

Improving Experimentation Skills through the Implementation of Project Based Learning: Analysis of Creative Thinking Skills

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Abstract

This research aims to: (1) determine the effect of Project Based Learning (PjBL) on students' experimentation skills; (2) determine the influence of creative thinking skills on students' experimentation skills; (3) knowing the interaction between Project Based Learning (PjBL) and creative thinking skills on students' experimentation skills. The subjects of this research were all fourth grade elementary school students. This research uses a quantitative type of research with a quasi-experimental research design that provides pretests and posttests to the control class and experimental class groups. The research instruments used were performance to measure students' experimentation skills and written tests to measure students' creative thinking skills. Data analysis prerequisite tests include normality tests, homogeneity tests, and balance. Hypothesis testing uses a two-way ANOVA test with different cells. The results of this research show that (1) Project Based Learning (PjBL) influences students' experimentation skills; (2) Creative thinking skills influence students' experimentation skills; (3) The application of Project Based Learning (PjBL) has an effect on students who have high creative thinking skills. The conclusion of this research is that there is an influence of Project Based Learning on experimentation skills in science learning in terms of creative thinking skills.

Keywords: *Project Based Learning, experimentation skills, creative thinking skills*

Abstrak

Penelitian ini bertujuan untuk: (1) mengetahui pengaruh Project Based Learning (PjBL) terhadap keterampilan eksperimen siswa; (2) mengetahui pengaruh keterampilan berpikir kreatif terhadap keterampilan eksperimen siswa; (3) mengetahui interaksi Project Based Learning (PjBL) dan keterampilan berpikir kreatif terhadap keterampilan eksperimen siswa. Subyek penelitian ini adalah seluruh siswa kelas IV Sekolah Dasar. Penelitian ini menggunakan jenis penelitian kuantitatif dengan desain penelitian quasi eksperimen yang memberikan pretest dan posttest pada kelompok kelas kontrol dan kelas eksperimen. Instrumen penelitian yang digunakan adalah performance untuk mengukur kemampuan eksperimen siswa dan tes tertulis untuk mengukur kemampuan berpikir kreatif siswa. Uji prasyarat analisis data meliputi uji normalitas, uji homogenitas, dan keseimbangan. Pengujian hipotesis menggunakan uji ANOVA dua arah dengan sel berbeda. Hasil penelitian menunjukkan bahwa (1) Project Based Learning (PjBL) berpengaruh terhadap keterampilan eksperimen siswa; (2) Keterampilan berpikir kreatif berpengaruh terhadap keterampilan eksperimen siswa; (3) Penerapan Project Based Learning (PjBL) berpengaruh terhadap siswa yang memiliki kemampuan berpikir kreatif tinggi. Kesimpulan penelitian ini adalah terdapat pengaruh Project Based Learning terhadap keterampilan eksperimen dalam pembelajaran IPA ditinjau dari keterampilan berpikir kreatif.

Kata kunci: *Project Based Learning, keterampilan eksperimen, keterampilan berpikir kreatif*



INTRODUCTION

According to Ministry of Education and Culture Decree number 8 of 2022, IPAS is a subject that studies living things and inanimate objects in the environment and their interactions, and examines human life as individuals as well as social creatures who interact with their environment. The material in science and science learning is a combination of scientific and social material. As a subject that studies science, IPAS aims to encourage students to develop analytical skills in solving complex problems and encourage students' ability to innovate or make new discoveries. Training analytical skills in solving complex problems in science learning can be done by developing students' experimentation skills (Wiratman, et al: 2023). Experimentation skills are one of the keys to implementing science or science learning (Aldiyah: 2021).

Based on the results of observations in the field, data was obtained that the implementation of science and science learning in developing experimentation skills was still lacking. The lack of development of experimental skills is due to limitations in preparing adequate experimental equipment, the experiments carried out are not well designed, the experimental activities are more demonstrative and do not provide opportunities for students to design their own experiments, the students' activities in discussions and analysis are not optimized, experiments are not applied in the real world. This condition will result in limited students' conceptual understanding of the material being studied, students' difficulties in connecting theory with concepts that exist in the real world, students cannot develop their creative thinking skills, and their interest in learning decreases.

Experimentation skills are an important aspect in science and technology learning because they are able to develop students' scientific attitudes in accordance with the science and science learning objectives stated in the Ministry of Education and Culture Decree number 8 of 2022. Experimentation skills can be applied through experimental or practicum learning (Mosiienko, et al: 2023). Learning by developing experimental skills is an effective way to increase student motivation and involvement in the science or science learning process (Ratnaningtyas, D.I., & Wilujeng: 2021). To develop students' experimentation skills, a learning model is needed that actively involves students in the learning process. The learning model that enables students to face real situations and solve problems through directed experimental activities is Project Based Learning. Project Based Learning (PjBL) is a strategy in the learning process that uses projects or activities as the main means of improving students' abilities in aspects of knowledge, attitudes and skills (Anggarini: 2021).

Project-Based Learning (PjBL) has several main principles, including student-centered learning, learning can develop student creativity, creating a challenging and fun learning atmosphere in the classroom (Yaniarti: 2021). Project Based Learning (PjBL) is suitable for application in science learning to develop experimentation skills. Experimentation skills are students' skills in planning, carrying out and analyzing trials or experiments in a systematic and scientific way (Winangun: 2021). Experimentation skills include the skills to formulate problems, propose and test hypotheses, design and assemble instruments, collect, process and interpret data and communicate written or verbally based on empirical evidence obtained from experimental activities (Supena, et al, 2021). In developing experimentation skills, new ideas or ideas that are different and innovative are needed, so students' ability to think creatively is needed. Creative thinking is one of the important components that students must have in developing experimentation skills (Chen, et al: 2022).

Several studies related to the application of Project Based Learning (PjBL) include research conducted by Suradika, et al (2023) with the title "Project-Based Learning and Problem-Based Learning Models in Critical and Creative Students", with the research results showing that the application of the model Project Based Learning (PjBL) can improve students' ability to think creatively. Research conducted by Kusadi,

et al (2020) entitled "Project Based Learning Model on Social Skills and Creative Thinking", with research results showing that the application of the Project Based Learning (PjBL) model has a significant influence on social skills and creative thinking abilities student. Research conducted by Chen, et al (2022) entitled "Effect of Project-Based Learning on Development of Students' Creative Thinking", with research results showing that the application of Project-Based Learning can improve students' creative thinking skills. Other research also conducted by Wijayanti, et al (2019), with the title "Improving student creative thinking skills through project based learning" also shows the results of the significant influence of implementing Project Based Learning (PjBL) on students' creative thinking skills which consist of fluency, flexibility, originality and elaboration.

Several studies on Project Based Learning (PjBL) have been proven to have a positive influence on the learning process, but there has been no research to look at the direction of Project Based Learning (PjBL) on students' experimentation and creative thinking skills in elementary schools simultaneously. Therefore, researchers are interested in researching further about the application of Project Based Learning (PjBL) to experimentation skills in terms of creative thinking in science and science learning in elementary schools in Dagangan District. Based on this description, this research is entitled "The Effect of Using Project Based Learning (PjBL) on Experimentation Skills in Science Learning in terms of Creative Thinking". It is hoped that the results of this research can become a reference for educators to develop and implement Project Based Learning (PjBL) in classroom learning by using experimental methods in science and science learning in terms of students' creative thinking in elementary schools.

METHOD

This research uses quantitative research. The design of this research uses a quasi-experimental research design. In this research, the quasi-research design used is factorial design. Sukadi (2019) explains that factorial design is used to evaluate the impact of two or more treatments on related variables. Factorial design is a form of experimental design that is adapted to moderator variables that can influence treatment and independent variables on the dependent variable (Sugiyono, 2019). There are three variables in this research, namely the independent variable, the dependent variable and the moderator variable. The independent variable in this research is Project Based Learning. The experimental class was treated using Project Based Learning, while the control class was treated with direct learning or conventional models. The dependent variable in this research is experimentation skills, while the moderator variable in this research is creative thinking skills. The population in this study was all fourth grade elementary school students in Dagangan District, Madiun Regency, totaling 567 students, then random sampling was carried out from this population. The sample in this study was grade IV elementary school students at SDN Jetis 01, SDN Sewulan 02, and SDN Dagangan 02, totaling 60 students.

The data collection technique used in this research is an instrument in the form of test questions (pretest and posttest) and performance assessment which are tested first before being applied to the control class and experimental class. The test instrument used in this research is in the form of questions in the form of descriptions. The reason for choosing questions in the form of descriptions is because they are more comprehensive and are considered more capable of measuring indicators. The test instrument in this research was used to measure students' creative skills in the science and science subject material changing the shape of objects. There are four indicators to measure students' creative thinking skills, namely: fluent thinking (Fluency), flexible thinking (Flexibility), original thinking (Originality), and elaborative thinking (Elaboration). Performance assessment takes the form of a worksheet when students

carry out experimental activities. Performance assessment in this research is used to assess students' activities during experimental activities. The use of this assessment is to see students' achievements in developing their experimentation skills. The experimental skills to be seen in this research are: asking questions, predicting, observing, classifying, conducting experiments, using tools and materials, interpreting and communicating.

This research uses a 2 x 2 factorial design, so the hypothesis test used is two-way analysis of variance, which is the method used to test differences in variance of two or more variables. The main elements in variance analysis are variance between groups and variance within groups. Hypothesis testing using two-way ANOVA is carried out if the data has been tested for prerequisites. The prerequisite tests used in this research are the normality test to find out whether the sample to determine the hypothesis comes from a normally distributed population or not, the homogeneity test to see whether the two sample groups in the study come from a homogeneous population, and the balance test to find out whether the data are balanced or not.

In carrying out this research, students were introduced to a project to develop students' experimentation skills in terms of students' skills in creative thinking. The next step is to set the overall project implementation schedule. This activity is carried out by teachers and students. The project carried out was in the form of a project on science learning material on changes in the form of objects. Teachers assess students' experimentation skills through student performance activities. Students' creative thinking skills were measured by giving written tests before and after treatment in the control class and experimental class groups.

RESULTS AND DISCUSSION

This research aims to examine the effect of Project Based Learning on students' experimentation skills in terms of students' creative thinking skills. Students' experimentation skills are measured through students' performance activities in experimental activities before and after being given treatment. Meanwhile, students' creative thinking skills were measured through written tests before and after being given treatment. This research applies Project Based Learning for the experimental class and direct or conventional learning models for the control class. Both classes were given a pretest for students' initial creative thinking skills before being given treatment. After being given treatment, a posttest was carried out to determine the effect of treatment on creative thinking skills. Both classes had experimental activities with performance in both classes. The experimental class carries out performance activities through the application of Project Based Learning. The following data is presented in the form of a pretest and posttest score table for the use of Project Based Learning in the control class and experimental class

Table 1. Pretest, Posttest Score Data for Control Class and Experimental Class.

	Experimental Class				KelasKontrol			
	Experimentation Skills		Creative Thinking Skills		Experimentation Skills		Creative Thinking Skills	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Mean	56,4	85,2	56,95	83,85	56,3	77,1	55,8	76,35

The pretest data shows that the students' experimentation skills and creative thinking skills in both classes before being given relative treatment were the same or at the same level, both of them still got low scores. This similarity is also proven by the

results of the homogeneity test for the two sample classes showing that both classes come from groups with the same initial abilities. Posttest data shows that the treatment given to both classes had a significant influence (as seen from the average posttest score). The data also shows that the experimental class obtained a higher average score than the control class.

Based on the normality test, it can be obtained that the creativity test data for both classes is normally distributed. Meanwhile, based on the homogeneity test, the data is homogeneous. Next, a hypothesis test was carried out using the t test with the following results:

Paired Samples Test									
		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Pre test - Post test	-28.800	4.514	1.009	-30.913	-26.687	-28.531	19	.000

From the results above, it was found that Sig (2-tailed) < 0.05, so it can be concluded that Project Based Learning has an effect on students' experimentation skills. In this section, several details regarding the research findings and analysis will be explained. The results of the analysis will be discussed in general, starting from the students' initial abilities to improving the experimental skills of both classes. Based on the data that has been obtained, the initial abilities of the two classes are relatively the same and can be categorized as the same, this is because students have not received an explanation regarding the material regarding changes in the shape of objects when the test was carried out. They only rely on initial knowledge obtained from previous levels of education where they are not given material or creativity tests.

In general, students are not familiar with instruments for measuring experimental skills in the form of performance and instruments for measuring creative thinking skills. This is because in general the instruments used by teachers in the form of tests only measure students' ability to memorize material. Meanwhile, the instrument used in this research is more about questions that require in-depth answers. Students are also rarely given the opportunity and challenge to answer questions with varied answers. Under conditions like this, time and process are needed to train students to get used to the new model.

After being given treatment with the application of Project Based Learning, students in the experimental class showed a significant increase in experimentation skills and creative thinking skills. This can be seen from the average post-test score of the experimental class. The average performance results on experimentation skills and creative thinking skills test results for the experimental class that used Project Based Learning were higher than the control class that used conventional learning. This proves the influence of using Project Based Learning on students' experimentation skills and creative thinking skills.

When implementing Project Based Learning, students tend to be more active and enthusiastic in the learning process. This can be seen from the students' activities in the aromatherapy candle making project which shows the students' enthusiastic, active and enthusiastic attitude. This is in accordance with research conducted by Yuliana, et al (2022) which shows an increase in students' interest in learning through the implementation of Project Based Learning. Student activity can be seen from all stages in the Project Based Learning (PjBL) model. The stages in implementing Project Based Learning (PjBL) are providing basic questions (questions that are challenging and related to the real world), designing project implementation (determining the project theme, type of project, rules for project work, selecting activities to be carried out,

determining tasks each member and determine the materials and tools needed), create a project implementation schedule, project work, assess project results and evaluation (Almulla, 2020). Based on observations in class, student activity can be seen from students' activities in making basic questions, preparing project designs, determining the tools and materials needed according to each student's creativity, determining the distribution of tasks, preparing project schedules independently, carrying out projects responsibly and presenting the results. well.

A positive attitude in the learning process helps students to produce better products in their projects. The implementation of Project Based Learning (PjBL) proves that there is an increase in students' ability to experiment and think creatively in experimental classes. The increase in experimental skills is proven by several indicators and concrete results, namely an increase in students' abilities in designing experiments, analyzing data, preparing tools and materials independently, solving problems and communicating experimental results. Improvement in experimentation skills can be measured through the fulfillment of indicators of experimentation skills (Apriani & Widhiasih, 2020). Meanwhile, increasing creative thinking skills is proven by various concrete indicators and results, namely improving the skills of fluent thinking, flexible thinking, original thinking and elaborative thinking. Improving creative thinking skills is said to be successful if the indicators for creative thinking skills are met (Manurung, et al, 2020). In general, the implementation of Project Based Learning (PjBL) can increase students' enthusiasm, enthusiasm and activeness in learning in class. This is in accordance with what was stated by Hanif, et al, (2019), regarding the advantages of implementing Project Based Learning (PjBL), namely that it can increase student learning motivation, increase ability to solve problems, improve collaboration skills and improve skills in managing learning resources. The application of Project Based Learning really helps students gain a deeper understanding of the material when they actively build their understanding by completing a project using their own ideas (Saputra: 2023)

From the research results, there was a significant increase in students' experimentation skills and creative thinking skills in the experimental class. The magnitude of the increase in students' experimentation skills and creative thinking skills can be seen from the students' average scores. Increasing students' experimentation skills and higher creative thinking skills in the experimental class is an implication of treatment with the application of Project Based Learning. Based on data analysis using two-way Anova, the results can be obtained that: (1) Project Based Learning (PjBL) has an effect on students' experimentation skills; (2) Creative thinking skills influence students' experimentation skills; (3) The application of Project Based Learning (PjBL) has an effect on students who have high creative thinking skills.

CONCLUSION

Based on research findings and analysis, it can be concluded that there is a positive influence of implementing Project Based Learning on students' experimental skills in science subjects in terms of creative thinking skills. This influence can be seen from the increase in students' experimentation skills and students' creative thinking skills in the learning process using the Project Based Learning model. Increasing students' experimentation skills can be seen from several indicators, namely students' skills in asking questions, predicting, observing, designing experiments, using tools and materials, interpreting, and communicating. Improving students' creative thinking skills can be seen from four indicators, namely fluent thinking skills, flexible thinking, original thinking, and elaborative thinking. Based on research conducted by the experimental class that was given treatment, the average score for experimental skills and creative thinking skills was higher compared to the control class. The implementation of Project Based Learning (PjBL) has an influence on students' experimental skills, as evidenced

by the increase in students' abilities in designing experiments, analyzing data, determining their own tools and materials and communicating research results well. Creative thinking skills influence students' experimental skills, as evidenced by the students in their group being able to design their experiments well and in an original way, which is different from other groups. It is recommended that the use of the Project Based Learning model be applied in classroom learning because it has many benefits, including making students more active in learning, improving students' creative thinking skills, improving students' experimentation skills, and increasing collaboration and student involvement in class.

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