Effectiveness of Problem-Based Learning Model on Critical Thinking Skills in Elementary Mathematics Education

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Abstract
Critical thinking skills are needed by students. One of the efforts to improve this ability is to use an effective and easy learning model, so that students are able to solve certain problems. This study aims to determine the effectiveness of the Problem Based Learning learning model on critical thinking skills in mathematics subjects. This type of research is quantitative research. The research sample was 83 fourth grade students of public elementary schools in Wonogiri District. Data analysis was conducted using simple linear regression analysis technique. The results showed the correlation value (R) = 0.506, meaning that there is a positive linear relationship between variables; the coefficient of determination R Square = 0.861, meaning that the Problem Based Learning learning model has an influence of 86.1% on the effectiveness of critical thinking skills. The significant value is 0.000 < 0.05 and the t value is 2.512 > t table 1.664, meaning that it accepts the alternative hypothesis. The research conclusion is that the Problem Based Learning learning model is effective in developing critical thinking skills in grade IV mathematics subjects.
Keywords: Problem Based Learning, skills, critical thinking.

Abstrak
Keterampilan berpikir kritis sangat diperlukan oleh peserta didik. Salah satu upaya meningkatkan keterampilan tersebut yaitu menggunakan model pembelajaran efektif dan mudah, sehingga peserta didik mampu menyelesaikan persoalan tertentu. Penelitian ini bertujuan untuk mengetahui efektivitas model pembelajaran *Problem Based Learning* terhadap keterampilan berpikir kritis pada mata pelajaran matematika. Jenis penelitian ini adalah penelitian kuantitatif. Sampel penelitian adalah 83 peserta didik kelas IV di SD Negeri kecamatan Wonogiri. Analisis data dilakukan dengan menggunakan teknik analisis regresi linier sederhana. Hasil penelitian menunjukkan bahwa: rerata tes dari 63.50 menjadi 89.35; nilai korelasi (R) = 0.506 artinya ada hubungan linear positif antar variabel; *koefisien determinasi* R *Square* = 0,861, artinya model pembelajaran *Problem Based Learning* memberikan pengaruh 86.1% terhadap efektivitas keterampilan berpikir kritis. Nilai signifikan sebesar 0.000 < 0,05 dan nilai t hitung 2,512 > t tabel 1.664, artinya menerima hipotesis alternatif. Kesimpulan penelitian adalah model pembelajaran *Problem Based Learning* efektif dalam mengembangkan keterampilan berpikir kritis pada mata Pelajaran matematika kelas IV.
Kata kunci: Problem Based Learning, keterampilan, berpikir kritis.

INTRODUCTION

Learning in the 21st century requires activities that are able to provide space for students to explore knowledge according to their learning style. Through the concept of knowledge exploration learning, it is hoped that the problems that exist in the environment can be overcome by providing analysis and answer solutions. This is what raises, the need for learning today to be oriented to problems that exist in the community environment.

Problem Based Learning (PBL) is a learning model that uses problems as a focus to develop problem-solving skills, materials, and self-regulation (Hasmyati, 2017). Nafiah (2014) also argues that PBL is a learning approach that uses real-world problems as a context for students to learn about critical thinking and problem-solving skills, as well as to gain essential knowledge and concepts from the subject matter. PBL is a learning model whose main starting point is the problem and how to solve it. This learning model emphasizes solving problems given by the teacher based on information that students have (Rahmasari, 2016).

Problem Based Learning (PBL) is a learning model in which students are faced with a real problem that has been experienced by students. Widiasworo (2018: 149) argues that the problem-based learning model is a teaching and learning process that presents contextual problems so that students are stimulated to learn. The problem is faced before the learning process takes place so that it can trigger students to research, describe and find solutions to the problem (Ardianti *et al.*, 2021). Based on some of the opinions above, it can be synthesized that *Problem Based Learning* (PBL) is a model of teaching students by focusing on students' real-world problems and allowing students to find solutions, thereby increasing critical thinking, problem-solving skills, materials, and self-regulation of a student.

According to Maryati (2018), there are 5 steps in implementing PBL, namely (1) orienting students to the problem; (2) organizing students to research; (3) assisting independent and group investigations; (4) developing and presenting work; (5) analyzing and evaluating the problem solving process. According to Soemarjadi (in Asrori, 2020,) explains that skills are behaviors that are acquired through learning stages. Meanwhile, according to Nasihudin and Hariyadin (2021): skills are the ability to carry out a particular task, both physically and mentally. This skill involves the use of thoughts, ideas, and creativity. Meanwhile, according to Zubaidah (2016), skills are abilities that are implemented in the implementation of work or activities. These skills are formed from experience and the learning process.

PBL-based learning is the focus of research because, the facts in the field obtained data, namely: teachers predominantly choose the lecture method and use student worksheets (LKPD). In the lecture method, the teacher tends to provide a summary of the formula and do examples of exercise problems. This is what directs students to imitate the answers to the problems presented. The logical consequence of this method is: learners memorize mathematical formulas and work on problems that are similar to those given by the teacher. this is certainly less profitable for students, because if the problem is raised to the stage of analysis, synthesis, or evaluation, then students cannot work on it.

Critical thinking skills are analyzing arguments through aspects of finding basic similarities and differences in the material or learning topics studied Erlistiani, *et al.*, 2020). Larasati and Syamsurizal (2022) also suggested that the ability to think critically is the ability to correctly conclude a problem, review and thoroughly examine the decisions taken. Critical thinking skills are needed to analyze a problem to the stage of finding a solution to solve the problem (Al Fanny and Roesdiana, 2020). According to Sudiarta, *et al.*, (2021) the importance of critical thinking skills is to stimulate the way individuals think in order to optimize the potential ideas in their minds so that they can be well honed to solve certain problems. Based on the opinions of the experts above, it

can be synthesized that critical thinking skills are needed to stimulate a person's way of thinking by reviewing and thoroughly examining the decisions taken so that a problem can be resolved properly.

Based on the description above, the researcher can formulate the problem formulation, namely: is the *Problem Based Learning learning* model effective on critical thinking skills in mathematics subjects? The purpose of this study was to determine the effectiveness of the *Problem Based Learning learning* model on critical thinking skills in mathematics subjects.

METHODS

This research uses a type of quantitative research with a quasi-experimental method. According to Emzir (2009: 28), a quantitative approach is an approach that primarily uses the postpositivist paradigm in developing science (such as thinking about cause and effect, reduction to variables, hypotheses and specific questions using measurement and observation and theory testing), using research strategies such as experiments and surveys that require statistical data. Meanwhile, according to Sugiyono (2019) pseudo-experiment or quasi-experimental is a research design that has a control group, but cannot function fully to control external variables that affect the implementation of the experiment.

The population in this study were all fourth grade students in Wonogiri sub-district public schools. The sampling technique used *cluster random sampling* technique. The results of sampling obtained 83 fourth grade students in Wonogiri sub-district State Elementary School. Data collection techniques with a description test that has been tested for content validity with t-tests, reliability with Cronbach Alpha, level of size, and differentiating power. Data analysis using simple linear regression analysis techniques and hypothesis testing with Independent Sample t-test to see the effectiveness of the PBL learning model on critical thinking skills.

RESULTS AND DISCUSSION

Result

The results of the research on the effectiveness of the *Problem Based Learning learning* model on critical thinking skills in mathematics subjects, obtained data which are processed as follows:

Descriptive Statistical Test

Descriptive statistical analysis aims to provide an overall description of the data used in the study, by paying attention to the average value, standard deviation, variance, maximum value, minimum value and total. The results of the descriptive statistical test can be seen in the following table.

Table I. Descriptive Statistics

		Mean	N	Minimum	Maximum	Std. Deviation	Std. Error Mean
Paired Samples Statistics							
PBL	*Pretest*	58.78	83	42	81	11,345	2,567
	Posttest	80.56	83	67	98	10,986	2,248

Table 1. shows that the average pretest score of the experimental class is known to be different from the average posttest score. The average pretest score was 58.78 and the average posttest score was 80.56. The average score of the experimental class

increased by 21.78. Thus it can be concluded that the PBL learning model on critical thinking skills.

Validity Results

To test the validity of the test material, it is done by comparing r count with r table. If r count> r table then it can be said that a statement item is declared valid. vice versa if if r count < r table then a statement item is declared invalid. In this study r count 0.691> r table 0.2816, so it can be interpreted that the test material is said to be valid.

Reliability Results

The reliability test is used to determine whether the questionnaire used is reliable or reliable as a measuring tool. The credibility of a questionnaire can be seen from the *Cronbach's Alpha* value, where if the *Cronbach's Alpha* value> 0.60 then the questionnaire can be said to be reliable, but if the *Cronbach's Alpha* value <0.60 then the questionnaire is considered unreliable. In this study, the Cronbach's alpha value (0.725) > 0.600, so it can be said that the test material is reliable.

Distinguishing Power Result

Differentiating power is the ability of a question item to be able to distinguish between participants who have mastered the material in question and participants who are less or have not mastered the material in question. In this study, the composition of the question material was 2 easy, 5 medium and 3 difficult. The results of data analysis to see the effect of PBL learning model on thinking skills using simple linear regression analysis techniques.

Level of Difficulty Results

The difficulty test is used to determine the level of difficulty of a question item. In other words, the difficulty test will show how easy or difficult a question can be answered by students. Based on the difficulty test, there are 2 easy questions, 5 medium questions, and 3 difficult questions.

Prerequisite t-test

Normality test

The normality test is carried out to evaluate the distribution of data in a group of data or variables, whether the data distribution is normal or not. This study uses the Shapiro-Wilk normality test because the sample in this study is less than 100 (<100). The results of the normality test in this study can be seen in the following table.

Table 1. Normality Test

	Tests of Normality					
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	df	Sig.
Pretest	,193	81	,200*	,953	81	,771
Posttest	,187	81	,200*	,959	81	,808

*. *This is a lower bound of the true significance.*

a. *Lilliefors Significance Correction*

Based on table 1, it is known that the Sig. value for the pretest is 0.771 and the Sig value for the posttest is 0.808. Both Sig values of the two tests are > 0.05 so it can be concluded that the samples come from a normally distributed population.

Homogeneity Test

Homogeneity test is a statistical method used to show that the variances of two or more groups of data samples come from the same population. The results of the homogeneity test in this study can be seen in the following table.

Table 2: Homogeneity Test

Test of Homogeneity of Variance			
Levene Statistics	df1	df2	Sig.
3,316	81	81	0.074

Based on table 2, it can be concluded that based on the mean for the demonstration learning model variable 0.074> 0.05. So it can be concluded that the sample has a homogeneous variation.

Hypothesis testing

This study uses a paired sample t-test to assess whether there is a difference in mean values between two samples that are paired or related to each other. The results of the homogeneity test can be seen in the following table.

Table 3. The t-test

		Paired Differences					t	Df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest-Posttest	-12,087	10,879	3,319	-20,134	-5,678	-3,780	81	,002

Based on table 3, it is known that the Sig. (2-tailed) value of 0.002 <0.005. So it is concluded that there is an effect of PBL learning model on critical thinking skills. This is also reinforced by the calculation results of simple linear regression which obtained a value of R = 0.506, which can be interpreted that there is a positive linear relationship between the PBL learning model variable and the dependent variable, namely critical thinking skills. The results of the calculation of the coefficient of determination R *Square* obtained a value of 0.861. It can be interpreted that the *Problem Based Learning learning* model provides 86.1% influence on critical thinking skills.

Discussion

Based on the research results above, it can be described that the PBL learning model has effectiveness on critical thinking skills. This is reinforced by the results of the t test where the significant value of the pre-test and post-test values is 0.002 <0.05, which means that there is an influence between the PBL learning model on critical thinking skills. In addition, from the calculation of the coefficient of determination R *Square* obtained a value of 0.861, which means that the *Problem Based Learning learning* model provides 86.1% influence on critical thinking skills. This is because the learning model used will make it easier for students to build mathematical concepts. The above statement is in line with Setiyaningrum (2018) that the *Problem Based Learning* (PBL) model is an approach that involves students in dealing with real problems from everyday life as the beginning of the learning process. In this way, students are invited to solve the problem, making it one of the innovative learning methods that encourage student activeness in learning and are expected to create meaningful learning experiences. In this model, the teacher acts as a motivator, facilitator and guide for students in the problem-solving process.

The Problem Based Learning (PBL) learning model has a positive impact on students' critical thinking skills in mathematics subjects. This can be seen in the average pretest score of 58.78 and the average posttest score of 80.56. The average score of the experimental class increased by 21.78. The influence of PBL on critical thinking skills is in line with Nafiah's (2014) statement that *Problem Based Learning* (PBL) is a learning approach that uses real-world problems as a context for students to learn about critical thinking and problem solving skills, as well as to gain essential knowledge and concepts from the subject matter. On the other hand, the PBL model has a positive impact which can help students think creatively in solving problems. As one of the variations of effective learning models, PBL makes it easier for students to understand the material

being taught (Dewi *et al.*, 2023). *Problem-based* learning has been proven to be effective and provide significant results in the learning process. This is because this model encourages students to work collaboratively in finding solutions to real problems that match the characteristics of PBL (Sari *et al.*, 2023)*.* Furthermore, the impact of using the learning model is explained by Fauzi & Metroyadi (2020) that PBL helps lead learners to build knowledge creatively and bring up critical thinking skills.

Critical thinking skills will be formed if the learning model used can link the material with real experiences and contexts that are relevant to students. This shows that the PBL model has benefits in learning. This is explained by Warsono and Hariyanto (2013: 68) the *Problem Based Learning* (PBL) *learning* model has several benefits, namely: learners will be challenged to solve problems that will make them accustomed to facing problems and social solidarity will be fostered by discussions with group mates. In addition, the PBL learning model is interactive learning and encourages active participation of students in the learning process and will also strengthen their understanding of the concepts taught (Wulandari and Taufina, 2021). The PBL learning model also serves as a guide for educators in planning learning activities in class that focus on problems, starting from the preparation of learning tools, media, and tools, to evaluation tools that aim to achieve learning objectives, namely students being able to provide solutions to these problems (Mirdad, 2020). The PBL learning model leads to reduced misconceptions in mathematics learning and creates active learner interaction (Ojose, 2015).

CONCLUSION

The Problem Based Learning learning model on critical thinking skills in class IV subjects at Wonogiri District State Elementary School is effective. This conclusion is based on the results of the average pretest score of 58.78 and the average posttest score of 80.56. The average score of the experimental class increased by 21.78. This shows a positive impact after the application of the *Problem Based Learning learning* model.

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