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Improving Creative Thinking Ability and Achievement with Problem-Based Learning in Science Subjects

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Abstract

This study aims to determine the effect of the application of the Problem based learning model in an effort to improve creative thinking skills and student achievement at PIONEER Depok Elementary School in science subjects. One of the advantages of the Problem-based learning model is that it is able to train students to think high-level, critically and creatively in solving problems. Creative thinking ability can be measured based on indicators of fluency, flexibility of originality in thinking, and thinking in detail. The research method used is quasi-experimental. The results obtained must be from the learning is that there is a significant influence in the application of the PBL (Problem Based Learning) model on student achievement. This means that the implementation of Problem Based Learning is effective in increasing students' creative thinking skills and learning achievement. This research was conducted by observing and doing pre-test and post-test to show maximum results so that the implementation of PBL in science learning.

Keywords: Creative Thinking Ability, Problem Based Learning , Student Achievement

Peningkatan Kemampuan Berfikir Kreatif dan Prestasi dengan Pembelajaran Berbasis Masalah pada Mata Pelajaran IPA

Abstrak

Penelitian ini bertujuan untuk mengetahui pengaruh penerapan model pembelajaran Problem based learning dalam upaya untuk meningkatkan kemampuan berpikir kreatif dan prestasi siswa SD PIONEER Depok pada mata pelajaran IPA. Salah satu keunggulan dari model pembelajaran Problem based learning yaitu mampu melatih siswa berpikir tingkat tinggi, kritis dan kreatif dalam memecahkan masalah. Kemampuan berpikir kreatif dapat diukur berdasarkan indikator kelancaran, keluwesan originalitas dalam berpikir, dan berpikir secara terperinci. Metode penelitian yang digunakan adalah quasi eksperimen. Hasil analisis penelitian ini adalah penerapan pembelajaran dengan pendekatan Problem Base Learning (PBL) berpengaruh signifikan terhadap kemampuan berpikir kritis dan prestasi siswa. Berdasarkan penelitian ini menunjukkan bahwa penerapan pembelajaran Problem Based Learning efektif meningkatkan kemampuan berpikir kreatif dan prestasi belajar siswa. Penelitian ini dilakukan dengan observasi dan melalukan pre-test dan post-test untuk menunjukkan hasil yang maksimal sehingga penerapan PBL dalam pembelajaran IPA sangat direkomendasukan.

***Kata Kunci**: Kemampuan Berpikir Kreatif , Problem Based Learning , Prestasi Siswa.*

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INTRODUCTION

The progress of a nation is largely determined by the quality of its education (Megawati et al., 2020). Indonesia before the pandemic, according to a survey conducted by Trens in Mathematical and Science Study (TIMSS), Indonesian student achievement for science was ranked 45th out of 48 survey participating countries (Arifuddin, 2020). According to a survey conducted by The Organization of Economic Cooperation and Development (OECD) through the Program for International Student Assessment (PISA), Indonesian student achievement for science is 396 points, this situation places Indonesia's position below the average of countries that are members of the OECD, which is 489 points(OECD, 2019). If this condition is not immediately anticipated, then in the next few years Indonesia will not be able to compete with other nations in the world because the quality of Indonesian people is below the world average. This condition is exacerbated by the constraints of learning activities during the pandemic.

Indonesia's low achievement in the PISA event is because Indonesian students are less able to complete tests that require high-level thinking processes (Megawati et al., 2020). In other words, Indonesian students are very lacking in completing tests that require critical and creative thinking skills, analytical, evaluative, logical thinking and reasoning (Kurniati et al., 2016). This lack of achievement is also triggered by teachers who are accustomed to using textbooks (texts), students tend to memorize formulas and work on questions according to examples, students are rarely faced with problems that occur in their lives (Muhyani et al., 2020). So that when Indonesian students solve problem solving problems, their scores tend to be low, this happens because they do not get training to solve problem solving problems in their learning activities (Hartatiana, 2014).

To become a superior generation or at least equal to countries in the world in the 21st century, education applied to students in Indonesia must be oriented to 21st century skills, namely critical thinking skills, collaboration, creativity and communication (Septikasari & Frasandy, 2018). These four skills are soft skills needed to emerge as winners in the Industry 4.0 era, according to research on the contribution of soft skills to have the biggest contribution to getting quality products (Noto Widodo, Pardjono, 2013). Research at Harvard University exposes that soft skills contribute to a person's success in his career up to 80%(Yuyun Yunarti, 2016).

One of the efforts to produce superior generations in the future is the need for a change in the learning paradigm from teacher center (teachers as learning subjects) to student centers (students as learning subjects). The concept of active student learning by finding and building their own concepts is able to improve high-level thinking skills, be creative, and skilled in problem solving. In line with this situation, the Ministry of Education and Culture issued learning guidelines with a new paradigm that requires students to find out, formulate problems, analyze, and collaborate to solve problems associated with everyday life(Kemendikbud, 2017). Fourth soft skills that must be mastered, one of them is creative thinking skills. Creative thinking skills are the ability to find updates and be able to solve problems carefully. It is in this creativity that a person's personality is always positive to find new things by creating products (Arnyana, 2019). To foster student creativity, it can be honed through learning with a project based learning approach, problem based learning, cooperative group investigation, and inquiry learning (Arnyana, 2019).

Problem Based Learning (problem-based learning) is a learning model that uses problems in everyday life as a vehicle to increase knowledge and also foster creative thinking skills in solving problems This learning model is also able to build students' ability to think creatively (Handoyo et al., 2021), and is able to increase students' creativity in solving problems (Fatimah

et al., 2022; Iqbal et al., 2018; sulami et al., 2022; Sutarto et al., 2022). Problem Based Learning leads students to solve problems (Komarudin, 2017)(Sari et al., 2021) and in the end are able to answer questions correctly so that it affects the improvement of student achievement (Handoyo et al., 2021).

Based on observations and interviews with teachers and students at Pioneer Elementary School, science learning is mostly carried out using a conventional learning approach, where the teacher explains the material being taught using the lecture method, while students become passive listeners. As a result of conventional learning, the classroom atmosphere is less dynamic, students tend to be passive. So that students are not actively involved in learning, the impact of student achievement is not satisfactory and student creativity is also low.

Taking into account the above conditions, it is necessary to make efforts to improve learning activities so that learning activities are able to create a dynamic classroom atmosphere, students are actively involved in learning. So it is expected that students' creative thinking skills grow and student achievement in science lessons increases. One way is to apply the Problem Base Learning (PBL) learning model.This study aims to determine the effect of applying the Problem Based Learning learning model on creative thinking skills and student achievement, when compared to conventional learning.

METHOD

This research is included in quantitative research, with a pretest-posttest control group design approach. The research approach used is a quasi-experimental research (quasi-experimental design) (Creswell, 2010). This type of research is a nonequivalent control group design. This type of research is a development of experimental research (true experimental design) but because the control group does not function perfectly to control external variables that affect(Muhyani, 2019). The research design can be seen in Table 1.

Table 1. Research Design

Class	Test	Treatment	Test
KE	T_0	P_{KE}	T_1
KK	T_0	P_{KK}	T_2

Information:
KE= Experimental Group
KK= Control Group
T_0 = Pre-test
P_{KE}= Science Learning with PBL
P_{KK}= Conventional Science Learning
T_1 = *Post-test*
The implementation of this research consists of three stages:
The first stage is research preparation which includes: 1). Selection of research sites, considering the pandemic period, not all schools can be used as research sites, from several schools contacted, Pioneer Elementary School allowed it to be used as research sites 2). Management of documents in the form of research permits; 3). Prepare learning tools from lesson plans to student activity sheets for the experimental class, and research instruments to be used; 4). Conduct trials to determine the validity and reliability of the instrument. Then The second stage can be seen in Table 2.

Table 2: Research Activity

	Experimental group	Control group
Activity	1. Pretest 2. Learning with PBL 3. posttest	1. Pretest 2. Conventional learning 3. posttest

The third stage, the final stage is the stage of collecting data obtained from the field, to be processed and analyzed. Data collection instruments in this study consisted of tests and non-tests, tests were used to measure student achievement, while non-tests in the form of questionnaires were used to measure thinking skills. Each instrument has been validated beforehand and fulfills the valid and reliable elements. Both instruments were given to the experimental group and the control group in the form of pre-test and post-test.

The results of the pre-test and posttest from both groups, both learning achievement and creative thinking were tabulated in the range 0-100. The aim was to facilitate data analysis. Furthermore, the pretest data from both the experimental group and the control group were then analyzed, the analysis was carried out descriptively and inductively. Descriptive analysis was used to determine the research data, while posttest (inferential) inductive analysis was used to determine whether or not it had an effect on hypothesis testing using t-test.

Before testing the hypothesis, the data is first analyzed whether the data is homogeneous or not, and whether the data distribution is normal or not. To determine the normality of the data used Shapiro Wilk test. The homogeneity test uses the Test of Homogeneity of Variance. If the data is normally distributed and homogeneous, then the t-test uses parametric statistics, otherwise the t-test uses non-parametric statistics. Data analysis using SPSS for Windows Version 25 program.

RESULT AND DISCUSSION

The data obtained in this study, both pre-test and post-test for the experimental group and control group are presented in Table 3.

Table 3. Descriptive Statistics of Research Subjects.

Statistik	Experimental group				Control group			
	Creative Thinking		Score		Creative Thinking		Score	
	pretest	posttest	pretest	posttest	pretest	posttest	pretest	posttest
n	13	13	13	13	12	12	12	12
X_{max}	60,00	90,00	77,50	92,50	85,00	85,00	90,00	92,50
		65,00	70,00	77,50	50,00	60,00	70,00	70,00
Range	10,00	X_{min}	50,00	15,00	35,00	25,00	20,00	22,50
Mean	56,15	72,69	74,81	83,85	65,77	67,69	77,50	80,00
SD	4,16	8,81	2,39	4,28	12,72	8,57	6,29	6,12

From Table 3 above, information is obtained that the science learning achievement of the experimental group students has a pre-test mean score of 74.81 while the post-test score is 83.85. From this value, it shows that in the experimental class there is an increase in the average science learning achievement. Science learning achievement of students in the control group had an average pre-test score of 77.50, while the post-test mean score was 80.00. The control group also experienced an increase in students' science learning achievement. Science learning

achievement in both the experimental group and the control group has increased. The average increase in the experimental group was 9.01 while the average increase in the control group was 2.50. So that the increase in the experimental group was higher when compared to the control group.

Table 1 also states that the creative thinking ability of the experimental group students has a pre-test mean score of 56.15 while the post-test mean score is 72.69. From this value, it shows that in the experimental group there is an increase in the average creative thinking ability of students. The students' creative thinking ability in the control group had an average pre-test score of 65.77, while the average post-test score was 67.69. The control group also experienced an increase in students' creative thinking skills. The creative thinking ability of students in both the experimental group and the control group has increased. The average increase in the experimental group was 16.54 while the average increase in the control group was 1.92. So that the increase in the experimental group was higher when compared to the control group. These results indicate that according to descriptive analysis, learning with the PBL approach is able to improve students' science learning achievement and improve students' creative thinking skills.

Normality test

Table 4. Normality Test Results of Creative Thinking Ability and Students' Science Learning Achievement

Test of Normality								
Shapiro-Wilk	**Experimental Group**				**Conntrol Group**			
	Creative Thinking Skills		**Learning Achievement**		**Creative Thinking Skills**		**Learning Achievement**	
	pretest	posttest	pretest	posttest	Pretest	posttest	pretest	posttest
Statistic	821	821	750	750	808	927	750	750
Df	5	3	3	3	4	4	3	3
sig	119	119	0	0	117	577	0	0

Table 4 shows the results of the analysis of the normality test using the Test of Normality with the Shapiro-Wilk test on the pretest and posttest values in the experimental class and control class producing very significant results, as evidenced by the data df = 3, decision making if sig is greater than 0.05 then it can be stated that the data obtained from the experimental class and control class are in the normal category.

Homogeneity Test

To find out whether two or more groups of sample data come from populations that have the same variance, a homogeneity test is carried out. The results of the homogeneity test are presented in Table 3**.**

Table 5. Homogeneity Test Results of Creative Thinking Ability and Student Achievement Experiment Group and Control Group

Test of Homogenelty of Varian					
		Levene Statistik	df1	df2	sig
Creative Thinking Skills	Based on mean	1.524	5	18	232
	Based on median	1.057	5	18	416
	Based on median and with adjusted df	1.057	5	8.090	448
	Based on trimmed mean	1.372	5	18	281
Learning Achievement	Based on mean	4.710	5	15	9
	Based on median	2.812	5	15	55
	Based on median and with adjusted df	2.812	5	10.652	73
	Based on trimmed mean	4.487	5	15	11

Based on the results of the calculation of the entrepreneurial spirit above, using the Test of Homogenelty of Varience on the pre-test and post-test scores in the experimental group and control group produced very significant results. It is proven that decision making if sig is greater than 0.05, it can be stated that the data obtained from the experimental class and control class are in the homogeneous category or the same. Therefore, one of the requirements of the independent test can be fulfilled.

T test results

The results of the descriptive analysis are known from the research data showing that the students' creative thinking ability there is an average difference between the experimental class and the experimental groups, the average increase is 16.54 while the control group is 1.92. Likewise, the science learning achievement of the experimental group and the control group experienced an average increase, the experimental group experienced an average increase of 9.01 while the control group experienced an increase of 2.50. From the results, both creative thinking ability and science learning achievement according to descriptive analysis of the application of the PBL learning model affect the creative thinking ability and student achievement.

However, to answer the research hypothesis whether the PBL learning model has an effect on students' critical thinking skills and achievement in science subjects, it needs to be proven by inferential statistical analysis with t-test (t-test) using SPSS 25 software. The results of SPSS analysis for creative thinking skills and science learning achievement in the experimental class are presented in Table 4.

Table 6. Table of Paired Sample t test Table of Creative Thinking Ability and Science Learning Achievement in the Experimental Group

			Paired Differences					T	df	Sig. (2-tailed)
			Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
creative thinking skills	Pair 1	pre-test - post-test	-330.769	209.701	58160	-457.490	-204.048	-5.687	12	0
learning achieve.	Pair 1	pre-test - post-test	-361.538	198.068	54934	-481.230	-241.847	-6.581	12	0

Table 4 shows the results of the paired simple t test analysis in the experimental group, the t value is 5,687 with (df) frequency data (n-1) is 13-1, the result is 12. Based on the sig value. (2 failed) shows 0.000. This value is less than 0.05. Because the value of sig. (2 failed) is smaller than 0.05 then Ha is accepted, in other words there is a significant difference between the pre-test and post-test mean. Thus, in the experimental group, it was proven that the application of PBL improved students' thinking skills.

From Table 4 it can also be seen about student achievement, the results of the analysis with the SPSS paired simple t test in the experimental group the t-count value is -6.581 the value (df) of frequency data (n-1) with a total sample of 13 is 13-1, so the df value is 12. By looking at sig.(2 failed) of 0.000, and this value shows less than 0.05, then H0 is rejected, in other words Ha is accepted. Thus there is a significant difference between the mean pre-test and post-test, this shows that in the experimental group the application of PBL improves student achievement.

The results of the analysis with SPSS 25 creative thinking skills and science learning achievement in the control group can be seen in Table 5

Table 7. Table of Paired Sample t test of Creative Thinking Ability and Science Learning Achievement on Control Group

			Paired Differences					T	df	Sig. (2-tailed)
			Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
creative thinking skills	Pair 1	pre-test - post-test	-16667	340.677	98345	-233.122	199.789	-169	11	.869
learning achievm.	Pair 1	pre-test - post-test	-83.333	358.870	103.597	-311.349	-144.682	-804	11	0

Table 5 shows the results of the paired simple t test analysis in the control group, the t value is 169 with (df) frequency data (n-1) is 12-1, the result is 11 Based on the sig value. (2 failed) shows 0.000. This value is less than 0.05. Because the value of sig. (2 failed) is smaller

than 0.05 then Ha is accepted, in other words there is a significant difference between the pre-test and post-test mean. Thus, in the experimental group, it was proven that the application of PBL improved students' thinking skills.

From Table 5 it can also be seen about student achievement, the results of the analysis with the SPSS paired simple t test in the experimental group the t-count value is -804 the value (df) of frequency data (n-1) with a sample of 12 is 12-1, so the value of df is 11. By looking at sig.(2 failed) of 0.000, and this value shows less than 0.05, then H0 is rejected, in other words Ha is accepted. Thus there is a significant difference between the mean pre-test and post-test, this shows that in the control group the application of PBL improves student achievement.

Hypothesis testing

To test the truth of the statement statistically and to draw a conclusion whether to accept or reject the statement, it is necessary to test the hypothesis. On the basis of the pre-test and post-test calculations in Table 5 and Table 6 using the paired simple t test in the experimental group and the control group, it is necessary to analyze the comparative data on the results of increasing creative thinking skills and student achievement based on post-test scores in both groups with using independent sample t test. The results of the analysis with SPSS 25 for the independent sample t test of creative thinking skills can be seen in Table 6.

Table 8. Independent Sample Table t test of Students' Creative Thinking Ability

		Levene's Test For Equality Of Variances		T-Test For Equality Of Means						
		F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confedence Interval of the Difference	
									Lower	Upper
Creative Thinking Skills	Equality Variances assumed	0,051	0,822	-3.260	23	.002	-180.000	.55209	-291.005	-68995
	Equality Variances not assumed			-3.260	46.961	.002	-180.000	.55209	-291.068	-68932

The results of the analysis in Table 6 independent calculations Sample t test in the experimental group and control group shows the t count result of -3.260 with a total of 25 students. The value of sig. (2-tailed) is 0.002, this value is less than 0.05, this result is used to test the following statistical hypotheses:

H0 : If the value of Sig. (2-tailed) > 0.05, indicating that there is no significant difference between the mean (mean) post-test scores in the experimental group and the control group.

Ha : If the value of Sig. (2-tailed) < 0.05, indicating that there is a significant difference between the mean (mean) post-test scores in the experimental group and the control group.

Because the results of the analysis with SPSS 25 sig. (2-tailed) is 0.002 and this value is less than 0.05, then H0 is rejected, thus Ha is accepted. Based on the results of the hypothesis test, it was stated that there was a significant difference between the post-test mean (mean) values in the experimental group and the control group. These results indicate that the Problem Base Learning (PBL) learning model has an effect on increasing students' creative thinking.

The results of the independent sample t-test analysis for student achievement in the experimental group and control group can be seen in Table 7.

Table 9. Independent Sample Table t test Student Achievement

Learning Achievement		Levene's Test For Equality Of Variances		T-Test For Equality Of Means						
		F	Sig.	t	df	Sig(2-ailed)	Mean Difference	Std.Error Difference	95% Confedence Interval of the Difference	
									Lower	Upper
learning achievement	Equal variances assumed	.550	0,462	-3.816	23	0	-228.000	59.755	-348.146	-107.854
	Equal variances not assumed			-3.816	47.091	0	228.000	59.755	-348.206	107.794

Based on the independent calculation of the sample t test in the experimental class and control class in Table 7, the results of the t count are -3,816 with a total of 25 students. The results of the analysis in Table 8 independent calculations Sample t test in the experimental group and control group shows the t count result of -3,816 with a total of 25 students. The value of sig. (2-tailed) is 0.002, this value is less than 0.05, this result is used to test the following statistical hypotheses:

H0 : If the value of Sig. (2-tailed) > 0.05, indicating that there is no significant difference between the mean (mean) post-test scores in the experimental group and the control group.
Ha : If the value of Sig. (2-tailed) < 0.05, indicating that there is a significant difference between the mean (mean) post-test scores in the experimental group and the control group.

Then, the results of the analysis with SPSS 25 sig. (2-tailed) is 0.002 and this value is less than 0.05, then H0 is rejected, thus Ha is accepted. Based on the results of the hypothesis test, it was stated that there was a significant difference between the post-test mean (mean) values in the experimental group and the control group. These results indicate that the Problem Base Learning (PBL) learning model has an effect on students' science learning achievement.

Based on the results of hypothesis testing, it shows that the application of the Problem Base Learning (PBL) learning model has a significant effect on creative thinking skills and student achievement. These results are in line with research conducted by Fitriyah and Ramadani who concluded that the application of PBL improves students' thinking skills (Fitriyah & Ramadani, 2021) as well as the research conducted by Aisyah and her team which concluded that the application of PBL had an effect on problem-solving abilities (Tosun & Senocak, 2013) and student cognitive learning outcomes. (Asiyah et al., 2021). A similar study was conducted by Inshasika et al that the PBL learning model was able to improve students' cognitive achievement (Insyasiska et al., 2015)(Asiyah et al., 2021)(Hartini et al., 2014).

CONCLUSION

Based on the research data and the results of research data analysis, the conclusion of this study is that the application of the Problem Based Learning learning model is able to significantly improve students' creative thinking skills, and is also able to significantly improve student achievement. It can also be concluded that the Problem Based Learning learning model is better in improving students' creative thinking skills and achievement when compared to conventional learning.

Observing the results of this study, it is recommended for teachers in order to improve students' creative thinking skills and learning achievement to change their learning model from conventional learning (teachers as learning centers/explaining material with the lecture method) to Problem Base Learning learning models. Considering that this research was conducted during a pandemic, further research should be carried out under normal conditions, with an adequate number of parallel classes and a more natural class atmosphere (not feeling like they are being researched). For other researchers, it is necessary to conduct similar research in other places with a higher number of parallel classes, or at a higher level (junior high school or senior high school).

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