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The Influence of Problem Based Learning on Problem Solving Ability in Science Materials in Elementary Schools

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Abstract: Problem solving abilities have a significant role in increasing students' cognitive capacity, however, there are still difficulties in developing these skills. This research aims to assess the influence of the Problem Based Learning Model on students' problem solving abilities. This research is a quasi-experimental quantitative type with a pretest-posttest control group design. Fourth semester students in classes C and D of the PGSD Study Program were taken as samples using the Purposive Sampling technique. Data was collected through a research instrument in the form of a problem solving ability test in the Elementary School Science Learning Materials course. The results of hypothesis analysis using the Mann-Whitney test show the Asymp value. Sig. (2-tailed) is 0.000, which is smaller than 0.005. Therefore, it can be concluded that Hypothesis is Accepted. This means that there are differences between the experimental class which uses the PBL model and the control class with conventional learning. Thus, it can be concluded that the PBL model has an influence on the problem solving abilities of PGSD students.

Keywords: Elementary science; Problem based learning; Problem solving skill

Introduction

Natural Science comes from the English "natural science" and is often referred to as "Science," can be defined literally as a discipline that studies natural events. This implies that science is not just an accumulation of knowledge, but rather a research process that is structured and involves various strategies to produce a body of knowledge that is always developing (Pratiwi, 2021). Natural Science (Science) education for prospective elementary school teachers has a significant role in forming scientific attitudes and thinking skills. Science contributes to the development of inquiry thinking and problem solving abilities, because in science there are three main elements: attitude formation, processes and scientific knowledge (Maryani et al., 2021; Nursakinah et al., 2023; Sutiani et al., 2021). Problem Based Learning (PBL) is a learning model that challenges students to solve authentic or real problems in the context of everyday life (Amalia et al., 2019; Dwi et al., 2018; Ismail et al., 2018).

From the results of interviews with course lecturers conducted in February 2023, there were several problems experienced by students. Among them, during lectures, only a few students are active, both asking and answering questions, most students are less active in lectures and only tend to listen and take notes, so the lecture process is still dominated by the lecturer, which means that students' problem solving abilities are still not visible.

The Problem Based Learning model is considered appropriate for developing students' critical thinking skills in finding and solving problems (Adhelacahya et al., 2023; Ningrum et al., 2021; Saputra et al., 2019). The Problem Based Learning (PBL) model is a problem-oriented learning scheme (Arta et al., 2020). One learning model that can be used to support innovative learning is problem based learning (Setyawan et al., 2021). The various advantages and benefits of PBL are one of the

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reasons PBL is widely used at various levels of education to deliver learning material (Samsudin et al., 2021). Learning is a process in which activities take place with students and educators as well as learning resources in a good environment. Organized as an effort to improve students' thinking abilities, ability to construct new knowledge, and ability to master subject matter (Diastuti et al., 2022). PBL is a student-centered learning model, and the existence of the PBL model will have an impact on the learning process. PBL helps students obtain existing information and organize their knowledge about basic and complex knowledge (Nirmayani et al., 2023). In fact, it is reasonable to conclude that PBL fosters important dispositions necessary for professional practice while recognizing the complexity of teaching and learning (Naslund et al., 2015). Colleges new to PBL programs need to find a balance between how much information they provide students directly and how much information they can discover on their own (Epler et al., 2022).

As prospective elementary school teachers who must master all subjects including science, the PBL model guides students to formulate questions during the learning process, as a representation of authentic situations or real world problems (Palupi et al., 2020). PBL learning is required to solve the problems presented by exploring as much information as possible (Djaga et al., 2022). PBL aims to help students solve challenges or problems by utilizing various learning materials (Maharani et al., 2022). Science Problem Solving Ability is an important component in science learning. Because science learning in elementary schools teaches how to instill curiosity about the natural surroundings, the success of this learning is closely related to students' problem-solving abilities (Hayyun et al., 2023). One of the many learning models that emphasizes problem solving and directs students to find the problem concept is the Problem Based Learning (PBL) model (Oktaviana et al., 2020).

The problem-based learning model is a learning model that involves authentic problems in students' learning approaches so that they can manage their knowledge (Chang et al., 2022; Desania et al., 2020; Sukackė et al., 2022). Individuals with good scientific process skills can solve problems they encounter in everyday life both in a short time and by using appropriate methods (Gültekin et al., 2022). PBL problems are usually structured and complex. Problems that are too simple can make students bored and hinder learning (Leasa et al., 2023). Another skill that has importance among the desired behavior of students in developing countries is problem solving skills (Topsakal et al., 2022). Problem solving ability is a learning process carried out by students. Gaining experience in using the knowledge and skills they already have to apply them in solving problems is not routine (Sudarsono et al., 2022).

In this research, researchers hope to find empirical evidence about the influence of PBL on PGSD students' problem-solving abilities in science learning. The results of this research provide useful information for teachers and curriculum developers to improve the quality of learning and develop students' problem solving skills.

Method

This study uses a quantitative approach. The type of research used is quasi-experimental or quasi-experimental consisting of two research groups, namely experimental, which is a group of students whose learning applies learning using the Problem Based Learning model and control is a group of students whose learning uses direct learning. This research was conducted at Ahmad Dahlan University, where the population was students in the fourth semester of the Elementary School Teacher Education study program. The sample is a portion or representative of the population to be studied (Arikunto, 2014). The sampling technique used in this research is purposive sampling, because the samples to be taken are adjusted to research needs. The sample for this research was class C as an experimental class with 30 students and class D as a control class with 30 students. Data collection for hypothesis testing was carried out in 6 meetings in the experimental class and control class.

The research implementation provided a pretest before treatment to determine the initial condition of students regarding their problem solving abilities in both the experimental and control classes. At the end of the meeting after the treatment, a posttest was given to see the results of the treatment that had been given. This research design was used to find out whether students' problem solving abilities using PBL model learning were better than direct learning. The following is an overview of the pretest-posttest control design. The stages that will be carried out in this research are: Initial Test Stage (Pretest), the pretest is carried out to prove that the control class and experimental class have the same ability in problem solving abilities. If the results of the pretest show insignificant results, then the research can proceed to the next stage, namely the stage of providing treatment. The stages of providing treatment are carried out so that students are involved in the Problem Based Learning learning model which is used to improve students' problem solving abilities. Stages of giving a final test (posttest), giving a final test (posttest) to find out whether the results of using the Problem Based Learning learning model have an influence on students' solving abilities after being given treatment (Borg et al., 1998).

The data collection technique used in this research is a measurement technique where the data collection instrument is a problem solving ability test instrument where the pretest and posttest questions are in the form of multiple choices which contain the four indicators of problem solving ability. The data analysis techniques in this research are descriptive statistical tests and inferential tests. Descriptive statistical tests are used to describe the average value and standard deviation of problem solving abilities. The inferential test is used to see the increase in students' problem solving abilities with the PBL model which is better than direct learning in elementary science material courses. Tests carried out include: 1) Normality test with SPSS via the Shapiro-Wilk test as a prerequisite test for hypothesis testing. 2) Test homogeneity with SPSS via the Lavene test as a prerequisite test for hypothesis testing. 3) Test the hypothesis using SPSS if the data is normally distributed and homogeneous then continue with testing the hypothesis using the t-test. However, if the data is not normally distributed then proceed with hypothesis testing using the Mann-Whitney test.

Result and Discussion

Descriptive Statistical Analysis

The results of descriptive analysis relating to students' science problem solving abilities are aimed at students' ability to complete science problem solving tests.

Descriptive of Students' Science Problem Solving Abilities (Post-Test) in the Experimental Class

To provide an overview of students' science problem solving abilities in the experimental class using the Problem Based Learning Model implemented in class D PGSD UAD. Below are statistics on students' science problem solving in the experimental class after being given treatment.

Table 1. Descriptive Statistics of Experimental Class Post-Test Problem Solving

	N	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation	Variance
Pre-test Experiment	30	23	54	77	66.57	1.282	7.021	49.289
Post-Test Experiment	30	12	80	92	85.80	.665	3.643	13.269
Valid N (listwise)	30							

Based on the table 1, it can be concluded that the pretest score for students' science problem solving before implementing the Problem Based Learning Model in class D on elementary school science learning material obtained a mean value of 66.57 and a standard deviation of 7.021. The lowest score obtained by students was 54, while the highest score obtained by students was 77 and (range) was 23. Meanwhile, the posttest score for students' science problem solving after implementing the Problem Based Learning Model in class D on elementary school science learning material obtained a mean score of 85.80 and standard deviation 3.643. The lowest score obtained by students was 80, while the highest score obtained by students was 92 and (range) was 12.

Science pretest and posttest scores for experimental class students, if the category is in the problem solving score, then the frequency distribution can be seen in table 2. Based on the table 2, it can be concluded that the science problem solving abilities of students who were taught using the Problem Based Learning learning model obtained the highest scores in the 85-100 interval, as many as 21 students. There were 9 students who got the lowest scores in the interval 70 -84.

Table 2. Categories of Problem Solving Ability

Interval	Criteria	Pretest	Posttest
85 – 100	Very high	0	21
70 – 84	High	12	9
55 – 69	Medium	16	0
40 – 54	Low	2	0
0 – 39	Very low	0	0

Description of Students' Science Problem Solving Abilities (Posttest) in the Control class

To provide an overview of students' science problem solving abilities in the control class by applying the direct learning model implemented in class C PGSD UAD. Below are statistics on science problem solving for students in the control class after being given treatment.

Table 3. Descriptive Statistics of Control Class Post-Test Problem Solving

	N	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation	Variance
Pre-Test of Control	30	30	54	84	65.97	1.535	8.406	70.65
Post-Test of Control	30	23	67	90	79.70	1.096	6.001	36.01
Valid N (listwise)	30							

Based on the table 3, the students' science problem solving pretest score before applying the direct learning model in class C PGSD UAD on elementary science learning material obtained a mean value of 65.97 and a standard deviation of 8.406. The lowest score obtained by students was 54 and the highest score obtained by students was 84 and (range) was 30, while the posttest score for solving science problems for students after implementing the direct learning model in class C PGSD UAD on elementary science learning material obtained a mean score of 79. 70 and standard deviation 6.001. The lowest score obtained by students was 67 and the highest score obtained by students was 90 and (range) was 23.

The results of the control class students' science pretest and posttest scores if categorized into problem solving scores, the frequency distribution can be seen in Table 4. Based on the table 4, it can be concluded that the science problem solving abilities of students who were taught using the direct learning model obtained the highest scores in the 85-100 interval for 7 students. There were 2 students who got low scores in the interval 55 - 69.

Table 4. Categories of Problem Solving Ability

Interval	Criteria	Pretest	Posttest
85 – 100	Very high	0	7
70 – 84	High	10	21
55 – 69	Medium	18	2
40 – 54	Low	2	0
0 – 39	Very low	0	0

Description of the Comparison of Students' Science Problem Solving Abilities in the Experimental and Control Classes

To provide an overview of students' science problem solving abilities in the experimental class using the Problem Based Learning Model and in the control class using the direct learning model implemented in class C PGSD UAD. The results and discussion of the posttest from the experimental class and control class are as follows.

Table 5. Descriptive Statistics Comparison of Students' Science Problem Solving Abilities in the Experimental and Control Classes

	N	Range	Minimum	Maximum	Mean	Std. Error	Std. Deviation	Variance
Post-Test of Experiment	30	12	80	92	85.80	.665	3.643	13.269
Post-Test of Control	30	23	67	90	79.70	1.096	6.001	36.010
Valid N (listwise)	30							

In accordance with the calculation of posttest results in the experimental class and control class above, it can be concluded that there are statistical differences in the two classes. The statistical results show that the experimental class students' scores are higher than the control class scores with a difference of 2 scores, namely the experimental class score is 92 and the control class score is 90. It can be seen from the lowest score of the two classes the difference is 13 scores, namely the lowest score for the experimental class is 80 while the control was 67. Based on this, the students' science problem solving ability was highest in the experimental class, while the students' science problem solving ability score was the lowest in both classes. In measuring data centered on Posttest scores, it can be seen that the mean score of experimental class students is higher than the mean score of control class students with a score of 85.80 for the experimental class and 79.70 for the control class. Apart from that, in measuring the posttest score data, there are differences in the variance and standard deviation of the experimental class and the control class. Namely the experimental class was 13.289 and 3.643, while the control class was 36.010 and 6.001.

Inferential Statistical Analysis

The results of inferential statistical analysis are designed to answer the research hypotheses that have been put forward. Before carrying out inferential statistical analysis, hypothesis testing is first carried out, namely the normality test and homogeneity test.

Normality test

The normality test aims to find out whether the population is normally distributed. The test statistic used in the normality test is Shapiro-Wilk. The hypothesis tested is as follows, H_0: Data is normally distributed; H_1: Data is not normally distributed. Test criteria: H_0 accepted if > significance level ∝ (0.05).

Table 6. Differential Statistics for Normality Test

	Class	Shapiro-Wilk		
		Statistic	Df	Sig.
Science Problem Solving Skill in Elementary School	Pre-Test Experiment (PBL)	0.942	30	0.1
	Post-Test Experiment (PBL)	0.944	30	0.113
	Pre-Test Control (Convensional)	0.963	30	0.202
	Post-Test Control (Convensional)	0.913	30	0.018

The calculated value obtained for the pretest score in the experimental class with the Problem Based Learning model Pvalue > ∝ significance level ∝ = 0.05) is 0.100 > 0.05 and the calculated value obtained for the pretest score in the control class with the direct learning model is 0.202 > 0.05. The test criteria are that the data is normally distributed if Pvalue > ∝ so it can be concluded that the pretest scores for both experimental and control classes are included in the normal category. Meanwhile, the posttest score in the experimental class with the Problem Based Learning model Pvalue > (significance level ∝ = 0.05) is 0.113 > 0.05 and the calculation results obtained for the posttest score in the control class with the direct learning model are 0.018 < 0.05. The test criteria are that the data is normally distributed if Pvalue > ∝ so it can be concluded that the posttest scores for both classes, both experimental and control classes, are included in the abnormal category.

Homogeneity Test

Based on the population normality test, it turns out that the control class is not normally distributed while the experimental class is normally distributed. According to the explanation above, the next test is the homogeneity test. The aim of the homogeneity test is to find out whether the variances of the two populations are homogeneous (the same). The homogeneity test can be calculated using Lavene's test. The hypotheses tested are as follows: accept if P value >.

Table 7. Differential Statistics for Homogeneity Test

		Levene Statistic	df1	df2	Sig.
Students' Science Problem Solving Skill	Based on Mean	5.730	3	116	.001
	Based on Median	4.980	3	116	.003
	Based on Median and with adjusted df	4.980	3	95.283	.003
	Based on trimmed mean	5.750	3	116	.001

Based on the results of data analysis using Lavene's Test, the significant value (Sig) Based on Mead was 0.001 > 0.05, so it can be concluded that the variance of the experimental class post-test data and control post-test data is not the same or heterogeneous. Thus, if one of the conditions (not absolute) of the independent sample t-test is not fulfilled, then we will use an alternative method using the Mann Whitney U Test.

Table 8. Inferential Statistics Mann Whitney U Test

	Student learning outcome
Mann-Whitney U	173.000
Wilcoxon W	638.000
Z	-4.107
Asymp. Sig. (2-tailed)	.000

a. Grouping Variable: Class

Based on the "Statistical Test" output, it is known that the value of Asymp. Sig (2-tailed) is 0.000 < 0.05. So it can be concluded that the hypothesis is accepted. Thus it can be said that there is a difference between the experimental class using the PBL model and the control class using conventional learning. Because there are significant differences, it can be said that there is an influence of the use of the problem based learning model on the problem solving abilities of UAD PGSD students.

The findings of this research indicate that there are differences in problem solving abilities between the experimental class and the control class. This difference can be explained by several factors, which include the following aspects. Learning that uses the PBL model focuses on problems and encourages active student involvement in the problem solving process through the syntax steps of this model. PBL syntax includes stages such as student orientation towards problems, organizing students to learn, guiding problem investigations by students individually and in groups, developing and presenting work results, as well as analysis and evaluation of problem solving results (Shofiyah et al., 2018).

In the first session of implementing the PBL model, students appeared to be confused, especially when faced with problems presented in the form of quizzes via the Quizizz platform. This condition arises because students do not have experience in solving problems that require thinking skills. However, in the second session, students began to be able to overcome this confusion and succeeded in formulating alternative solutions to the problem. From the third to sixth meeting, students seemed increasingly skilled in understanding, formulating solution steps, and presenting results and conclusions. This increase in ability has a positive impact, as can be seen from the mean score of experimental class students which is higher than the mean score of control class students, namely 85.80 for the experimental class and 79.70 for the control class. These findings indicate that problem-based learning, as implemented through the PBL model, can train students in solving problems, indicating an increase in problem solving skills. A similar opinion was also expressed by Arta et al. (2020), Umar et al. (2022), Ngereja et al. (2020), and Lozano et al. (2022) that the PBL model has a positive impact on students during the learning process.

A different situation occurs in the control class, where learning tends to be monotonous and dominated by teacher activities. Students in this class have little opportunity to practice problem-solving skills because the learning process focuses more on solving routine problems, with the occasional encounter with non-routine problems. This condition causes students to have difficulty understanding problems when faced with certain situations. Apart from that, the lack of activities that create a relaxed learning atmosphere makes students less motivated and enthusiastic in participating in learning.

Conclusion

Based on the results of the research and discussion, it can be concluded that the application of the problem based learning model has a significant positive effect on students' problem solving abilities in elementary school science learning materials. This is proven by the results of the hypothesis test, which obtained a significant value of 0.000 < 0.005. Thus, it can be concluded that Ho is rejected and Ha is accepted, so there is an influence of problem based learning innovation on the problem solving abilities of PGSD students at Ahmad Dahlan University.

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Conflicts of Interest
All authors declare that there is no conflicts of interest.

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