



The Influence of the Implementation of the Integrated PBL (Problem Based Learning) Model with Differentiated Learning on Students' Critical Thinking Skills in Science Subjects

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Abstract: Based on the results of the pre-study, it is known that students' critical thinking skills are still not optimal. This is caused by the learning approach that has not been able to encourage the development of creativity and high-level thinking skills. To overcome this problem, the Problem Based Learning (PBL) approach combined with differentiated learning is offered as an innovative strategy to improve students' critical thinking skills. This study uses a quantitative approach with an experimental method. The design applied is Pre-Experimental with the form of One-Group Pretest-Posttest. The subjects of the study were fifth grade students of Elementary School 47/IV Jambi City. The critical thinking ability measurement instrument has been validated through expert judgment and limited trials. The indicators measured include the ability to identify problems, analyze arguments, evaluate information, draw logical conclusions, and make rational decisions. The results of the study showed a significant increase in critical thinking skills after the implementation of learning. The average pretest score of 53.23 increased to 75.32 in the posttest, which shows that the approach applied has a positive influence on the development of students' critical thinking skills. The integration of PBL with differentiated learning is not only able to encourage the improvement of critical thinking skills, but also provides space for individual learning needs, as well as increasing students' active involvement in the learning process. Theoretically, this study strengthens the relevance of constructivism theory in elementary education. Practically, the results of this study provide alternative effective and adaptive learning strategies for teachers in developing critical thinking skills in heterogeneous classes.

Keywords: Problem Based Learning, Science, Critical Thinking.

Introduction

The era of globalization always prioritizes the development of science and technology. There are so many technological developments that replace the role of humans. Technology is like a double-edged sword that is equally sharp. On the one hand, technology can facilitate human activities, but on the other hand,

technology will replace the role of humans. The development of new technology that has been massively developed is Artificial Intelligence (AI). AI has extraordinary capabilities in processing data and transforming it into the form of information needed by humans (Labobar, 2024).

Currently, we as humans cannot avoid the rapid development of technology. It is undeniable that humans are now dependent on AI. This causes critical

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thinking skills to decline. Humans become very passive towards science and information. In fact, AI is just a computer program designed to imitate human intelligence (Labobar, 2024). Humans still really need critical thinking skills to be able to analyze, make decisions, interact, evaluate, conclude, and synthesize events that cannot be done by, (Indriani et al., 2024) by AI (Indrayani, , 2024). Although AI technology is developing rapidly, critical thinking skills must still be possessed and developed by each individual to respond to problems in life. A person who thinks critically will be able to change and adjust their way of thinking according to reasoning about a condition.

Critical thinking skills are a crucial competency for humans in general and in the context of education it is very important for students to have, but in reality this is not in accordance with expectations. The critical thinking skills of students in Indonesia are still relatively low. This can be seen from data based on the four-year study of the International Trends in International Mathematics and Science Study (TIMSS) that Indonesian students are still at a low level in terms of critical thinking skills (Syafitri et al., 2021). Strengthened by the results of the 2018 Programme for International Student Assessment (PISA) survey published in 2019 in the science performance category, Indonesia is ranked 71st, with an average score of 396, down from 62nd (Syafitri et al., 2021). This shows that the critical reasoning ability of Indonesian children is still very low compared to children in other countries, especially in the field of science.

The 21st century requires the role of critical thinking skills. Critical thinking is part of the 6C competencies (Critical Thinking, Creative, Collaborative, Communicative, Citizenship, and Character) that students must have. Critical thinking is an important ability in the student learning process, where in 21st century learning not only cognitive abilities are prioritized, but also prioritize students' abilities in the process of developing character (Sulistyaningrum et al., 2019). So critical thinking competency is very important to be developed in the world of education to shape students' character so that they face global challenges.

In the context of education, students' critical thinking skills can be developed in the classroom by stimulating and facilitating students with problem-based learning. Critical thinking itself is a competency that involves students to connect information logically, analyze, and evaluate to make good decisions (Sri Nopiani et al., 2023). Learning activities that can facilitate students to be able to connect information logically to solve problems are the PBL (Problem Based Learning) learning model. The PBL learning model

opens up opportunities for students to solve real problems related to everyday life, so that it can stimulate analytical and evaluation skills for problems. PBL places students in situations where they must investigate factual problems and develop solutions, PBL encourages students to think critically in solving problems (Affandy et al., 2024).

In addition to using the PBL learning model, teachers can use a differentiated approach to facilitate diverse students. The diversity of students in terms of abilities, interests, and learning styles is often not facilitated properly by teachers in the learning process. This causes students who have different learning needs to be less motivated to participate and play an active role in learning. To overcome challenges like this, differentiated learning can be used as an approach to facilitate students' needs in learning. Differentiated learning can increase student engagement and help students achieve their maximum potential in developing critical thinking competencies (Siswani, Sudirman & Angga, 2024).

The integration of the PBL model with differentiated learning is one solution to overcome the problem of low critical thinking skills of students. This model not only allows students to learn through problem solving, but also provides opportunities for each student to get learning that suits their abilities, interests, and learning styles. This is in line with Vygotsky's Sociocultural Theory view on the Zone of Proximal Development which states that effective learning must be at a level slightly higher than the student's actual abilities (Lai, 2023).

Previous research shows that the application of the PBL model can improve students' critical thinking skills. Research conducted by Arviani et al., (2023) found that students who learn using the PBL model have better levels of critical thinking compared to students who learn with a conventional approach. Meanwhile, research by Onyishi & Sefotho, (2020) confirms that differentiated learning has a positive influence on students' motivation and learning outcomes. However, the integration between PBL and differentiated learning in the context of science learning in elementary schools is still rarely studied. Previous research has focused more on the application of one of the two approaches. In fact, this integration is believed to have a more significant influence on students' critical thinking skills. Therefore, this study is very relevant to be carried out. On the other hand, interdisciplinary science learning requires an approach that encourages students to think comprehensively and critically. Through the PBL model, students will be presented with problems that require integration between science and social concepts. Through this approach, students can understand the

concept in depth and are also able to implement it in everyday life (Jumhur et al., 2024).

In addition, differentiated learning provides additional benefits by considering student diversity. Students of SDN 47/IV Jambi City are known to have varying ability backgrounds, differentiated learning is an appropriate approach to increase student engagement in science learning. This integration is expected to help students learn more actively so that they are able to develop critical thinking skills more optimally.

The implementation of the PBL learning model integrated with differentiated learning is also in line with education policies in Indonesia that prioritize the student-centered learning approach as stated in the Merdeka Curriculum. This curriculum emphasizes the importance of developing student competencies, including critical thinking skills, collaboration, and independence in learning (Kemendikbud, 2022). In addition to supporting national education policies, this study also contributes to teachers in planning innovative and effective learning strategies. Teachers can understand how to integrate PBL and differentiated learning to create more meaningful learning for students. Thus, this study not only provides theoretical benefits, but also provides practical benefits that can be directly applied in classroom learning.

Method

The research method used in this study is an experimental research method. The type of research used is Pre-experimental design in the form of a one group pretest-posttest design. This research was conducted at SD Negeri 47/IV Jambi City. VE research as an experimental class. The time of the research was carried out during active school hours, namely in the even semester of the 2024/2025 school year which began in January 2025. The population in this study were grade V students of SD Negeri 47/IV Jambi City in the even semester of the 2024/2025 school year consisting of 5 study groups. The total number of grade V students is 167 students.

The sample in this study consisted of an experimental class of 28 VE class students taken from a portion of the population of 167 students. The data collection techniques used were observation and test techniques.

Data analysis techniques in this study include analysis of critical thinking skills. The collected data is presented in a frequency distribution table to facilitate further data calculation and processing. Before conducting the analysis, the researcher first validated the instrument to ensure that the instrument used can

truly measure critical thinking skills accurately. Instrument validation was carried out through expert judgment and continued with a limited trial to determine the reliability and validity of the instrument construct.

The critical thinking skills measured in this study include several indicators, including: (1) the ability to identify problems, (2) the ability to analyze arguments, (3) the ability to evaluate evidence and sources of information, (4) the ability to draw logical conclusions, and (5) the ability to make decisions based on rational reasons.

Next, the researcher checked the validity of the sample by conducting normality tests and homogeneity tests to ensure that the data met the assumptions in the statistical processing used.

Results and Discussion

The Problem Based Learning (PBL) learning model integrated with differentiated learning was applied in class V of SD Negeri 47/IV Jambi City, consisting of 28 students. The learning process took place over three meetings, with each meeting lasting 3 x 35 minutes. Before the learning activity began, students were given a pretest containing questions to measure critical thinking skills. Student activities while working on the pretest can be observed in Figure 1.



Figure 1. Critical Thinking Skills Pretest Activity

When working on the pretest, students are not allowed to open books, notes, or ask friends. This provision aims to ensure that the pretest results truly reflect the initial knowledge possessed by students. Data from this pretest is also used as a basis for assessing the development of students' creative thinking skills after participating in learning.

The learning process applies the Problem Based Learning (PBL) model integrated with differentiated learning. This model consists of five stages, namely: (1) the problem orientation stage, (2) the student organization stage, (3) the group investigation guidance stage, where at this stage the process differentiation strategy is applied which is adjusted to the students'

learning styles, such as visual, auditory, and kinesthetic, (4) the development and presentation stage of the work results, and (5) the analysis and evaluation stage of the problem solving process. At the beginning of the learning, the teacher conveys the learning objectives, then the students carry out literacy activities by reading texts from books. After that, the students discuss and the teacher asks essential questions that are relevant to the learning material.

At the problem orientation stage, the teacher presents the problem in the form of a short story, then asks students questions related to the observed problem. Presenting problems related to everyday life aims to train students to think more critically. Through this approach, students are expected to be able to identify problems, analyze situations, and find innovative solutions, so that their critical thinking skills can develop optimally. An example of student activity at the problem orientation stage can be seen in Figure 2.

At the stage of organizing students, they are invited to discuss together in solving the problems given. The teacher forms groups based on the students' learning styles, namely visual, auditory, and kinesthetic. After that, the teacher distributes the Student Worksheets (LKPD) to each student. An example of activities in this stage can be seen in Figure 2.



Figure 2. Stage of Organizing Students

At the stage of guiding group investigations with the process differentiation strategy, the teacher guides students in investigating the problems given. Students are given the freedom to carry out learning activities according to their respective learning styles. Students with a visual learning style obtain information through images and videos, students with an auditory learning style understand the material through explanations from the teacher, while students with a kinesthetic learning style seek information from article clippings posted in the classroom. An example of activities at this stage can be seen in Figure 3.

At the stage of developing and presenting the results of the work, after completing the investigation, the teacher asks students to answer questions that have been provided in the Student Worksheet (LKPD). An

example of activities in this stage can be seen in Figure 4.



Figure 3. Stage of Guiding Group Investigation



Figure 4. The activity stage is developing and presenting the results of the work.

After conducting the investigation, the students were asked by the teacher to summarize the results of their research as a conclusion. Then, they presented the results of the discussion. One form of activity in the analysis and evaluation stage of problem solving can be seen in Figure 5.

After the learning is completed, students take a posttest in the form of 10 essay questions to measure their critical thinking skills. The questions used in the posttest are the same as the pretest, with the aim of seeing an increase or decrease in students' critical thinking skills. The process of completing the posttest by students can be seen in Figure 6.



Figure 5. Analyze and Evaluate Stage of Problem Solving Process



Figure 6. Critical Thinking Skills Posttest Activity

Critical thinking ability data includes the results of the pretest and posttest given to grade V students of SD Negeri 47/IV Jambi City. The evaluation instrument used in both tests consisted of 10 essay questions that reflect critical thinking indicators. The pretest was given to 28 grade V students of SD Negeri 47/IV Jambi City. After the pretest data was collected, an analysis was conducted to determine the maximum and minimum scores obtained by students, as well as to calculate the average (mean) and standard deviation scores.

The results of the pretest analysis showed that the average score was 53.23 with a standard deviation of 10.046. The lowest score obtained by students was 35, while the highest score reached 75. The instrument used in the posttest was the same as the pretest in order to accurately measure whether there was an increase in critical thinking skills after students received treatment. The results of the posttest analysis showed that the average score increased to 75.32 with a standard deviation of 10.242. The lowest score obtained by students was 55, while the highest score reached 95.

Table 1. Pretest and Posttest Result Data

	N	Minimum	Maximum	Mean	Std
Pretest	28	35	75	53.23	10.046
Posttest	28	55	95	75.32	10.242

The research data were analyzed through normality tests and hypothesis tests. The normality test aims to determine whether the data used is normally distributed or not. The results of the normality test show that the significance value (Sig.) Of 0.80 is greater than 0.05 ($0.80 \geq 0.05$), so that the pretest data has a normal distribution. The normality test was carried out using the Liliefors method, where the probability value (Sig.) Is compared with the significance level (α) of 0.05. With these results, the pretest data meets the requirements for conducting a hypothesis test that assumes a normal distribution.

Hypothesis testing was conducted to answer the problem formulation in this study. The method used was the paired sample T-test with the help of SPSS at a

significance level of 5%. The test results showed that the t-test value for creative thinking ability was 15.304 with a probability of 0.000. Because the probability value (Sig.) 0.000 is less than 0.05 ($0.000 \leq 0.05$), H_0 is rejected and H_a is accepted. This indicates that the Problem Based Learning (PBL) model integrated with differentiated learning has a significant influence on students' critical thinking skills.

Thus, it can be concluded that the implementation of the Problem Based Learning (PBL) model integrated with differentiated learning has an effect on improving students' critical thinking skills. This study aims to describe the effect of the PBL model integrated with differentiated learning on students' critical thinking skills in the subject of science for grade V at SD Negeri 47/IV Jambi City. To answer this research problem, several stages were carried out, starting from pre-research, instrument creation, validity and reliability testing, treatment, and normality testing and hypothesis testing.

In this study, critical thinking skills were measured through essay questions arranged based on critical thinking indicators and consisting of 10 questions. The questions were tested at the pretest and posttest stages. The pretest results showed an average score of 53.23, while the posttest showed an increase with an average score of 75.32. This increase occurred because during the pretest, students had not received treatment, while in the posttest they had followed the learning process applied. Thus, it can be concluded that there is a significant difference between before and after the treatment. This is in line with previous research which states that the application of differentiated learning with Problem Based Learning (PBL) can improve students' mathematical creativity.

Problem Based Learning (PBL) Model integrated with differentiated learning consists of several stages in its implementation, namely: problem orientation, organizing students, guiding group investigations with process differentiation strategies, developing and presenting work results, and analyzing and evaluating the problem solving process (Janmariando et al., 2023). Problem Based Learning (PBL) is a learning model that involves students to think critically and skillfully in solving a problem. The level of success of Problem Based Learning depends on the activeness of the students.

At the problem orientation stage, students are introduced to a problem through a short story, then the teacher asks questions related to the problem. Presenting problems that are relevant to everyday life aims to train students' creative thinking skills. PBL can be an alternative to improve the quality of learning (Sari & Rosidah, 2023). Next, at the stage of organizing students,

they are involved in group discussions to find solutions to the problems given.

Critical thinking is the process of identifying various assumptions by integrating previous knowledge to obtain relevant information. This process allows one to generalize mathematical situations reflectively, including problem solving, formulating conclusions, analyzing possibilities, and making decisions (Kusumawati et al., 2022). This process encourages students to be more active in classroom learning. After that, the teacher divides students into groups based on their respective learning style preferences and distributes Student Worksheets (LKPD) as a learning guide.

At the stage of guiding group investigations with process differentiation strategies, researchers apply process differentiation by compiling LKPD designed according to students' learning styles. In differentiated learning, the concept of process differentiation emphasizes the interaction of students with learning materials, so that they can find the most effective way to learn. In differentiated learning methods, the learning process is designed to increase students' motivation and readiness to learn. With increased motivation and readiness, students' creative thinking skills will also develop (Astria & Kusuma, 2023).

At this stage, the teacher gives directions to students to collect information that will help them understand and find solutions to the problems given. Students are given the freedom to adjust learning activities according to their learning style. For example, students with a visual learning style understand information through pictures and videos, auditory learning styles understand information through teacher explanations, while kinesthetic learning styles obtain information by reading article excerpts posted in the classroom. The presentation of varied learning resources helps students choose the learning method that best suits their needs. At the stage of developing and presenting the results of the work, students are asked to answer questions that have been prepared by the teacher in the LKPD. This stage aims to encourage students to build their own understanding, so that they can develop their thinking skills.

Students' critical thinking skills are reflected in the process of exploring new ideas, such as expressing different opinions from their group mates when presenting discussion results. In addition, students show courage by asking questions about things they do not yet understand. Critical thinking as an intelligent disciplined process of active and skilled conceptualization, application, analysis, synthesis, and evaluation gathered from, or produced by, observation, experience, reflection, reasoning, or communication

(Syafitri et al., 2021). This process reflects how students develop creative ideas and dig deeper into information, which is an important aspect of creative thinking skills.

At the stage of analyzing and evaluating the problem-solving process, the teacher asks students to write conclusions and present the results of their discussions. The ability of students to explain and conclude trains them to think fluently and in detail, which is one indicator of critical thinking. Students who have diverse abilities and potentials, make teachers have to be creative and apply appropriate learning strategies (Dhamayanti, 2022). Through this stage, students have the opportunity to improve communication skills, express opinions, and argue in learning. The critical thinking process that takes place during learning helps them face complex challenges and find innovative solutions, so that they become more independent and skilled in problem solving.

In addition, critical thinking skills also develop through activities to convey problem-solving results, both in writing and orally. During the learning process, students show enthusiasm and activeness in participating in the activities provided, thanks to the application of the right learning model. The Problem Based Learning (PBL) learning model helps teachers create a learning environment that begins with problems that are important and relevant to students, allowing them to gain a deeper learning experience (Suswati, 2021). The Problem Based Learning (PBL) model integrated with differentiated learning allows students to learn directly by facing problems that are in accordance with real situations in everyday life. This model is designed to improve students' critical thinking skills, as evidenced by the difference in values before and after treatment.

The results of the hypothesis test using the paired sample T-test showed that the significance value was 0.000, which was smaller than 0.05, and was reinforced by the results of the posttest which were higher than the pretest. Based on these results, H_a was accepted, which means that there is a significant influence of the implementation of Problem Based Learning (PBL) integrated with differentiated learning on students' critical thinking skills in the subject of science for grade V of SD Negeri 47/IV Jambi City.

The application of this model has a positive impact on the learning process, in line with research conducted by Fitria Novita Sarie, which states that Problem Based Learning (PBL) is very effective in supporting differentiated learning (Sarie, 2022). Based on this explanation, it can be concluded that the Problem Based Learning (PBL) learning model integrated with differentiated learning has a positive impact on students' creative thinking skills. Through the application of PBL,

students are trained to face and solve various problems based on their own experiences.

The success of this learning model is also supported by differentiated learning, which helps students understand the material more effectively, so that learning objectives can be achieved optimally. Thus, the implementation of Problem Based Learning (PBL) integrated with differentiated learning not only improves students' critical thinking skills, but also ensures that each individual can understand the material according to their needs and potential. In addition, this model creates a more interactive, enjoyable, and productive learning environment.

Conclusion

Based on the results of data analysis, hypothesis testing, and discussion in this study, it can be concluded that the Problem Based Learning (PBL) learning model integrated with differentiated learning has an effect on students' creative thinking skills in the subject of science class IV SDN 47/Jambi City. The application of this model shows an increase in creative thinking skills, with an average pretest score of 53.23 and a posttest increase to 75.32.

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The research team contributed to the writing of this scientific paper, namely: idea, conception, data collection, analysis and interpretation of results, drafting the manuscript, DP; Supervision of article writing, ZKP, and JJ; Funding, acquisition, DP, and ANS.

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