X high school students on alternative energy material. The following conclusions are obtained based on the results of the research that has been carried out. First, the science literacy skills of students on alternative energy material have increased after the application of PjBL-STEM learning with the N-Gain score obtained of 0.57 in the medium category. Second, learning by using the PjBL-STEM model has an effect in improving literacy skills. Learning using the PjBL-STEM model is also able to develop students' creativity and improve students' literacy skills in solving problems, especially in everyday life. PjBL-STEM learning can encourage students to gain understanding through discussion, independent learning, and be able to analyze problems found in the surrounding environment.

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