JPPIPA 9(8) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Influence of Problem Based Learning Model on the Critical Thinking Elementary School

Ellen Widy Yuliasandra[1], Fitria Wulandari[1*]

[1] Elemetary Scholl Teacher Education, Faculty of Psychology and Educational Sciences, University of Muhammadiyah Sidoarjo, Indonesia.

Received: May 2, 2023
Revised: July 5, 2023
Accepted: August 25, 2023
Published: August 31, 2023

Corresponding Author:
Fitria Wulandari
fitriawulandari1@umsida.ac.id

DOI: 10.29303/jppipa.v9i8.3766

© 2023 The Authors. This open access article is distributed under a (CC-BY License)

Abstract: This study aims to determine the influence and effect's magnitude of Problem Based Learning on the critical thinking skills of fifth grade students at Jeruk Purut II Elementary School. The research method used is quantitative research with the type of Pre-Experimental Design and One Group Pretest-Posttest Design. The data collection technique uses a critical thinking ability test sheet consisting of 12 questions. Data analysis technique using paired sample t-test and ETA squared t test. The results of the pretest and posttest hypothesis testing showed a sig. (2-tailed) 0.00 which is less than 0.05 so that there is a significant effect of the Problem Based Learning model on critical thinking skills. Then, the eta squared calculation shows a value of 0.88 which is belong to very large category. The conclusion from the research results is that the Problem Based Learning model influences the critical thinking skills of fifth grade elementary school students and with effect's magnitude belong to very large category.

Keywords: Critical Thinking Skills; Elementary School; Problem Based Learning

Introduction

The development of critical thinking skills is carried out according to the philosophy of education put forward by Ki Hajar Dewantara. He was a figure in the Indonesian independence movement and a pioneer of education for the Indonesian people. The basic philosophy of Ki Hajar Dewantara is that education guides students to survive in the future. The function of education is to guide all potential children so that they can develop and be useful when they are adults (Niyarci, 2022). In his view, the theory of an independent spirit will give freedom to children to develop their potential in learning (Sani et al., 2022). Thus, Ki Hajar Dewantara's educational philosophy is the development of the full potential of the child (Sugiarta et al., 2019). By applying the educational philosophy of Ki Hajar Dewantara, students can fully develop their potential, including critical thinking skills.

The application of Ki Hajar Dewantara's philosophy in learning in elementary schools can use the Problem Based Learning model. Students will be introduced to real problems that exist in their environment and find solutions according to the Problem Based Learning model. This is the essence of Ki Hajar Dewantara's educational philosophy because he emphasizes education for children who can prepare them to survive in society as adults. By developing skills and solving problems, students will have useful skills when they grow up. Even though Ki Hajar Dewantara's educational philosophy has existed for a long time, it is still relevant for the development of education in Indonesia through the Problem Based Learning model approach.

Students' critical thinking skills in science learning are still low based on the results of PISA (Michie, 2019; Wicaksono & Sayekti, 2020). This is evidenced by looking at the results of Indonesia's Program for International Student Assessment (PISA) in 2018 which showed that Indonesia was in 74th place out of 79 countries (Utama & Kristin, 2020). Meanwhile, according to the results of the Trend in International Mathematics and Science Study (TIMSS) study, Indonesia was ranked 44th out of 49 countries in 2015

How to Cite:
Yuliasandra, E. W., & Wulandari, F. (2023). The Influence of Problem Based Learning Model on the Critical Thinking Elementary School. *Jurnal Penelitian Pendidikan IPA*, *9*(8), 6610–6618. https://doi.org/10.29303/jppipa.v9i8.3766

(Nurvitasari et al., 2022). TIMSS is organized by the International Association for the Evaluation of Educational Achievement (IEA), which aims to examine students' critical thinking levels. Therefore, learning that can improve critical thinking skills is not only important for the current development of students but also for their future (Bezanilla et al., 2019).

Critical thinking is a way of thinking in a directed process to solve problems and make scientific decisions in everyday life (Montoya et al., 2022). Critical thinking skills need to be developed in science learning because it trains students to solve problems actively and independently (Xu et al., 2023). Critical thinking in science learning is the mental process of students to evaluate various information they have so that they can find solutions to science problems (Prabasari & Wahyuningsih, 2021). Therefore, critical thinking skills need to be trained and accustomed to in science learning so that they can develop properly. Critical thinking skills is based on reflective thinking to determine the best alternative to solve the problem (Hamiyati et al., 2022). Critical thinking is one of the characteristics of intelligent people, but critical thinking occurs when it is preceded by critical awareness which can be developed through education. The importance of teaching critical thinking cannot be ignored anymore, because critical thinking can be a basic process in a dynamic state that allows students to repeat and reduce future uncertainties, so it is hoped that students will be able to deal with various problems that make sense (Raj et al., 2022).

Critical thinking aims to critically evaluate what we do for valid reasons, use research standards as a result of decision making, apply various strategies that are structured and justify the definition and application of these standards, seek and collect reliable information as evidence to support evaluation (Seibert, 2021). Critical thinking skills can encourage students to generate new ideas or thoughts about world issues. Students are trained to choose different opinions to distinguish which opinions are relevant and irrelevant, which opinions are correct and which are not.

The characteristics of critical thinking in terms of knowledge, abilities, attitudes, habits are using facts appropriately and honestly, organizing thoughts and expressing them clearly or reasonably, distinguishing between conclusions based on valid logic, identifying adequacy of data, supporting an argument that is irrelevant and presenting relevant arguments, questioning a view and questioning the implications of a view, realizing that the facts of one's understanding are always limited, recognizing the possibility of error from an opinion and the possibility of being able to in an opinion.

Critical thinking indicators according to Facione in (Utami et al., 2019) are interpretation, analysis, inference, evaluation, explanation and self-regulation. Interpretation indicators are understanding and expressing or the meaning of various experiences, rules, procedures or criteria. Then on the indicator analysis, identify the intended and actual inferential relationships between questions, concepts, descriptions that are intended to express judgments. After that, an evaluation indicator is used to assess questions that notes. Then the inference indicator is to identify the necessity to draw reasonable conclusions. The explanation indicator is to state and justify that reasoning in relation to evidence considerations, and present one's reasoning in the form of a convincing argument. The last indicator is self-regulation, which is consciously monitoring one's cognitive activity and the results learned, especially by applying skills in analyzing or correcting one of one's reasoning or results (Liu & Pásztor, 2022).

Based on pre-research observations on the science learning process for fifth grade students at Jeruk Purut II Elementary School, the learning model applied is not optimal. Observation of thinking ability was carried out using a critical thinking ability test instrument given by fifth grade students. The test results were calculated using predetermined criteria. Students' critical thinking skills have not yet developed because they still use the conventional lecture method so the results of the pre-research test show that only 10.5% of students can do critical thinking questions. The pre-research test was given in the form of 5 essay questions. Of the 19 students who took the test, 17 students had not demonstrated good critical thinking skills. They fail to understand the problem and are not used to solving problems. Science lessons provided do not require reasoning, argumentation and the problem solving in the environment around students. Thus, the science learning process at SDN Jeruk Purut II is not optimal in developing critical thinking skills.

Problem Based Learning is a learning method that can improve critical thinking skills in elementary school age students. The use of Problem Based Learning will increase student activity in participating in class (Kamala et al., 2022). Students not only receive information from teachers but actively seek, collect and organize information to find solutions to real problems in the environment around them. The application of Problem Based Learning can improve students' ability to solve problems critically (Alberida et al., 2022; Seibert, 2021; Ulger, 2018). Problem Based Learning can provide opportunities for students to express thoughts and provide similar experiences with ideas that students already have (Nurvitasari et al., 2022).

Problem Based Learning focuses on student learning process or student-centered learning (Fidan & Tuncel, 2019). By using Problem Based Learning, students can be more critical in learning science because they try to find solutions to problems in real life based on the science concepts, they learn (Setiati & Jumadi, 2023). Previous research on the effect of implementing Problem Based Learning on critical thinking skills in students showed a significant influence (Anggraini et al., 2023; Aufa et al., 2021; Handayani, 2021; Rahmadita, Mubarok, & Prahani, 2021; Yana, 2022; Yulia & Salirawati, 2023). Problem Based Learning can improve the ability to think critically, analytically, systematically and logically in finding solutions to problems (Ahmadiah et al., 2023). Students are directed to conduct empirical knowledge-based research so that a scientific attitude can develop (Alava et al., 2021). Students are also taught to work together with friends to build effective communication, exchange information and process data together in solving science problems (Nurlaelah, 2023).

The Problem Based Learning model is one of the models used to present the main problems that occur around the student's environment. The problems presented are the key to the success of the Problem Based Learning model because students are guided in the process of activities to solve these problems during the learning process. The syntax in Problem Based Learning is to provide orientation to students towards problems, prepare students to take part in learning, provide guidance to students to carry out scientific investigations, present the results of investigations, and evaluate the problem-solving process. By using the Problem Based Learning model, teachers can develop students' abilities to the maximum extent possible in learning activities. While the syntax of the Problem Based Learning model according to Arrends in (Firmadani & Wulansari, 2020) consists of five phases, namely: the first phase is the orientation of a problem in students. In this phase, the teacher will explain the purpose of learning to students, namely solving a problem. The second phase is grouping students to do research. The teacher will divide the tasks in each group according to the problems to be solved by students. The third phase is guiding students to collect information from various sources, conducting experiments to find out the truth, and determining solutions that can solve problems. The fourth phase is presenting the results where the teacher will help students to prepare experimental results in the form of a report and present the report in front of the class. The fifth phase is the evaluation of the problem-solving process. The teacher will help students to evaluate the experimental activities carried out along with the processes that have been used.

Based on the results of previous research conducted by (Utama & Kristin, 2020), it shows that Problem Based Learning affects improving the critical thinking skills of elementary school students. Then (Lailaturrahmah et al., 2020) research shows that Problem Based Learning has a positive effect on the ability to think critically in science students of fifth grade elementary school students. Furthermore, (Rahman et al., 2020) research shows that the Problem Based Learning model influence students' critical thinking skills and understanding of natural science concepts.

The importance of this research is to fill the gaps in previous research on specific research object, namely fifth grade students at SDN Jeruk Purut II. Research at the level of elementary school students is relatively small so that this research can contribute to the development of learning in elementary schools. This study uses the educational philosophy of Ki Hajar Dewantara in applying the problem-based learning model to improve students' critical thinking skills.

The existence of this research has benefits in the learning process, namely providing meaningful learning for elementary students. Meaningful learning for students is learning that encourages problem-solving skills by applying knowledge, combining information and skills, increasing motivation to learn and developing interpersonal relationships in group work. This study aims to describe any effect of the Problem Based Learning model on critical thinking skills in fifth grade students.

Method

Research on critical thinking skills of Jeruk Purut II Elementary School students uses a quantitative approach, namely an approach that uses aspects of measurement, calculation, formulas and certainty of numerical data in research designs, hypotheses, data collection, data analysis and conclusions up to writing. The type of research used is pre-experimental, which is a type of research that has not carried out a true experiment because it is still influenced by external factors (Zyphur & Pierides, 2020).

The design of the research method uses a one group pretest-posttest design that provides an initial test (pretest) before being given treatment and a final test (posttest) after being given treatment (Lo et al., 2020). In the one group pretest-posttest design it consists of objects before treatment (O_1), treatment, and objects after treatment (O_2). The independent variable is indicated by the treatment, which is the Problem Based Learning method, while the dependent variable is the ability to think critically as indicated by the differences in pretest and posttest (O_1 -O_2).

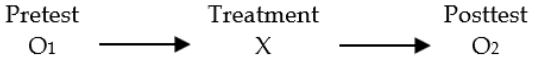

Figure 1. One group pretest-posttest design (Sugiyono, 2021)

The research will be carried out by giving an initial test before applying the Problem Based Learning method to science learning with the theme of heat and displacement, then the final test is given after the application of the Problem Based Learning method. The results of the t-paired test at the initial and final tests will show the significance of the effect of Problem Based Learning on the critical thinking skills of fifth grade students at SDN Jeruk Purut II. The two- tailed t-paired test uses a significance value of 5%. If there is a significant difference in the results of the initial and final tests, the Problem Based Learning method affects the critical thinking skills of fifth grade students at SDN Jeruk Purut II. Meanwhile, if there is no significant difference, the Problem Based Learning method will not affect the critical thinking skills of fifth grade students at Jeruk Purut II Elementary School.

The research sample was fifth grade students at Jeruk Purut II Elementary School, totaling 19 students consisting of 15 boys and 4 girls. Population is a generalized area consisting of subjects who have certain characteristics to be studied (Zyphur & Pierides, 2020).

Data collection techniques using tests. The test is a procedure for measuring ability in ways and rules that have been determined (Musianto, 2002). The main data collected through the test will be the basis for testing the research hypothesis. The test that will be given to fifth grade students consists of 2 parts, namely pretest and posttest. In the first test will be given before the application of Based Learning. The pretest will test students' critical thinking skills using 12 questions with 6 indicators, namely interpretation, analysis, evaluation, inference, explanation and self-regulation. The second test will be carried out after the application of Based Learning. The 2nd test is similar to the 1st test. The scores of the two tests will be compared to determine the effect of implementing Based Learning on critical thinking skills.

The research instrument used was a critical thinking ability test. The critical thinking ability test consists of 12 essay questions to measure critical thinking skills. Each question item will use indicators of interpretation, analysis, evaluation, inference, explanation and self-regulation. The number of questions for the interpretation indicator is 2 items, the analysis indicator consists of 2 items, the evaluation indicator consists of 2 items, the inference indicator consists of 2 items, the explanation indicator consists of 2 items, and finally the self-regulation indicator consists of 2 items. So, the total number of questions is 12 items. To find out the validity of the items, the researcher conducted a trial that was carried out in class VB students at Jeruk Purut II SDN. The following are the results of the validity test of the items:

Table 1. Question Validity Test

Question	1	2	3	4	5	6	7	8	9	10	11	12
rxy count	0.780	0.919	0.945	0.780	0.919	0.945	0.824	0.824	0.609	0.640	0.780	0.609
r table	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.456	0.456
Conclusion	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid

Based on the Output Validity Test Results using SPSS version 26 software, all items 1 to 12 are valid because the r_{count} value is greater than the r_{table} value. In conclusion, the test sheet of the questions met the validity criteria. So that the critical thinking ability test questions can be used for research. The results of these trials can be continued by conducting data reliability tests.

Table 2. Reliability Statistics

Cronbach's Alpha	N of Items
.945	12

Then, the test continued with the reliability test of the item instrument which aims to determine the reliability and consistency of the item instrument in collecting data for grade V students. Based on the results of the reliability test using SPSS version 26 software, Cronbach's Alpha value was greater than 0.90. In conclusion, the question test sheet meets the Reliability requirements.

The data analysis technique used in this study uses the influence test data analysis technique using the sample paired t-test. The paired t-test formula is as follows:

$$t = \frac{\sum d_i}{\frac{\sqrt{N \sum d_i^2 - (\sum d_1)^2}}{N-1}} \quad (1)$$

Information:
t = t value
d = the difference between the value of post and pre
N = number of samples

Then to calculate how big the effect is using the eta square formula. The Eta Square formula to calculate how much influence the criteria are as follows:

$$Eta\ Squared\ (\eta^2) = \frac{t^2}{t^2+N-1} \quad (2)$$

Information:
t = t test
N= Number of subjects

By carrying out a large influence test using the Eta Squared formula, researchers can determine the effect of the Based Learning model on the critical thinking skills of fifth grade students at SDN Jeruk Purut II.

Table 3. Criteria for Effect Size

Eta Square	Criteria
< 0.10	Small
0.10 < η 2 < 0.24	Medium
0.24 < η 2 < 0.37	Big
>0.37	Very large

Based on the Eta Square criteria table, it can be seen in the criteria column with results more than > 0.37, which is very large or very influential. The purpose of the Effect Size criteria table is to provide a guide in providing information on the results of the Eta Squared calculation in this research. The conclusion is to determine the magnitude of the effect after being given treatment.

Result and Discussion

This research is included in the pre-experimental type with the One Group Pretest Posttest model. The aim was to determine the effect of the Based Learning model on critical thinking skills in science grade V. This research was conducted at SDN Jeruk Purut II, Gempol District, Pasuruan Regency treatments.

During the research process, the researcher conveyed material and conditioned students according to the steps in the lesson plan from the opening to the closing which contained the steps of the Based Learning model. Students are asked to pay attention to every direction given. In the Based Learning model students form groups to conduct experiments on the worksheets that have been provided. LKPD 1 on Wednesday students do experiments on temperature and heat. Then in LKPD 2 on Thursday the students experimented with heat transfer. Learning activities in class V use the Syntax Based Learning model. In Phase 1 the orientation of a to students, in this phase the teacher will explain the learning objectives to students, namely solving a problem. Phase 2 groups students to carry out investigations, the teacher will divide tasks in each group according to the problems to be solved by students. Phase 3 guides students to collect information from various sources, conduct experiments to find the truth, and determine solutions that can solve problems. Phase 4 presents the results of the experiment in the form of a report in front of the class, where the teacher will help students prepare the results of the experiment in the form of a report and present the report in front of the class. Phase 5 evaluates the problem-solving process; the teacher will help students to evaluate the experimental activities carried out along with the processes that have been used.

The data analysis technique uses the t-test with the help of SPSS version 26 software. The procedure for inferential analysis with the t-test is to determine the hypothesis, determine the significance level, calculate the t value, compare the calculated t value with t table, and draw conclusions. In SPSS software version 26, the significance value of the t test results can be known by looking at the Sig. which is less than 5%.

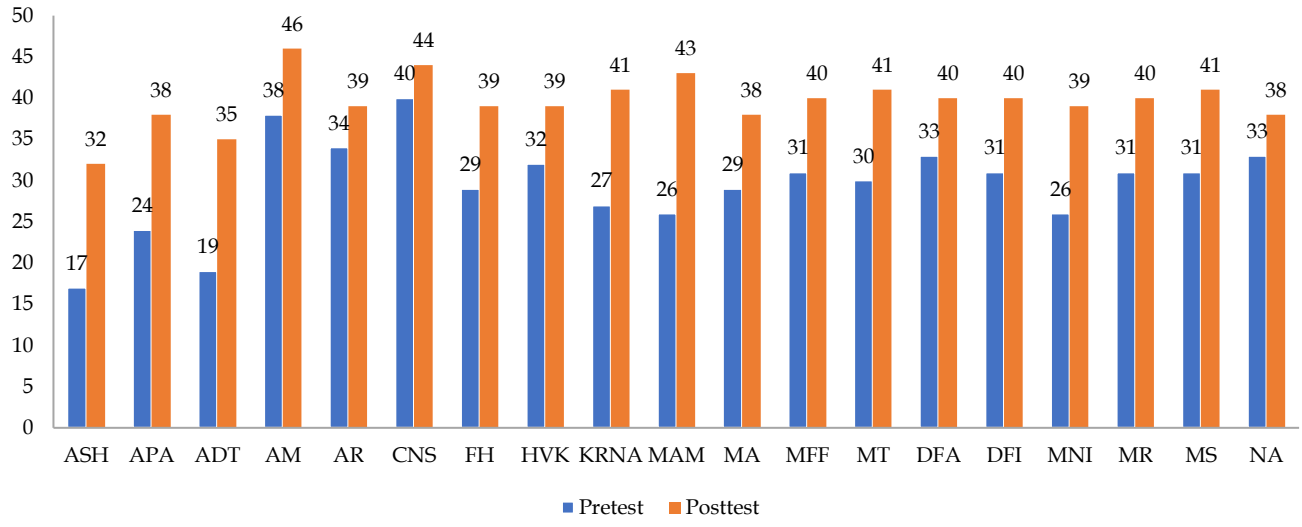

Figure 2. Graph of pretest and posttest critical thinking ability test results

Based on the graph above, it shows that there is an increase in critical thinking skills after learning using the Based Learning model. All students experienced an increase in results from pretest to posttest. The lowest pretest scores were ASH students with a score of 17 while the highest pretest scores were CNS students with a score of 40. The lowest posttest scores were ASH students with a score of 32 while the highest posttest scores were AM students with a score of 46.

Table 4. Average Value of Critical Thinking Ability

Indicator	Pretest Average	Posttest Average
Interpretation	4.79	5.71
Analysis	4.50	5.38
Inference	4.63	5.42
Evaluation	3.13	4.96
Explanation	3.17	4.83
Self-Regulation	3.17	5.08

Based on the table above, it can be seen that the 1st indicator, namely Interpretation, has an average pretest value of 4.79 and a posttest of 5.71. In the second indicator, the analysis has an average pretest value of 4.50 and a posttest of 5.38. In the third indicator, Inference has an average value of 4.63 pretest and 5.42 posttest. The 4th evaluation indicator has an average pretest value of 3.13 and 4.96 posttest. In the 5th indicator Explanation has an average pretest value of 3.17 and 4.83 posttest. While the 6th indicator, namely self-regulation, has an average value of 3.17 pretest and 5.08 posttest. Based on the table above it is known that the posttest average score is better than the pretest average on all indicators so it can be concluded that there is an effect of Based Learning which is shown by posttest average value.

Table 5. Tests of Normality

	Shapiro-Wilk		
	Statistics	df	Sig.
Pretest	.953	19	.452
Posttest	.934	19	.209

Based on table 5, we can see that the pretest significance value is 0.452 and the posttest is 0.209. Both show a significance value of more than 0.05, which means H0 is accepted. The purpose of the normality test is to find out whether the distribution of the pretest and posttest data meets the requirements so that it can be continued for the paired t-test. Based on the test results, it can be concluded that the two data are normally distributed.

Table 6. Paired Samples Statistics

	Means	N	Std. Deviation
Pretest	29.53	19	5.631
Posttest	39.63	19	3.041

Table 6 shows descriptive statistical data on pretest and posttest scores. The purpose of the statistical paired samples table is to provide a quantitative description in the form of the mean value and standard deviation of the research data. The mean values at pretest and posttest were different, namely 29.53 and 39.63 of 19 children. The standard deviation value in the pretest is greater than in the posttest. So, there is a variety of scores in the pretest between students who are unable and those who are able. The conclusion is that there is a difference in the average pretest and posttest scores and the diversity of pretest scores is greater than the posttest.

Table 7. Paired Samples Test

	t	df	Sig. (2-tailed)
Pretest- Posttest	-11.506	18	.000

Based on table 7 above the results of the pretest and posttest hypothesis test sig. (2-tailed) that is 0.00. This means that 0.00 <0.05, then there is a significant effect (Ha accepted and H_0 rejected). The purpose of the paired t test is to determine the difference in pretest and posttest data values. Thus, it can be concluded that there is an influence of the Based Learning model on the critical thinking skills of grade V SDN Jeruk Purut II Science.

Table 8. Eta Squared Test

N	t^2 (t- sample test)	Eta Squared	Information
19	-11.506	0.88	Very large

Based on the table above, the calculation results using the Eta Squared formula obtained a result of 0.880. The purpose of calculating eta squared is to determine the influence of the PBL model on critical thinking skills. So, it can be concluded that there is a large influence between Based Learning on the critical thinking skills of fifth grade students at Jeruk Purut II Elementary School.

Based Learning model on the critical thinking skills of fifth grade students at Jeruk Purut II Elementary School. Based on the calculation of the paired t test, it shows that the sig value of 0.000 is greater than 0.05 so that there is an influence of the Based Learning model on the critical thinking skills of grade V SDN Jeruk Purut II Science. The magnitude of the influence of the PBL model is shown in the results of the ETA Squared calculation, which is 0.880 so that it can be concluded that the PBL model has a very large influence on the critical thinking skills of students in grades 5 to elementary school 2. The advantages of the Based Learning model can stimulate students' critical thinking

skills, present learning that is more fun and can increase student activity in the learning process.

Learning activities can improve students' ability to understand the concept of temperature and heat and heat transfer. Students can understand the concept of temperature and heat by experimenting with measuring the temperature of water by hand. Then students can also understand the concepts of heat transfer by conduction, convection and radiation through the experiment of boiling water.

The results of this study support previous research, namely students' critical thinking skills can be increased through the Based Learning model. Research (Lailaturrahmah et al., 2020) shows that Based Learning has a positive effect on the critical thinking skills of science grade V elementary school students. Research (Rahman et al., 2020) the Based Learning model has an influence on students' critical thinking skills and understanding of natural science concepts. Research (Anggraini et al., 2023) Based Learning model has a high influence on students' critical thinking skills.

The weakness of this study is the use of the One Group Pretest Posttest design without using a control group. The number of samples used in this study is limited to one class so that the results cannot be generalized to a wider population.

Based on the background above, the hypothesis in this study consists of the null hypothesis (H_0) and the alternative hypothesis (Ha). The null hypothesis in this study is that there is no difference in the critical thinking skills of fifth grade students at Jeruk Purut II Elementary School before and after the implementation of Based Learning. While the alternative hypothesis is that there are differences in the critical thinking skills of fifth grade students at Jeruk Purut II Elementary School before and after the application of Based Learning.

Conclusion

In this study it can be concluded that there is an influence of the Based Learning model on critical thinking skills in science learning. Based on the results of the analysis of hypothesis testing paired samples t-test showed that there was an effect of the Based Learning Model on the critical thinking skills of grade V SDN Jeruk Purut II. And the Based Learning model can be said to be very influential on the critical thinking skills of fifth grade students at Jeruk Purut II Elementary School. This is shown by using Eta Squared which results is 0.880. Future research is expected to use the Two Grub Sample –Test design by using a control group and using a larger number of samples such as fifth grade students from several elementary schools.

Acknowledgments
The author would like to thank the principal and teacher of class V with science subjects at SDN Jeruk Purut II Gempol who assisted in carrying out the research that the author was conducting. The author also thanks those who helped in the smooth running of the research and writing of this article

Author Contributions
Conceptualization, Ellen Widy Yuliasandra; methodology, Ellen Widy Yuliasandra; validation, Fitria Wulandari; formal analysis, Ellen Widy Yuliasandra; investigation, Ellen Widy Yuliasandra; resources, Ellen Widy Yuliasandra; data curation, Ellen Widy Yuliasandra; writing-original draft preparation, Ellen Widy Yuliasandra; writing-review and editing, Ellen Widy Yuliasandra; visualization, Ellen Widy Yuliasandra; supervision, Fitria Wulandari; project administration, Fitria Wulandari; funding acquisition, Ellen Widy Yuliasandra. All authors have read and agreed to the published version of the manuscript.

Funding
This research was funded by Private Fund from author and received no external funding

Conflict of Interest.
The authors declare no conflict of interest.

References

Ahmadiah, N., Amin, B. D., & Sari, S. S. (2023). Development of Problem Based Learning Oriented Student Worksheets in Improving Students' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(2). https://doi.org/10.29303/jppipa.v9i2.2828

Alava, J. B. C., Vera, L. E. A., Tipán, V. F., & Pinargote, G. V. L. (2021). Problem-based learning as a methodological strategy in the teaching-learning process. *International Journal of Social Sciences and Humanities*, *5*(3). https://doi.org/10.53730/ijssh.v5n3.2028

Alberida, H., Sari, M., Razak, A., Syamsuriza, S., & Rahmi, Y. L. (2022). Problem Solving: A Learning Model to Foster Argumentation and Critical Thinking Ability for Students with Different Academic Abilities. *Jurnal Penelitian Pendidikan IPA*, *8*(3). https://doi.org/10.29303/jppipa.v8i3.1208

Anggraini, D., Yustina, Y., Daryanes, F., & Natalina, M. (2023). The Influence of Problem-Based Learning and Blended Learning on Students' Creative Thinking Ability in Class XI SMAN Plus Riau Province Material Body Defense System. *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1916–1921. https://doi.org/10.29303/JPPIPA.V9I4.1973

Aufa, M. N., Rusmansyah, R., Hasbie, M., Jaidie, A., & Yunita, A. (2021). The Effect of Using e-module

Model Problem Based Learning (PBL) Based on Wetland Environment on Critical Thinking Skills and Environmental Care Attitudes. *Jurnal Penelitian Pendidikan IPA*, *7*(3), 401–407. https://doi.org/10.29303/JPPIPA.V7I3.732

Bezanilla, M. J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domínguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity*, *33*. https://doi.org/10.1016/j.tsc.2019.100584

Fidan, M., & Tuncel, M. (2019). Integrating augmented reality into problem-based learning: The effects on learning achievement and attitude in physics education. *Computers and Education*, *142*. https://doi.org/10.1016/j.compedu.2019.103635

Firmadani, F., & Wulansari, A. (2020). *HOTS-Based Learning Model*. https://doi.org/10.4108/eai.12-10-2019.2292201

Hamiyati, H., Pada, A. U. T., Safrida, S., Khairil, K., & Artika, W. (2022). Application of Case Method Model Based on Character Values in Reproductive System Materials to Improve Critical Thinking and Conation skills. *Jurnal Penelitian Pendidikan IPA*, *8*(5). https://doi.org/10.29303/jppipa.v8i5.2045

Handayani, M., Puryatmi, H., & Hanafi, H. (2021). Peningkatan Keterampilan Berpikir Kritis melalui Model Problem Based Learning dalam Pembelajaran IPA di Sekolah Dasar. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(1), 548–555. https://doi.org/10.31004/edukatif.v4i1.1829

Kamala, I., Idayanti, Z., & Ulfah, T. T. (2022). Increasing Student Participation in Science Learning Through Problem Based Learning Models. *Jurnal Penelitian Pendidikan IPA*, *8*(4). https://doi.org/10.29303/jppipa.v8i4.1850

Lailaturrahmah, E., Tahir, M., & Rosyidah, A. N. K. (2020). Pengaruh Model Problem Based Learning (PBL) Terhadap Retensi dan Kemampuan Berpikir Kritis IPA Peserta Didik SD. *Jurnal Ilmiah Pendas: Primary Education Journal*, *1*(1), 1–11. https://doi.org/10.29303/pendas.v1i1.49

Liu, Y., & Pásztor, A. (2022). Effects of problem-based learning instructional intervention on critical thinking in higher education: A meta-analysis. *Thinking Skills and Creativity*, *45*. https://doi.org/10.1016/j.tsc.2022.101069

Lo, F. Y., Rey-Martí, A., & Botella-Carrubi, D. (2020). Research methods in business: Quantitative and qualitative comparative analysis. *Journal of Business Research*, *115*. https://doi.org/10.1016/j.jbusres.2020.05.003

Michie, M. (2019). Perbandingan Kurikulum 2013 Indonesia dengan Kurikulum Australia dengan Fokus pada Ilmu Pengetahuan Alam. *Jurnal Penelitian Pendidikan*, *19*(2). https://doi.org/10.17509/jpp.v19i2.19770

Montoya, M. S. R., Martínez, I. M. C., Sanabria-Z, J., & Miranda, J. (2022). Complex Thinking in the Framework of Education 4.0 and Open Innovation A Systematic Literature Review. *Journal of Open Innovation: Technology, Market, and Complexity*, *8*(1). https://doi.org/10.3390/joitmc8010004

Musianto, L. S. (2002). Perbedaan Pendekatan Kuantitatif Dengan Pendekatan Kualitatif Dalam Metode Penelitian. *Jurnal Manajemen Dan Wirausaha*, *4*(2). https://doi.org/10.9744/jmk.4.2.pp.123-136

Niyarci, N. (2022). Perkembangan Pendidikan Abad 21 Berdasarkan Teori Ki Hajar Dewantara. *Pedagogika: Jurnal Ilmu-Ilmu Kependidikan*, *2*(1). https://doi.org/10.57251/ped.v2i1.336

Nurlaelah, N. (2023). Problem-Based Learning Method for Improving the Learning Achievement of Students. *Edunesia: Jurnal Ilmiah Pendidikan*, *4*(2). https://doi.org/10.51276/edu.v4i2.330

Nurvitasari, N., Jaya, F., & Seituni, S. (2022). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Hasil Belajar Siswa. *Edusaintek: Jurnal Pendidikan, Sains Dan Teknologi*, *8*(2). https://doi.org/10.47668/edusaintek.v8i2.344

Prabasari, J. S., & Wahyuningsih, D. (2021). Development of Electronic Modules (E-Modules) Based on Problem Based Learning on Additives and Addictive Substances to Improve Students' Critical Thinking Ability. *Jurnal Penelitian Pendidikan IPA*, *7*(SpecialIssue). https://doi.org/10.29303/jppipa.v7iSpecialIssue.1233

Rahmadita, N., Mubarok, H., & Prahani, K. (2021). Profile of Problem-based Learning (PBL) Model Assisted by PhET to Improve Critical Thinking Skills of High School Students in Dynamic Electrical Materials. *Jurnal Penelitian Pendidikan IPA*, *7*(4), 617–624. https://doi.org/10.29303/JPPIPA.V7I4.799

Rahman, A., Khaeruddin, K., & Ristiana, E. (2020). Pengaruh Model PBL Terhadap Kemampuan Berpikir Kritis dan Pemahaman Konsep IPA Siswa Kelas V SDN 30 Sumpangbita. *Edumaspul: Jurnal Pendidikan*, *4*(1), 29–41. https://doi.org/10.33487/edumaspul.v4i1.201

Raj, T., Chauhan, P., Mehrotra, R., & Sharma, M. (2022). Importance of Critical Thinking in the Education. *World Journal of English Language*, *12*(3). https://doi.org/10.5430/wjel.v12n3p126

Sani, A. N. H., Mahmudah, S., & Muhammad, A. A. (2022). The Concept of Merdeka Belajar in Early

Childhood: Comparative Study of Reggio Emilia and Ki Hajar Dewantara's Thoughts. *JOYCED: Journal of Early Childhood Education*, *2*(2). https://doi.org/10.14421/joyced.2022.22-06

Seibert, S. A. (2021). Problem-based learning: A strategy to foster generation Z's critical thinking and perseverance. *Teaching and Learning in Nursing*, *16*(1). https://doi.org/10.1016/j.teln.2020.09.002

Setiati, N., & Jumadi, J. (2023). Development of E-Worksheet Problem Based Learning Model on Work and Energy to Improve Students' Physical Cognitive Abilities in Terms of Mathematical Representations and Verbal Representations. *Jurnal Penelitian Pendidikan IPA*, *9*(1). https://doi.org/10.29303/jppipa.v9i1.1757

Sugiarta, I. M., Mardana, I. B. P., Adiarta, A., & Artanayasa, W. (2019). Filsafat Pendidikan Ki Hajar Dewantara (Tokoh Timur). *Jurnal Filsafat Indonesia*, *2*(3). https://doi.org/10.23887/jfi.v2i3.22187

Sugiyono. (2021). Metode Penelitian Pendidikan (Kuantitatif, Kualitatif, Kombinasi, R&D dan Penelitian Tindakan). In *Metode Penelitian Pendidikan*.

Ulger, K. (2018). The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, *12*(1). https://doi.org/10.7771/1541-5015.1649

Utama, K. H., & Kristin, F. (2020). Meta-Analysis Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Kemampuan Berpikir Kritis IPA Di Sekolah Dasar. *Jurnal Basicedu*, *4*(4), 889–898. https://doi.org/10.31004/basicedu.v4i4.482

Utami, B., Probosari, R. M., Saputro, S., Ashadi, & Masykuri, M. (2019). Empowering critical thinking skills with problem solving in higher education. *Journal of Physics: Conference Series*, *1280*(3). https://doi.org/10.1088/1742-6596/1280/3/032047

Wicaksono, A. G., & Sayekti, I. C. (2020). Bagaimana perbandingan kurikulum 2013 dengan kurikulum Australia pada mata pelajaran IPA? *Natural: Jurnal Ilmiah Pendidikan IPA*, *7*(1), 21. https://doi.org/10.30738/natural.v7i1.8117

Xu, E., Wang, W., & Wang, Q. (2023). The effectiveness of collaborative problem solving in promoting students' critical thinking: A meta-analysis based on empirical literature. *Humanities and Social Sciences Communications*, *10*. https://doi.org/10.1057/s41599-023-01508-1

Yana, S., Yusrizal, Y., Halim, A., Syukri, M., & Elisa, E. (2022). Application of Problem Based Learning (PBL) Model to Improve Problem Solving Skill from Critical Thinking Skill Students on Dynamic Fluid Materials. *Jurnal Penelitian Pendidikan IPA*, *8*(2), 521–527. https://doi.org/10.29303/JPPIPA.V8I2.1329

Yulia, Z., & Salirawati, D. (2023). The Effect of Problem Based Learning on Students' Critical Thinking Ability and Scientific Attitude. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 4211–4217. https://doi.org/10.29303/JPPIPA.V9I6.3026

Zyphur, M. J., & Pierides, D. C. (2020). Statistics and Probability Have Always Been Value-Laden: An Historical Ontology of Quantitative Research Methods. *Journal of Business Ethics*, *167*(1). https://doi.org/10.1007/s10551-019-04187-8