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Project Based Learning Model on Elementary School Students' Science Process Skills and Creative Thinking Skills

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ABSTRAK

Pembelajaran yang kurang inovatif melalui gaya belajar yang masih monoton oleh guru serta pembeljaran yang hanya berfokus pada ranah kognitif akan berdampak pada hasil belajar khususnya keterampilan proses sains dan kemampuan berpikir kreatif. Siswa menjadi kurang aktif dalam memahami rangkaian kegiatan pembelajaran yang dilaksanakan. Penelitian ini bertujuan untuk menganalisis keefektifan model pembelajaran berbasis proyek terhadap keterampilan proses sains dan keterampilan berpikir kreatif siswa sekolah dasar. Metode penelitian yang digunakan dalam penelitian ini adalah penelitian eksperimen dengan menggunakan jenis eksperimen semu. Sampel dalam penelitian ini adalah 40 siswa yang dibagi menjadi dua kelompok. Perlakuan untuk kelas eksperimen menerapkan model pembelajaran berbasis proyek, dan kelas kontrol menggunakan model pembelajaran berbasis masalah. Metode pengumpulan data menggunakan teknik observasi, angket, dan tes. Teknik analisis data menggunakan statistik deskriptif dan statistik inferensial. Hasil penelitian menunjukkan adanya perbedaan yang signifikan pada tes hasil belajar. Uji independent sample t-test menunjukkan Sig. 2-tailed sebesar 0,016, yang berarti lebih kecil dari 0,05 (0,016<0,05). Hasil ini menunjukkan adanya perbedaan hasil belajar yang signifikan dimana kelas eksperimen lebih unggul dari kelas kontrol. Selanjutnya pengaruh model pembelajaran berbasis proyek terhadap keterampilan proses sains siswa mengalami peningkatan yang signifikan sebesar 63,7%, dan keterampilan berpikir kreatif meningkat sebesar 9,2%. Hasil penelitian menyimpulkan bahwa model pembelajaran berbasis proyek terbukti efektif dalam meningkatkan keterampilan proses sains dan keterampilan berpikir kreatif siswa.

ABSTRACT

Learning that is less innovative through a learning style that is still monotonous by the teacher and learning that only focuses on the cognitive domain will have an impact on learning outcomes, especially science process skills and creative thinking skills. Students become less active in understanding the series of learning activities carried out. This research aims to analyze the effectiveness of the project based learning model on elementary school students' science process skills and creative thinking skills. The research method applied in this study is experimental research using a quasi-experimental type. The sample in this research was 40 students that were divided into two groups. The treatment for the experiment class implements the project based learning model, and the control class uses problem based learning model. The data collection method employed observation, questionnaire, and test techniques. The data analysis technique utilized descriptive statistics and inferential statistics. Research results indicated significant differences in the learning outcomes of the test. The independent sample t-test showed Sig. 2-tailed by 0.016, which means smaller than 0.05 (0.016<0.05). This result shows a significant difference in learning outcomes in which the experiment class is superior to the control class. Later on, the effect of project based learning model on students' science process skills brings significant improvement by 63.7%, and creative thinking skills improves by 9.2 %. The study concludes that the project based learning model is proven effective in improving students' science process skills and creative thinking skills.

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1. INTRODUCTION

Education is the most important part of a nation's development. Education is the main factor determining economic growth, including increased labor/teacher productivity. A nation's growth and continuity are also significantly influenced by education (Sari & Angreni, 2018; Widiansyah, 2017). The condition becomes a sign that improving education quality must be taken more seriously so that the next generation can compete superiorly in this globalization era. Education quality is not separated from the learning process. Good learning will bring decent learning outcomes as well. Learning is a sequence of activities that make learning possible and are defined by communication and interaction between teachers and students, teaching resources, and the environment. This interaction aims to achieve learning activities, especially students' competence could change favorably for them. Hence, a teacher must have a certain understanding and methods to introduce and make students fathom the existing science. Science (IPA) as a discipline of study is knowledge obtained through collecting data through experiments, observation, and deduction to produce a credible explanation of a phenomenon (Herpratiwi & Tohir, 2022; Nugraheni, 2018). The scientific teaching approach is, of course, founded on scientific principles and adheres to the specifications of the curriculum being established. Of course, learning is accomplished by different methods or ways to implement learning processes focusing on educating students from the cognitive, affective, and psychomotor aspects. All teachers have used a variety of approaches, models, and teaching methods that are adaptable to the subject matter to carry out learning activities in the classroom. By utilizing a varied learning model, a teacher will find it easy to manage and deliver lesson material in the class. Providing the right learning model will also help develop students' abilities (Shahroom & Hussin, 2018; Sumantri et al., 2022). The learning model that may be utilized to promote the improvement of the current curriculum, especially in science learning, is the project-based learning model.

According to previous study the Project-Based Learning (PjBL) model is a learning model that involves students in a project based on a designed problem, and eventually, they may generate a real work (Saputra & Sujarwanta, 2021). This opinion is analogous to other opinion. Project Based Learning is a learning model involving students designing learning objectives to produce real products or projects (Nurdiansah & Makiyah, 2021). Not only that, Students have control over the project they will work on, how the project will be completed, and what kind of product will be produced. The PjBL model helps the overall self-development of students to a more professional level (Castaldi & Mimmo, 2019; Sharma et al., 2020).

In addition to implementing learning models, assessment of cognitive aspects, attitudes, and skills must be highlighted to measure how much changes and improvements in student science learning outcomes. Science process skills are directed skills (cognitive and psychomotor) used to solve a concept, principle, or theory, develop pre-existing conceptions, or reject new discoveries (Puspita, 2019; Sa'ida, 2021). Therefore, students' science process abilities are crucial to achieving good learning outcomes. The teacher can then determine the extent to which the students can complete an activity that requires them to understand concepts and theories. Science process skills consist of several activities, including observing, classifying, predicting, measuring, concluding, and communicating skills (Fajriyanti et al., 2018; Rauf et al., 2013). Acquiring a self-process skill requires assistance from the ability to think creatively to produce something that corresponds to what students want.

Students' ability to solve problems by arguing the facts and completing assigned activities demonstrates their aptitude for creative thinking. Therefore, the capacity to think creatively is very good for students to improve. Of course, knowing crucial features of numerous indications are required to boost one's ability to think creatively. That is; (a) fluid thinking, the ability to release ideas quickly and appropriately; (b) flexible thinking, the capacity to consider a variety of solutions to a problem; and (c) original thinking, the propensity to generate a wide range of ideas that are distinct from those of other people generally; (d) detailed thinking or the capacity to consider an idea in detail and put it into practice (Ningsih et al., 2021; Pramesti et al., 2022). Creativity or creative thinking is also crucial in improving education quality. Until now, creativity has been well-received as a competency that cannot be separated from learning processes and outcomes.

The previous studies has discussed a lot about project-based learning models with similar topics related to education from various levels, several studies that have been conducted on PJBL include (Li & Chu, 2021; Novianto et al., 2018). In this study, the researchers utilize the project-based learning model, specifically discussing on project based learning model's effectiveness on elementary school students' science process skills and creative thinking abilities. The research purpose is to determine the effectiveness of the project-based learning model on elementary school students' science process skills and creative thinking abilities. In a separate study, the application of the project-based learning model has the same advantages as aspects of science process skills and students' creative thinking abilities. These two aspects are recommended for use in students' cognitive development. But there is no research that examines these two aspects simultaneously by using different learning models. In addition, in general the method of

collecting data on aspects of science process skills tends not to change, namely using observation techniques and questions.

2. METHOD

This research is an experimental study employing quasi-experimental. Creswell explained that experimental research is the study used to determine the cause and effect of an independent variable on the dependent variable (Sulistiyarini et al., 2021). Meanwhile, a quasi-experimental is a type of experiment utilizing a control group but does not completely control external variables in experimenting (Rogers & Revesz, 2019). This research design is a nonequivalent control group design. A nonequivalent control group design is a research design that tests the difference between experiment and control groups by providing a pre-test to find out the initial condition by non-random group selection. Non-equivalent control group design is presented in Table 1.

Tabel 1. Design Research Nonequivalent Control Group Design

Group	Pre-test	Treatment	Post-test
Control	01	X1	02
Experiment	03	X2	04

This research consisted of three variables, one independent variable, and two dependent variables. The independent variable in this research is a project-based learning model, a learning approach, while the dependent variable is science process skills and creative thinking ability. This study was conducted in January in the even semester of 2023. The population taken was all students in grade V of the State elementary school 24 Cakranegara, consisting of 40 students in classes 4 A and 4 B. The sample collection technique uses purposive sampling. The instrument for data collection was an observation manual for science process skills and a questionnaire and essay questions for creative thinking ability. Aspects and indicators to be assessed are presented in Table 2 and Table 3**.**

Table 2. Science Process Skills

Aspect	Indicators
Observing	Use senses of hearing, sight and touch to obtain the necessary data
Classifying	Group the tools and materials in the project precisely and clearly
Predicting	Make estimates or temporary guesses before creating a project
Measuring	Use the tool according to the steps that have been made to test the project
Concluding	Conclude predictions that have been made in accordance with the theory that has been taught
Communicating	Convey project results clearly, precisely and affectively

Table 3. Creative Thinking Skills

Aspect	Indicators
Fluent thinking skills	Describe the materials based on self-understanding
Flexible thinking skills	Application of materials concepts with various techniques
Original thinking ability	Find examples of material concepts from everyday life
Detailed thinking skills	Analyze the material as material to equate perceptions with the project

Based on Table 2 and Table 3 the tests were distributed to students where the instrument for assessing science process skills used direct observation techniques. the instrument for the observation technique consists of six indicators, namely Observing, classifying, predicting, Measuring, Concluding and communicating Meanwhile, the ability to think creatively consists of two types of instruments, namely questionnaires and essay questions for the ability to think creatively. The instrument for students' creative thinking skills consists of four indicators, namely fluent thinking skills, flexible thinking skills, original thinking skills, and detailed thinking skills. Before testing students, we validated the instrument through expert judgment. The aim is to assess the accuracy of the content of the questions, the relevance of the objectives, and the accuracy of the construction of the questions. This validation process was carried out by two experts. The instruments used are tests and non-tests

This study implemented a project-based learning model with several stages. They are (1) determining basic questions; (2) making project design; (3) arranging scheduling; (4) monitoring project

development; (5) result assessment; and (6) experiment evaluation (Nurjanah & Cahyana, 2021). Data analysis utilized descriptive qualitative and inferential analysis covering normality test, homogeneity, independent sample T-test, and simple linear regression test. The study conducted a hypothesis test to determine the effect of the Project Based Learning model on science process skills and creative thinking ability.

3. RESULT AND DISCUSSION

Result

The descriptive analysis is presented in a descriptive statistical table containing minimal and maximal scores from the experiment and control classes on the pre-test and post-test. Descriptive analysis data is processed using SPSS 25 for windows. The descriptive analysis aims to observe the difference in the test results on the increase in student learning outcomes in the experimental and control classes, which were treated with different learning models. The presented data is pre-test data to measure students' initial capabilities. Afterward, the post-test data were obtained after conducting learning treatment. The data obtained from the pre-test and post-test result on improving students' cognitive learning outcomes consist of the lowest score, highest score, average (mean), and standard deviation. The results of data management with descriptive analysis are presented in the Table 4.

Table 4. Descriptive Analysis

Statistics	Pretest-Experiment	Posttest-Experiment	Pretest-Control	Posttest-Control
Mean	57.50	70.50	55.50	61.50
Std. Deviation	14.281	10.375	13.563	12.042
Minimum	30	50	30	40
Maximum	80	95	80	80

Table 4, shows the descriptive analysis output from the pre-test and post-test results to improve learning outcomes consists of analyzing the lowest, highest, average, and standard deviation scores. The results of the descriptive data analysis show that the average (mean) pre-test score of the experimental class before treatment is 57.50, with a 14.281 standard deviation. After being given treatment by applying the project-based learning model, the average result (mean) has increased by 70.50 with a standard deviation of 10.375, the minimum score obtained during the pre-test is 30, and the maximum score is 80. While the minimum score obtained in the post-test is 50, and the post-test maximum value after treatment using PBJL reaches 95. This data shows a difference in the experiment class's average pre-test and post-test scores. The average value (mean) output result for the control class before treatment is 55.50, with a standard deviation of 13.563. The average value after treatment using the problem-based learning model is 61.50, with a standard deviation of 12.042. The score obtained before treatment shows a minimum 30 score and a maximum 80 score. Meanwhile, the minimum score is 40, and 80 maximum scores after treatment using the PBL model. The analysis result shows a difference in average scores in the pre-test and post-test in the control class. The researchers used descriptive analysis data as prerequisite tests covering normality and homogeneity. The prerequisite test is used to carry out a different test (t) using an independent sample t- test. The sample T-test is a test to obtain the average difference and the effectiveness of the project based learning model (experimental class) and problem based learning models (control class).

The normality test in this research employed SPSS 25 for windows using Kolmogorov-Smirnov and Shapiro-Wilk techniques in the normality test. The normality test aims to determine whether the gathered data is normally distributed or not. Table 5 displays the Normality test result.

Table 5. Normality Test

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Pre-Experiment	0.181	20	0.087	0.918	20	0.090
Post-Experiment	0.190	20	0.058	0.942	20	0.260
Pre-Control	0.181	20	0.086	0.955	20	0.453
Post-Control	0.160	20	0.194	0.942	20	0.265

Table 5 shows the normality test results in the pre-test and post-test in the experiment and control class. The data is not normally distributed if the significance score is < 0.05. While if the significance score

is > 0.05, the data is normally distributed. In Kolmogorov-Smirnov and table, it shows a significance score > 0.05. Observing from pre-test and post-test results, experiment, and control class, the study deduces the data is normally distributed. Afterward, the research conducted a homogeneity test using the homogeneity of variance test. This test was applied to observe any similarities among variables in the experiment and control class. Data was homogeny if the significance score was> 0.05, and if the significance score was < 0.05, the data was not homogenous. Table 6 shows the homogeneity test result.

Table 6. Homogeneity test

Parameters		Levene Statistic	df1	df2	Sig.
Learning outcome	Based on Mean	2.267	1	38	0.140
	Based on the Median	1.858	1	38	0.181
	Based on the Median and with adjusted df	1.858	1	35.568	0.181
	Based on trimmed mean	2.259	1	38	0.141

Table 6 shows the significance score based on the mean is 0.140. Hence, the study deduced data variant of the pre-test experiment and pre-test control is homogeny or similar. Normality and homogeneity test results showed that data is normally distributed and homogeny, then the comparison between the two samples does not have a partner and is continued by using the t-test. The t-test implements the independent sample T-test. Table 7 explains the t-test result.

Table 7. Independent Sample T-Test

Parameters		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Study Outcome	Equal variances assumed	1.560	0.219	2.532	38	0.016	9.000	3.554	1.805	16.195
	Equal variances not assumed			2.532	37.186	0.016	9.000	3.554	1.800	16.200

Table 7 presents the analysis result of the independent sample t-test. The study then tested a hypothesis, determining whether the hypothesis was accepted or rejected. The proposed hypothesis is H_o: no significant difference in learning outcomes between applying Project Based Learning (experiment) and problem-based learning (control) models to learning outcomes. The other hypothesis is H_a: a significant difference occurred in learning outcomes between applying project-based learning (experiment) and problem-based learning (control) models to learning outcomes. To test the hypothesis, the research uses the output results of SPSS 25 for windows—test criteria using the coefficient of Significance with conditions. (1) if the significance score is <0.05, H_o is rejected; (2) If the significance score is >0.05, H_o is accepted.

The next test is a simple linear regression test with X independent variable (PjBL) and Y_1 dependent (SPS), and Y_2 dependent (CTS) variable. Because there is one variable, X, and two variables, Y, the test is carried out twice to see how much X influence has on Y_1 and X influence has on Y_2. The study utilized output results from SPSS 25 for windows to test the hypothesis. Table 8 explain the trial result of science process skills (SPS).

Table 8. Science Process Skills (SPS) Variable Simple Linear Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	30.120	6.777		4.444	0.000
	PjBL_(X)	0.637	0.106	0.818	6.029	0.000

Table 8 in column B shows that the constant (a) is 30.120. At the same time, PjBL (b) score is 0.637. So that it gets the following equation: Y = a + bX or Y = 30.120 + 0.637. From the equation, the study deduced:

(1) A constant positive score of 30.120 indicates a positive influence of the independent variable (PjBL). If the independent variable rises or is affected by one unit, the dependent variable (SPS) will also increase or fulfill. (2) The regression coefficient X of 0.637 states that if PjBL (X) increases by one unit, then SPS (Y1) will also increase by 63.7%. Then the trial result of science creative thingking skills (CTS) is show Tables 9.

Table 9. Creative Thingking Skills (CTS) Variable Simple Linear Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	64.660	15.580		4.150	0.001
	PjBL_(X)	0.092	0.243	0.089	0.379	0.709

Next, from the results in Table 9, column B, the constant score (a) is 64.660. Meanwhile, the PjBL score (b) is 0.092. So that it gets the following equation: Y = a + bX or Y = 64.660 + 0.092. From the equation, the study deduced: (1) A constant positive score of 64.660 indicates a positive influence of the independent variable (PjBL). If the independent variable rises or is effect by one unit, then the dependent variable (CTS) will increase or fulfill. (2) The regression coefficient X of 0.092 states that if PjBL (X) increases by one unit, then CTS (Y2) will increase by 9.2%.

Discussion

Applying the PjBL model in class by carrying out various activities that can increase students' interest in learning. So that later on Student knowledge, strategies, and skills are generally measured by most assessment instruments, ranging from self-administered questionnaires, rubrics, tests, interviews, observations, self-reflection journals, and others. Learning outcomes with the PJBL model receive a lot of attention, perhaps because employers explain that basic knowledge and skills are very important in students' readiness to work in the future (Guo et al., 2020; Habibi et al., 2020; Rahardjanto et al., 2019). This research result aligns with previous research stating that education stressing on project-based learning model will help the student attain good skills (Ariyani et al., 2019; Nurfathurrahmah et al., 2020; Uswatun Chasanah et al., 2016).

The teacher is only a facilitator to provide and explain material while students are active in carrying out class activities starting from working on projects, collaborating, developing creativity, to sharing experiences (Habibi et al., 2022; Widiana et al., 2021). Implementation project-based learning model in science learning provides a new way for students to acquire different knowledge from learning that only focuses on the contents of books and the teacher's explanations. This opinion is analogous to the previous study stating that in the learning process context, it can be said that project-based learning activities are a systematic learning process. A learning process that emphasizes students learning through projects such as challenging research assignments, authentic questions, and well-tailored products will increase student knowledge and skills (Nurdiansah & Makiyah, 2021). This statement is also relevant to other study that found the PjBL learning model has seven characteristics: involving students directly in learning, connecting learning with the real world, implementing research-based methods, involving various research sources, combining knowledge and skills, carrying out from time to time, and ending with certain products (Winarni & Purwandari, 2020).

Students' creative thinking abilities will increase in originality and elaboration when looking for solutions or problem-solving questions related to projects. There is relevance with previous research; The first is originality, shown during practicum and model making. The second aspect is elaboration, in which students seek deep meaning for the problem-solving process by taking detailed steps, developing or enriching other people's ideas, and examining the details to determine what way to take. There are even some students who experience an increase in all indicators of creative thinking, this is in line with the research conducted (Khoiri et al., 2023; Mukaromah & Wusqo, 2020; Putri et al., 2023). Based on this research, students use two different learning models: experiment and control class. The experimental class has a more significant influence than the control class. These results are consistent with several other studies which state that applying the PjBL model is better than the PBL or conventional models (Simbolon & Koeswanti, 2020).

The results of research using the project based learning model are proven to be able to improve cognitive abilities, especially in science process skills and students' creative thinking abilities. From the results of data analysis in this study, science process skills increased by 63.7% compared to previous studies (Suradika et al., 2023). while the ability to think creatively increased by 6.2%. The results of creative thinking skills can also be compared with previous research (Zakiah & Fajriadi, 2020). The previous

research focused on either science process skills or creative thinking skills only so there was no comparison with other variables, so process skills and creative thinking abilities got very high results when compared to this study. But even so this research is considered very good with an increase in students' cognitive abilities.

The results of this research will have a good impact on teachers in developing innovative learning models in developing science process skills and students' creative thinking abilities. Innovative learning models are very suitable for use in the 21st century education era. so that every teacher is required to be able to develop students' cognitive abilities, especially science process skills and creative thinking skills. The limitations of this study are that some of the data sources collected apply to the basic education level in Indonesia which can be generalized to a higher or international level, then indexing databases on national indexers to Scopus and the variables used by researchers are limited to science process skills and creative thinking skills has not been explored for other variables such as learning motivation, cooperation, talents and interests, as well as other variables.

4. CONCLUSION

Based on resulting analysis and the discussion that has been presented, it can be concluded that using project-based learning for elementary school children makes the teaching and learning process effective, challenging and fun especially for improving students' science process skills and creative thinking skills abilities. However, project-based learning also requires fairly mature readiness in implementation, such as preparing tools and materials, explaining the stages, prizes, and compiling instrument questions for groups. With careful preparation, it will support the success of the learning process according to the expected targets beforehand.

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