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The Effects of the STEM-integrated Project Based Learning (PjBL) Model on Students' Science Process Skills

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Abstract: Students' science process skills are still relatively low. One of the influencing factors is the choice of learning methods that are still conventional and there is no innovation in learning. This research aims to determine the effect of the STEM integrated Project Based Learning (PjBL) model on students' science process skills. This research is a quasi-experimental research with a posttest-only control group design. The data collection technique uses 20 multiple-choice questions developed by the science process skill indicators, which consist of five basic skill indicators: observing, measuring, communicating, predicting, and classification. The data analysis technique uses prerequisite tests (homogeneity and normality tests) and hypothesis testing (Manova test). Based on the results of the normality test, it was found that the data was normally distributed because it obtained a value of > 0.05. The homogeneity test results also showed that the data was distributed homogeneously because it obtained a value > 0.05. The results of hypothesis testing using the Manova test showed that science process skills were 0.000 < 0.05, so there was an influence of using the STEM-integrated PjBL model on students' science process skills. So it can be concluded that the STEM-integrated PjBL model can be said to be an innovation in learning to improve students' science process skills.

Keywords: PjBL Model; STEM; Science Process Skills.

Introduction

High-level thinking skills are very important for students to master in learning. This is because high-level thinking skills are one of the thinking activities that involve students' cognitive abilities in the teaching and learning process (Sucipto, 2017). However, many SMP/MTs students still have a low level of thinking ability. One of the causes of students' low level of thinking is that many students think that learning science is very difficult (Rahayu & Anggraeni, 2017). Thinking skills are closely related to science process skills because they involve students in problem-solving to develop their knowledge. One of the higher-order thinking skills is science process skills. Science process skills are a scientific method that can train the stages of an activity to carry out experiments (Yusuf & Nisa, 2018). Students can use science process skills as preparation for using scientific methods to develop their knowledge. Science process skills are skills that focus students on process learning to develop skills in understanding concepts and developing facts and values in everyday life (Widdina, Rochintaniawati, & Rusyati, 2018). Science process skills can be developed through students' personal scientific experiences (Hardianti & Kuswanto, 2017).

However, in reality, SMP/MTs students still have a low level of science process skills. The low level of science process skills is caused by students' lack of understanding of concepts in science learning (Af'idayani, Setiadi, & Fahmi, 2018). Science process skills involve aspects of cognitive skills, affective skills, and psychomotor skills, which if trained by students will make learning more meaningful (Rahayu & Anggraeni, 2017).

Science learning with the Science, Technology, Engineering, and Mathematics (STEM) approach trains students' various abilities. STEM can improve critical thinking abilities (Sukmana, 2018), scientific skills (Vishnu Wibowo, 2018), collaboration (Mu'minah &

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Aripin, 2019), and creative thinking (Heryanti, 2020). In the realm of primary and secondary education, the STEM approach is aimed at forming at least four attitudes of students who are aware of STEM (Bybee, 2013). First, students can understand and explain the problems around them and find solutions. Second, students recognize the characteristics of STEM disciplines. Third, students realize that the material, intellectual, and cultural environment is shaped by STEM disciplines. Finally, students show a caring attitude towards current issues related to STEM (energy security, renewable energy, quality environment).

The main advantage of learning with a STEM approach is increasing the ability for scientific attitudes and scientific processes (Stohlmann et al., 2012). These skills are needed in the 21st century by students to face global challenges. With STEM learning, students are asked to observe the natural and social conditions around them. Furthermore, students are invited to hone good literacy skills from various scientific disciplines, especially technology and science. This stage invites students to sharpen science concepts. Then, students solve and/or create solutions in the form of technological products through a series of scientific skills that have been honed. Finally, students carry out scientific (science) processes and attitudes to solve problems faced by the surrounding community.

One learning model that can be integrated with STEM is PjBL. Project Based Learning (PjBL) is one of the learning models emphasized in the 2013 curriculum. This is because the 2013 curriculum focuses on the learning process by inviting students to search for and build concepts (Rahayu, 2017). This learning model guides students to learn actively and provides meaningful experiences in the learning process. Students build concepts and experiences from the products they produce in a project-based learning process.

The Project Based Learning (PjBL) learning model is a learning model that uses projects/activities as the core of learning (Elisabet, et al., 2019). The learning model using Project Based Learning (PjBL) is emphasized in the 2013 curriculum. The use of the Project Based Learning (PjBL) learning model can be used in physics lessons, one of which is work and energy (Mayuni, et al., 2019). The project-based learning model is giving assignments to all students to be done individually, students are required to observe, read, and research (Doyan & Hadi, 2023).

Project-based learning is closely related to students' science process skills because by using a project-based learning model students can increase their creativity, activeness, and thinking abilities so that students' science process skills can develop. Integrating the PjBL learning model with the STEM approach is a good step to improve students' science process abilities. So far, research has obtained results that PjBL learning with STEM integration can increase students' interest in teach (Agung et al., 2022). What is meant by STEM (Science Technology Engineering and Mathematics) is an interdisciplinary approach that requires students to be active through discussion processes in the classroom. Students are required to actively use technology products in learning with a STEM approach (Hanim, et al., 2022). Furthermore, Hanim, et al (2022) STEM learning connects material with life, involves students in practice, guides students in practice, utilizes technology, uses active student learning strategies, communicates actively with students, and gives assignments in groups. Integrating STEM learning with simple technology can help understand the material and improve high-order thinking skills.

Project-based learning is very suitable for use in interdisciplinary learning. This is because learning involves a variety of academic skills in students, such as writing, arithmetic, literacy, and so on. Apart from that, this learning model is suitable for forming an understanding of concepts by assimilating various subjects. Thus, the PjBL learning model with a STEM approach is expected to be able to improve students' science process skills.

Method

This research is a quasi-experimental research with a posttest-only control group design. The population in this study was class VIII MTs students. Negeri 4 East Lombok for the 2023/2024 Academic Year, which consists of 5 classes with an average number of 32 students in each class, while the population is 154 students. In this study, the samples taken were 2 classes consisting of one experimental class and one control class. In the experimental class, treatment was given using the STEM integrated Project Based Learning model, while in the control class, treatment was given to the conventional learning model.

Sampling in this study used the Simple Random Sampling technique. The data collection technique uses 20 multiple-choice questions developed by the science process skill indicators, which consist of five basic skill indicators: observing, measuring, communicating, predicting, and classification. The data analysis technique uses prerequisite tests (homogeneity and normality tests) and hypothesis testing (Anova test).

Result and Discussion

The science process skills data described is the average score from the science process skills posttest and the observed scores on students' science process skills. Posttest scores for students' science process skills were obtained after being treated with an integrated STEM project-based learning model in the experimental class and conventional learning in the control class. Meanwhile, the scores from observations of students' science process skills were obtained during the learning process, both in the experimental class and in the control class. The results of the posttest and observations of science process skills were analyzed to see the effects during and after treatment in each class and are presented in Table 1.

Table 1. Data on science process skill scores for experimental and control classes

Class	The highest score	Lowest Value
Experiment	86	78
Control	51	23
Average	68	51

Based on the results of normality test calculations on science process skills, the Kolmogrov-Smirnov significance value was > 0.05, namely that the data was normally distributed. Then a homogeneity test was also carried out using the Levene test which showed a significance value of > 0.05, namely the data obtained was homogeneous. The results of the normality and homogeneity tests are presented in Table 2 and Table 3.

Table 2. Data Normality Test Results for Science Process Skills with SPSS.

Dependent variable	Class	Shapiro-Wilk		
		Statistics	df	Sig.
Science Process Skills	Experiment	0.948	29	0.162
	Control	0.943	28	0.131

Based on Table 2, the calculations carried out show that the data on science process skills abilities are normally distributed in the experimental class with a value of sig. namely, 0.162 and 0.131 both have values > 0.05. Likewise, in the control class, sig values were also obtained, namely 0.069 and 0.152, both of which had values > 0.05. So that both the experimental class and the control class show that the data is normally distributed.

Table 3. Data Homogenity Test Results for Science Process Skills with SPSS.

	Levene Statistic	df1	df2	Sig.
KPS	0.401500593	1	55	0.51

From the table above, the Sig value is obtained. = 0.511 If the significance level is set to a = 0.05 then the Sig value. = 0.511 > 0.05, which means that the data on students' science process skills is homogeneous.

Table 4. Data Anova Test Results for Science Process Skills with SPSS

KPS	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4249.256	1	4249.256	26.383	0.000
Within Groups	8858.463	55	161.063		
Total	13107.719	56			

From Table 4, the sig value is obtained. for the dependent variable science process skills it is 0.000 < 0.05 so it can be concluded that H_0 is rejected, which means there is a difference in science process skills between students in the experimental class and students in the control class. Sig value.

Science process skills data was obtained from two different instruments, namely using a posttest and an observation sheet. The scores for these two instruments are totaled which then becomes the science process skills score. As previously stated in Table 4, the average result of the science process skill scores of students in the experimental class was 68, while in the control class, it was 51. Of the two science process skill scores for both the experimental class whose learning used the STEM integrated project-based learning model and the controls whose learning uses conventional models show significant differences. This significant difference cannot yet be used as a decision-making tool. Due to the influence of the project-based learning model on students' science process skills, hypothesis testing using the ANOVA test is needed.

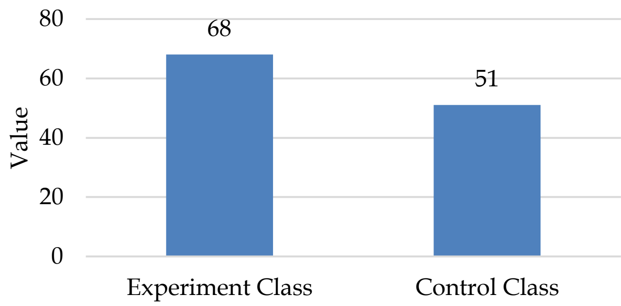

Figure 1. Science Process Skills Value Chart

Figure 1. Science Process Skills Value Diagram Test the science process skills hypothesis using the ANOVA test assisted by the SPSS 26 Windows OS program with data on science process skills in the experimental class and control class. The results of the hypothesis test on the influence of the STEM integrated project-based learning model on students' science process skills can be seen in Table 4. Data Anova Test Results for Science Process Skills with SPSS. From Table 4, the sig value is obtained. for the dependent variable science process skills it is 0.00 < 0.05 so it can be concluded that H0 is

rejected, which means there is an influence of the STEM integrated project-based learning model on students' science process skills.

The influence of learning using the STEM-integrated project-based learning model on science process skills cannot be separated from the important role of the STEM-integrated PjBL model. Learning using the STEM integrated project-based learning model allows students to be directly involved in project activities both individually and in groups to understand problems, search for information, plan solutions, implement plans, and communicate so that it has a positive impact on students' science process skills. In line with that, Natty et al. (2019) also stated that the STEM-integrated project-based learning model is a learning model that involves students both individually and in groups in their learning activities. A similar thing was also conveyed by Jatmika, et al (2020) that learning using the STEM-integrated project-based learning model showed positive results on students' science process skills. Furthermore, Suryaningsih and Nisa (2021) in their research made the integrated project-based learning model of Science, Technology, Engineering, Art, and Mathematics a best practice because it can build students' science process skills

Conclusion

There is an influence of using the STEM-integrated PjBL model on students' science process skills. So it can be concluded that the STEM-integrated PjBL model can be said to be an innovation in learning to improve students' science process skills.

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The authors declare no conflict of interest.

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