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The Effect of Project-Based Learning Models toward Science Process Skills (SPS) in Elementary School Students

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ABSTRACT
Science Process Skills are students' key to acquiring science knowledge scientifically. However, the state of SPS in elementary school students is still low. This study aims to determine the effect of the Project-based Learning (PJBL) learning model in science learning on students' science process skills (SPS) in elementary schools. The study used a pretest-posttest control group design. The research sample was 350 fifth grade elementary school students in Surakarta City. Samples were chosen randomly. The data collection technique uses the SPS test in terms of the learning process. Data analysis was performed using the independent t-test. The research results obtained a significance value at the 95% confidence level of 0.000 <0.05 so it can be concluded that there is a difference between students in the experimental and control groups. Students who use the PJBL model have a higher SPS compared to the learning model that is usually applied in class (assignments). Research recommends that teachers be able to design PJBL learning for better student SPS.

Keywords: Project-based learning, science process skills, elementary school, science learning

Introduction

Project-based learning has received significant attention in recent years. The PJBL model is a learning model that focuses on involving students in real-world projects and authentic experiences (Belwal et al., 2020; Juuti et al., 2021). The PJBL model has proven to be a valuable tool for improving science process skills in elementary school students (Safaruddin et al., 2020; Nasir et al., 2019). Science process skills are very important for students to develop a deep understanding of scientific concepts and engage in scientific investigations effectively (Ardianti & Raida, 2022; Adriyawati et.al., 2020; Miller & Krajcik, 2019). Project-based learning encourages students to become active participants in their learning process. Rather than passively receiving information, students engage in hands-on activities and investigations, cultivating a sense of ownership and responsibility in their scientific investigations (Krall et a., 2022; Nguyen & Duong, 2022). Through project-based learning, students learn how to ask questions, formulate hypotheses, design experiments, and collect data (Khaeruddin et al., 2023). This active involvement helps develop critical thinking skills, problem-solving skills, and an understanding of the scientific method as important aspects of science process skills (Arif & Putri, 2022; Oyewo et al., 2022; Suteja & Setiawan, 2022).

Project-based learning promotes a collaborative learning environment. By engaging in group projects, students learn how to work effectively in teams, communicate ideas, and engage in productive discussions (Knoblauch, 2022; Zhao & Wang, 2022). Collaborative learning not only improves science process skills but also develops important interpersonal skills that are valuable in all aspects of life (Purwianingsih et al., 2023; Owens & Hite, 2022). Students learn to value diverse perspectives, build consensus, and share responsibility which is essential for successful scientific investigations. Project-based learning also encourages students to apply their knowledge in real-world contexts. By working on projects that are relevant and meaningful to them, students understand the practical application of science in everyday life (Elvianasti & Kartikawati, 2022; Oyewo et al., 2022). For example, a science project on environmental sustainability can teach students about the importance of reducing waste or conserving energy. By applying scientific concepts to real-life scenarios, students gain a deeper understanding of scientific principles and develop a greater enthusiasm for science. Previous research has shown that PJBL has a significant influence on the development of science process skills of elementary school students (Hsin & Wu, 2023; Ulfayantik et al., 2022; Nugroho et al., 2023; Nasir, 2023).

By encouraging active participation, collaborative learning, real-world applications, and personalized experiences, project-based learning provides a holistic approach to science education (Krajcik et al., 2023). Therefore, this research is interested in exploring the effect of project-based learning on science process skills specifically in elementary school students, highlighting its positive impact on student development.

Research Methodology

This research is a quasi-experimental research. The study used a pretest-posttest control group design. The research sample was 350 fifth grade elementary school students in Surakarta City. Samples were randomly selected from five districts in Surakarta City, consisting of Laweyan, Banjarsari, Pasar Kliwon, Jebres, and Serengan Districts. The data collection technique uses the SPS test in terms of the learning process. SPS indicators were developed with the matrix in Table 1 consisting of observing, classifying, predicting, and communicating (Bundu, 2006).

Table 1 Indicators of Science Process Skills

No	Aspect	Indicator
1	Observe	Observing an object or event in detail
2	Classification	Identify and name the observable properties of a group of objects that can be used as a basis for classifying.
3	Predictions	Estimating events that will occur based on the results of observations and classifications.
4	Communication	Convey and clarify ideas orally or in writing.

The validity and reliability of this research instrument were fulfilled through the content validity and reliability of Cronbach's alpha. Data analysis was performed using the independent t-test. The classic assumption test was carried out before the t test analysis, namely using the normality test analysis using the Kolmogorov-Smirnov and homogeneity test using the Levene test. Research analysis was carried out using SPSS software tools.

Results and Discussion

Students' initial ability on their science process skills was measured at the beginning of the study. The group of students in the experimental class applied the Project-based Learning model, while the control group applied the Problem-based learning model. At the end of the study, researchers measured SPS in both groups, both the experimental group and the control group. The SPS measurement results are presented in Table 2. The group of students in the experimental class applied the Project-based Learning model, while the control group applied the Problem-based learning model. At the end of the study, researchers measured SPS in both groups, both the experimental group and the control group. The SPS measurement results are presented in Table 2.

Table 2. Science Process Skills Description Data

Group	Model	Data	Mean	Min	Max
Experiment	Project-based Learning	Pretest	64.50	52.50	81.25
		Posttest	86.44	67.85	86.76
Control	Problem-based Learning	Pretest	65.25	54.65	80.55
		Posttest	73.76	61.10	84.15

Data acquisition in the experimental and control groups is presented in the data distribution table and then analyzed using the independent t test. The analysis prerequisite test is carried out first, consisting of a normality test and a homogeneity test. The results of the prerequisite test analysis are presented in Table 3.

Table 3. Normality and Homogeneity Test Results

Group	Model	Data	Normality	Homogeneity
Experiment	Project-based Learning	Pretest	Sig. = 0.187 > 0.05, it can be concluded that the data is normally distributed	Sig. = 0.878 > 0.05, it can be concluded that the data is homogeneous
		Posttest	Sig. = 0.166 > 0.05, it can be concluded that the data is normally distributed	Sig. = 0.889> 0.05, it can be concluded that the data is homogeneous

Control	Problem-based Learning	Pretest	Sig. = 0.174 > 0.05, it can be concluded that the data is normally distributed	Sig. = 0.866 > 0.05, it can be concluded that the data is homogeneous
		Posttest	Sig. = 0.163 > 0.05, it can be concluded that the data is normally distributed	Sig. = 0.856 > 0.05, it can be concluded that the data is homogeneous

The data in Table 3 shows that the research data has fulfilled the prerequisite analysis test. The research data is normally distributed and comes from the same variant. The results of the independent t test analysis have been carried out with the results presented in table 4.

Table 4. Independent Sample t-Test Results

Group	Model	Sig.	Conclusion
Experiment	Project-based Learning	0.000 < 0.05	There are SPS differences between the experimental group and the control group
Control	Problem-based Learning		

The results of the independent t test analysis showed that sig. of 0.000 <0.05 so it can be concluded that at the 95% confidence level the application of the Project-based Learning model has an effect on students' science process skills in elementary school. The implementation of the PJBL model in the experimental group was carried out by following the stages of the PJBL model. The first stage is the preliminary stage, where the teacher introduces the project theme and provides an overview of the learning objectives. This stage is very important because it helps students understand the relevance and purpose of the project, which motivates their involvement and curiosity.

After the Introduction, students proceed to the planning stage. At this stage, they collaborate with their peers to brainstorm ideas, set goals, and outline plans for achieving them. They also develop timelines and allocate tasks among group members. Teachers guide and facilitate this process, ensuring that students have a clear direction and understanding of their responsibilities. After planning is complete, students proceed to the investigation stage. Students carry out investigations and gather information to deepen their understanding of the project topic. This stage encourages students to explore a variety of sources, such as books, articles and online platforms, enabling them to develop research skills while broadening their knowledge base.

The next stage is to create. At this stage, students apply the knowledge and skills gained from the research phase to develop their projects. Learning ends with a presentation activity. They show off their projects to their classmates, teachers and even their parents. This phase not only allows students to showcase their work but also helps them develop effective communication and presentation skills. Students learn to effectively articulate their thoughts, explain their findings, and respond to questions or feedback.

This study corroborates previous research that an optimally implemented PjBL model can improve science learning outcomes in elementary schools (Ulfayantik et al., 2022; Nugroho et al., 2023; Nasir, 2023). The application of the PjBL model not only increases student engagement and motivation but also equips them with the necessary skills to excel in scientific inquiry (Hsin & Wu, 2023). As educators continue to embrace project-based learning, they empower students to become lifelong learners and critical thinkers who can explore the complex world of science with confidence and curiosity.

Conclusion

The results of the independent t test analysis showed that sig. of 0.000 <0.05 so it can be concluded that at the 95% confidence level the application of the Project-based Learning model has an effect on students' science process skills in elementary school. SPS in the group of students who applied the PjBL model was better than those who applied PBL. This study recommends that teachers be able to design PjBL models in science learning adapted to the characteristics of students for effective implementation so as to improve SPS and student learning outcomes in science.

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