OPEN ACCESS

Jurnal Riset Pendidikan MIPA, 6(1): 46-54, June 2022
ISSN 2549-0192 (e) | 2549-0184 (p)
https://new.jurnal.untad.ac.id/index.php/jrpm/

The Effect of Problem Based Learning Models on Student Critical Thinking Ability and Problem Solving of Science Concept

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Article History
Received 03 January 2022
Revised 08 February 2022
Accepted 14 March 2022

Keywords:
Problem-based learning, critical thinking, and problem-solving.

Abstract

This study aims to determine the effect of problem-based learning models on students' critical thinking skills and problem-solving in science concepts at SMP Negeri 7 Palu. The research design was a non-equivalent control group design with a quasi-experimental research method. The population is class VII students. The selected class was Class VII A (n=32) as the experimental class and Class VII B (n=27) as the control class. Data collection used essay test instruments and problem-solving essay test questions. Qualitative data, the average teacher observation result is 95.71 with a very active category and the average student observation result is 93.45 with an active category. Quantitative data was obtained from the results of data analysis with the t-test. The results of the t-test for critical thinking skills are the same. Asymp.Sig (2-tailed) 0.000 < 0.005) then H_1 is accepted. The results of the t-test of Asymp.Sig problem-solving ability (2-tailed) 0.000 <0.05 H_1 are accepted. The results showed that there was a significant effect of the problem-based learning model on students' critical thinking skills and problem solving. concept of science at SMP Negeri 7 Palu.

doi: 10.22487/j25490192.2022.v6.i1.pp.46-54

Introduction

Competencies that must be mastered to face global competition in the 21st-century world of work are the ability to think critically and solve problems as the main provisions in preparing for changes in an increasingly modern and developing era. (Vockley, 2008). Competency standards for primary and secondary education unit graduates state that students must be able to show critical thinking ability, and be creative in building, using, and applying information about the surrounding environment to be able to solve problems (BNSP, 2006).

One of the goals of education in the realm of science is to improve critical thinking, and logical responses, and develop problem-solving abilities (Dogru, 2008). Science lessons have very complex characteristics not only given as knowledge, but include the ability to collect facts, investigate, and connect facts to be interpreted, compile, or test ideas. Students are expected to be able to understand the concepts and principles of science and their interrelation and are applied in solving problems in life (Permendikbud No. 21 of 2016).

The characteristics of students who have critical thinking and problem-solving ability are being able to ask the right questions, provide effective and efficient information, have reasonable reasons, be creative, incorporate relevant problem-solving, make decisions, and have consistent and credible conclusions (Fisher, 2009). Work to solve problems in his mind, find everything for himself, try to realize and apply his ideas, explain reasons and make evaluations of information. (Cheong & Cheung, 2008).

Field facts obtained by researchers during a teaching at SMP Negeri 7 Palu from 2012 to date explain that the science learning process as an attitude, and applications have not been touched in learning so students' critical thinking and problem-solving ability are classified as low or not optimal, especially not 100% according to completeness criteria minimum. It can be seen from the students' daily test scores which show that out of 32 students, only 11 people can achieve the minimum completeness score, which is 75, or if it is stated as a percent of 100% of the students, only 34.37% have the score reached completeness criteria minimum, while 65, The other 63% have not received a complete score, far below the completeness criteria minimum, which is 75.

Wulandari et al. (2015), stated that low student critical thinking and problem-solving ability are initiated by passive learning. The teacher is the

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main source and informant, causing the accumulation of information or concepts that are not useful for students (Astika et al., 2013). The low ability of students to argue during discussion is also an indicator of low critical thinking ability and student problem solving in learning, students are accustomed to being taught lessons instead of searching and solving independently so students' reading interest and looking for less information on learning material, are ashamed to ask questions and do not dare to express opinions and answering questions from the teacher, are unable to provide reasons or opinions related to the answers given (Adnyana, 2012).

Teacher-centered learning is monotonous and emphasizes the cognitive aspects, hindering student creativity, resulting in feelings of boredom and students' lack of participation and lack of understanding and teacher readiness to implement innovative learning models so that teachers teach in traditional ways (Budiastra et al. 2015). Students are eager to follow the learning process if a pleasant climate or atmosphere is created, and a good and friendly relationship is established between students and teachers so that students can master the concepts given and consciously use their own strategies for learning (Kyriacou, 2011).

Teachers as managers in learning must be able to play a role in creating a conducive learning climate so that students can learn comfortably and are required to be more creative in choosing innovative learning models as an effort to improve strategies that can build critical thinking ability and students' problem-solving abilities so that results are achieved. Maximum in science learning (Sumiati & Azra, 2007). One of the learning models recommended by the government in the 2013 curriculum according to Permendikbud Number 21 of 2016 concerning process standards is problem-based learning (Ariyana et al. 2019).

Empirical evidence that supports the problem-based learning model in improving critical thinking and solving problems is the result of research conducted by Wulandari & Fitriyyah (2019), which concludes that the problem-based learning model affects the critical thinking ability of SMP Negeri 3 Kragan students about global warming material. This is indicated by the high post-test average score of students' critical thinking ability in the experimental class compared to the control class which has very critical criteria. Likewise, the research results of Sahyar & Yulia (2017), stated that the problem-solving abilities of students who are taught using the problem-based learning model are better than conventional learning.

Based on the background of the problem and the results of research conducted by previous researchers who have successfully applied the problem-based learning model to critical thinking ability and other research that applies the problem-based learning model to problem-solving ability, researchers are interested in conducting research to see how the learning model influences problem-based learning on critical thinking ability and problem-solving of science concepts in SMP Negeri 7 Palu.

Materials and Method

This type of research is a quasy-experiment. The research design used was the nonequivalent control group design (Sugiyono, 2015). The design of this research can be seen in Table 1.

Table 1. Research design

Group	*Pretest*	Treatment	*Posttest*
E	0	X_1	0
C	0	X_2	0

Information
E: Experiment class
C: Control class
X1:Teaching and learning process using Problem-based learning model
X2:Teaching and learning process with The conventional model of learning
O: Pre-test/post-test students' critical thinking ability and problem-solving

This research was conducted at SMP Negeri 7 Palu for the 2020/2021 academic year in grade VII. The population in this study were all students of SMP Negeri 7 Palu who were registered in the 2020/2021 academic year.

The sample in this study used class VII. The researcher chose class VII A with 32 students as the experimental class and class VII B with 27 people as the control class. Determination of the sample based on the low learning outcomes seen from the average value of students' daily tests in the experimental class shows that of 32 students only 11 people can achieve a minimum completeness score of 75 or if expressed in percent of 100% of the students only 34.37% whose scores reach the completeness criteria

minimum., while the other 65.63% have not got a complete score, far below the completeness criteria minimum which is 75.

The control class shows that out of 27 students only 10 people can achieve a minimum completeness score of 75 or if expressed as a percent of 100% only 37.03% of the students scored the completeness criteria minimum, while the other 62.97% had not got the complete score, far below the completeness criteria minimum which was 75. The two classes that had not received treatment, it shows that the student's initial ability is equal between the experimental and control classes, so the sample is suitable for further research

The operational definition of a variable is a definition based on the defined properties that can be observed or observed. In this study, the operational definition of the variables is:

1) Learning model problem-based learning is a learning that begins by exposing students to problems, with all the knowledge and abilities that students have, students are asked to solve problems using concepts.
2) Critical thinking ability of students is the ability of mental processes to analyze or evaluate information obtained from observations, experience, common sense, or communication, using aspects of critical thinking ability, such as providing simple explanations, building basic ability, concluding, making further explanations, and strategies and tactics.
3) Problem-solving ability is the ability to solve problems that will be measured through the ability of students to solve a problem, by using problem-solving steps according to Polya, they are: (1) understanding the problem, (2) preparing a problem-solving plan, (3) implementing a problem-solving plan, and (4) checking again.

Types and sources of data

1) Quantitative data, in the form of scores on the pretest critical thinking and problem-solving before learning and posttest critical thinking and problem-solving after learning obtained through the essay test.
2) Qualitative data, in the form of student learning activity data obtained from observations during learning activities using teacher and student observation sheets.

Research instruments

Essay test

This essay test functions to measure students' critical thinking and problem-solving ability after learning using a problem-based learning model. The data that has been obtained is then analyzed using the formula:

$$NP = x\ 100\ \frac{R}{SM}$$

Descriptions :

NP = Percent value sought
R = Raw scores obtained by students
SM = Ideal maximum score
100 = Fixed number

With the following criteria:

Table 2. Category of student ability level through tests

Score (100%)	Category
81 - 100	Very good
61 - 80	Good
41 - 60	Enough
21 - 40	Poor
0 - 20	Very Poor

(Prasetyani et al., (2016))

Observation sheet

There are two observation sheets used, they are the teacher and student activity observation sheets. The observation sheet used is based on the step of the problem-based learning model.

The score obtained is then calculated using the following formula:

$$P = \frac{A}{N} \times 100\%$$

Description:

P = percentage of student/teacher activity
A = total score obtained by students/teachers
N = total score

Table 3. Observation result category

91-100% ≥95%	Very active
76-90% 80% ≤ <95%	Active
56-75% 65% ≤ <80%	Pretty active
41-55% 4 50% ≤ <65%	Less active
0-40% 5 ≤50%	Not active

Data analysis technique

Data normality test

The normality test used is the Kolmogorov-Smirnov test with SPSS 18.0. Significance level (α) = 0.05

Test decision

H_0 is accepted if sig> 0.05,

H_1 is accepted if sig <0.05

Homogeneity Tes

The calculation of the homogeneity test in this study used the Levene's test with SPSS 18.0. Significance level (α) = 0.05

Test decision

H_0 is accepted if sig > 0.05,

H_1 is accepted if sig < 0.05

Hypothesis test

Hypothesis testing in this study is to use the "t" test using SPSS 18.0. The t test on two parties is used with the following formula: (Sudjana, 2005).

$$t = \frac{Md}{\sqrt{\frac{\sum x^2 d}{N\,(N-2)}}}$$

Description

Md = mean of the difference between pretest and posttest

Xd = deviation of each subject (d-Md)

∑X2d = sum of squares of deviation

N = subjects in the sample

db = determined by N-1

Test decision

Significance level (α) = 0.05 If sig t-count > 0.05, then H_0 is accepted, conversely if sig t-count < 0.05, then H_0 is rejected.

Results and Discussion

Analysis of critical thinking hypothesis test

Critical thinking normality test

This normality test has criteria if Asymp. Sig. (2-tailed) > 0.05, the data is normally distributed, whereas if Asymp. Sig. (2-tailed) < 0.05, the data is not normally distributed.

The results of the calculation of the posttest data normality test using SPSS 18.0 can be seen in Table 4

Table 4. Results of normality test on critical thinking ability

One-Sample Kolmogorov-Smirnov Test

		Thinking_ Experiment	Thinking_ control
N		32	27
Normal Parametersa, b	Mean	82.9688	61.8519
	Std. Deviation	6.58191	8.89556
Most Extreme Differences	Absolute	.170	.153
	Positive	.143	.150
	Negative	-170	-153
Kolmogorov-Smirnov Z		.961	.793
Asymp. Sig. (2-tailed)		.315	.556

a. Test distribution is Normal.

b. Calculated from data.

Homogeneity test of critical thinking ability

The results of the data homogeneity test can be seen in Table 5.

Table 5. Result of homogeneity test on critical thinking ability

Test of Homogeneity of Variances

critical thinking_ ability			
Levene Statistics	df1	df2	Sig.
3,318	1	57	.074

The test criteria if the significance value (sig)> 0.05 then (Ho) is accepted, which means the data is homogeneous. The significance level (sig) <0.05 then (Ho) is rejected, which means the data is not homogeneous.

Hypothesis test of critical thinking

Data were analyzed with parametric statistics through a t-test. To determine the effect of the problem-based learning model on the critical thinking ability of class VII students of SMP Negeri 7 Palu. This test was carried out with the help of the SPSS 18.0 computer program, the hypothesis to be tested reads as follows:

- H_0: There is no significant difference in the problem-based learning model on the critical thinking ability of grade VII students of SMP Negeri 7 Palu
- H_1: There is a significant difference in the problem-based learning model on the critical thinking ability of grade VII students of SMP Negeri 7 Palu.

The basis for making decisions is as follows:

If the Sig. (2-tailed) value> 0.05, then H_0 is accepted and H_1 is rejected.
If the Sig. (2-tailed) <0.05, then H_1 is accepted r and H_0 is ejected.

The results of the t-test analysis on the critical thinking ability of students of SMP 7 Palu can be seen in Table 6.

Analysis of problem-solving hypothesis test

Table 6. Output independent t-test of critical thinking ability

Independent Samples Test

		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% Confidence Interval of the Difference	
									Lower	Upper
critical thinking_ ability	Equal variances assumed	3.318	.074	10.462	57	.000	21.11690	2.01834	17.07523	25.15856
	Equal variances not assumed			10.202	47.133	.000	21.11690	2.06992	16.95306	25.28073

Table 7. Result of normality test of problem solving ability

One-Sample Kolmogorov-Smirnov Test

		Experiment_ solving	control_breaker
N		32	27
Normal Parameters a, b	Mean	88.7188	62.6296
	Std. Deviation	4.94639	5.70525
Most Extreme Differences	Absolute	.232	.248
	Positive	.183	.248
	Negative	-.232	-238
Kolmogorov-Smirnov Z		1.313	1.287
Asymp. Sig. (2-tailed)		.063	.073

a. Test distribution is Normal.
b. Calculated from data

Table 8. Results of homogeneity test of problem-solving ability

Test of Homogeneity of Variances

Problem-Solving ability			
Levene Statistics	df1	df2	Sig.
1,668	1	57	.202

Table 9. Result of t-test of problem solving ability

Group Statistics

	Class	N	Mean	Std. Deviation	Std. Mean Error
Problem-solving ability	Class VII A	32	88.7188	4.94639	.87441
	Class VII B	27	62.6296	5.70525	1.09798

Table 10. Output independent t-test of problem-solving ability

Independent Samples Test

		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% Confidence Interval of the Difference	
									Lower	Upper
Problem-solving abilityl	Equal variances assumed	1.668	.202	18.816	57	.000	26.08912	1.38656	23.31259	28.86565
	Equal variances not assumed			18.587	51,921	.000	26.08912	1.40362	23.27246	28.90578

Critical thinking ability

The percentage of students when viewed from the results of the posttest critical thinking class applied conventional learning (control group) with good categories and classes that applied problem-based learning model learning (experimental class) with very good categories. These results indicate that there is a difference in scores between the experimental class and the control class where it can be seen that the experimental class scores are higher than the control class.

These results are also supported by statistical test analysis on hypothesis testing using the t-test for students' critical thinking ability. It shows that the implementation of problem-based learning has an effect on the critical thinking ability of grade VII students of SMP Negeri 7 Palu. This is in accordance with the theoretical study according to Safitri et al. (2015), saying that the problem-based learning model is an innovative learning strategy, where in this model the teacher encourages students to develop various abilities, such as ability in problem-solving, creativity, and critical thinking ability. Wulandari & Fitriyyah (2019), state that learning uses the problem-based learning model by giving problems to students and these problems being solved by students,

Results The average percentage of students' critical thinking ability indicators based on the posttest scores was in the good category in the control class and the very good category in the experimental class. The highest indicator of students' critical thinking ability in the experimental class is the Inference indicator on the sub-indicator making induction and considering the results of the induction. Drawing conclusions according to the facts is the goal of the indicator making inductions and considering the results of the induction. Students in the experimental class have the ability to make better conclusions than the control class because students in the experimental class are trained through Students' worksheets where the problem is presented as the main focus in accordance with the stages of the problem-based learning model which guides students to be able to make conclusions independently.

Rosita & Bahriah (2016), giving problems in Students' worksheets is done to train students to think critically, solve problems and have a highly curiosity attitude. Problems presented in learning are problems that exist in everyday life. interact with friends and teachers, and exchange ideas, so that their insights and thinking power develop and realize many things or events that they can encounter in their daily life related to the science concepts they are learning. This is in accordance with the research of Lasry & Aulls (2007), which states that a richer learning approach will increase learning advantages in solving science problems, generate better conceptual knowledge, and be more confident in mastering concepts.

The qualitative data from the teacher's average observation result was 95.71 with a very active category and the average result of student observation was 93.45 with an active category. The problem-based learning Model has been applied in accordance with the stages of the learning model. Students learn contextually, experience it themselves, learn in groups, the percentage of results through class discussions, and apply it in everyday life. Contextual learning theory views that the learning process actually takes place only if students are able to process or construct information or knowledge themselves in such a way that the knowledge becomes meaningful according to their frame of mind (Gafur, 2003). Also in accordance with the opinion of (Masek & Yamin, 2011).

Problem-solving ability

Apart from seeing the influence problem-based learning model regarding the ability to think critically, this study also aims to determine the effect of the problem-based learning model on solving science problems of seventh-grade students of SMP Negeri 7 Palu by looking at the differences in students' abilities in solving science problem-solving ability between the experimental class and the control class. The post-test analysis shows different results, it can be seen that the results of the posttest quantitative analysis of the ability to solve science problems show that the average score of the experimental class students is very good and the control class average score is good. These results indicate that there is a difference in scores between the experimental class and the control class. It can be seen that the experimental class scores are higher than the control class.

Results of the average percentage of students' critical thinking ability indicators based on the post-test scores were in the good category in the control class and the very good category in the experimental class. The highest indicator of students' critical thinking ability in the experimental class is the indicator of understanding the problem.

Students who already have the ability to understand problems well will be the basic capital for him to face and solve various problems faced in his life and reinforce the concept in him. Understanding ability in science learning is very important to note, this is because understanding science can bring students to a deep understanding of the concept in solving the problems they face. Comprehension is the translated term of comprehension.

According to Syaharuddin (2019), understanding is the ability to explain a situation or an action. From this understanding, there are three main points of understanding, the ability to recognize, the ability to explain, and the ability to draw conclusions. These results are also supported by the data analysis of the results of statistical tests on hypothesis testing using the t-test. It can be concluded that the implementation of the problem-based learning model has an effect on the problem-solving ability of grade VII students of SMP Negeri 7 Palu.

The syntax of the problem-based learning model has been applied according to the stages of the learning model. Students are no longer passively receiving and understanding the information provided by the teacher, but they try to find themselves and think actively in solving problems.

Students try to answer questions that exist in the Students' worksheet in groups and try to use existing literature to support in solving the problems at hand. According to Hariawan et al. (2014), if this happens, students are able to develop their ideas, insights, and creativity which makes them active in the learning process and the main thing is that they get meaning from learning science which turns out to be useful in everyday life.

Birgili (2015), in his research, uses problems in everyday life. Students have the opportunity to solve these problems based on their experiences and succeed in attracting students' attention when studying in class. The feeling of being involved with the group makes students able to face the challenges that confront them so that students will be more motivated in learning (Silberman, 2013).

Problem-solving activities in learning encourage creative thinking by directing students to develop new scientific knowledge by helping them find relationships between variables and generating scientific ideas in relation to a concept and a number of solutions to certain problems that are centered on how to solve problems faced scientifically (Arif, 2018). Other factors that affect students' problem-solving abilities are attitudes toward learning from students themselves, learning motivation from students, learning concentration, time available for learning, and saving learning gains (Hamiyah, 2014).

The problem-based learning model is a learning model that can be used to improve students' abilities in solving science problems, this is in line with research conducted by Jennifer

(2015), problem-based learning model is a problem-centered model learning.

Conclusions

There is a significant effect of the problem based learning model on the critical thinking ability of students at SMP Negeri 7 Palu. It is proven by the existence of an average value for the experimental class is greater than the control class. Obtained an average value of the experimental class of 82.97 and the average value of the control class of 61.85 with a t-test significance level of 0.000 less than 0.05 or (0.000 <0.05) so that it can be concluded that there is a significant influence. The significant problem-based learning model for critical thinking ability.

There is a significant effect of the problem-based learning model on the problem-solving ability of the Science concept of SMP Negeri 7 Palu students. It is proven by the existence of an average value for the experimental class that is greater than the control class. Obtained an average value of the experimental class of 88.71 and the average value of the control class of 62.63 with a significance level of 0.000 less than 0.05 or (0.000 <0.05) so it can be concluded that there is a significant influence on the learning model problem-based learning on problem-solving ability at SMP Negeri 7 Palu.

Acknowledgments

With all humility and sincerity, the author would like to thank the people who have provided a lot of input and guidance to the author, from the beginning of guidance to the preparation of this paper till it is ready to publish.

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