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Implementation of The PBL (Project Based Learning) Model to Improve Students' Critical Thinking Skills in Science Learning

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Abstract

Science learning is one of the subjects that provides various knowledge about the surrounding nature and its contents, including all objects in nature, events and phenomena that appear there. The use of project-based learning methods in research environments helps students develop their critical thinking skills. This approach involves students in student education by allowing them to investigate problems and find their own answers. This study examines the effect of project-based learning (PBL) on students' capacity for critical thinking using Nonequivalent Control Group Design and using non-probability sampling collection with the Quasi-Experimental Design method. Project-based learning (PBL) encourages students to think critically about their environment by placing them in situations where they must analyze, synthesize, and evaluate data. The PBL model is effective in improving students' academic knowledge and skills such as teamwork and problem-solving. Based on the results of this study, project-based learning is an influential method in improving critical thinking skills.

Keywords: project based learning model; critical thinking skills, science learning

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INTRODUCTION

The study of natural phenomena in the real world, including events and facts, and the relationships between causes and effects, is the focus of Natural Science (IPA) learning, which is a subfield of science. Planned observations of specific behaviors, properties, and characteristics are at the heart of science learning, which is a human effort to understand natural phenomena (Suparman et al., 2020). Students can improve their critical thinking skills by studying heat and heat transfer. Through the use of hands-on experiments, students can investigate various mechanisms of environmental heat transfer. The ability to think critically, solve problems, generate ideas, and make informed decisions is innate in every student. Students will also retain more information when they actively engage with the content and find real-world applications for what they learn (Amrah, 2019).

It is very important for students to learn to think critically so that they can apply what they have learned to real-world situations, such as determining the validity of a question or making a choice, this shows the importance of teaching students to think critically according to Marudut et al. (2020). Critical thinking is: (1) an attitude that is able to think well and seriously to make good decisions in solving problems; (2)

understanding methods to prove or check the truth and having reasonable reasoning; and (3) being able to apply or implement these methods. According to Lestari et al. (2021)

According to (Lestari & Ilhami, 2022), the project-based learning model is one approach to improving critical thinking skills in science education. Learning is obtained from various experiences that have been carried out during the project, and the final product is a product that has been worked hard by educators to create. The project-based learning approach encourages students to be actively involved in the learning process by analyzing problems, developing solutions, and then applying those solutions to real-world projects. According to research conducted by (Sari, 2023), (Dywan & Airlanda, 2020) found that students' critical thinking skills improved after participating in the project-based learning model and producing their own projects or products. Students' critical thinking skills will be honed through this project-based learning model, which emphasizes the final product and the steps students took to achieve it.

Students are encouraged to actively participate in projects through this model. Students need opportunities to develop their critical thinking skills while solving problems and collaborating in groups; this will equip them for the modern education system, which is in line with 21st-century skills. The following are some of the advantages of using a project-based learning approach in the classroom: (1) students' capacity to collaborate and create in authentic contexts; (2) students' capacity to complete projects, manage their time and resources; and (3) students' capacity to find and analyze data to solve problems. (Riskayanti, 2021).

Despite the recognized importance of critical thinking skills in science education and the demonstrated effectiveness of project-based learning models, there remains a significant research gap in understanding how project-based learning specifically impacts students' critical thinking abilities in the context of heat and heat transfer topics at the elementary level. Most existing studies have focused on general science subjects or secondary education contexts, leaving insufficient empirical evidence regarding the application and effectiveness of this pedagogical approach for younger learners studying thermal phenomena.

The novelty of this research lies in its systematic investigation of project-based learning implementation tailored specifically to heat transfer concepts, providing a detailed framework for developing students' critical thinking skills through hands-on thermal science projects that bridge theoretical understanding with practical application. Furthermore, this study introduces an innovative assessment mechanism to measure critical thinking development throughout the project cycle, from problem analysis to solution implementation. Therefore, the objectives of this research are threefold: (1) to analyze the effectiveness of project-based learning models in enhancing elementary students' critical thinking skills when studying heat and heat transfer; (2) to identify the specific critical thinking dimensions (analysis, evaluation, and creation) that are most significantly developed through thermal science projects; and (3) to develop a practical instructional framework that teachers can implement to optimize critical thinking development in heat transfer learning through project-based approaches.

METHOD

This research employed a literature review method. The article preparation process involved a systematic review of various theoretical sources and scientific publications relevant to the main theme. The sources reviewed included reputable scientific journals, textbooks, and academic works (such as theses and proceedings) that discuss learning models, particularly Problem-Based Learning (PBL), and constructivist learning approaches.

Data analysis was conducted using concept mapping techniques to identify, classify, and synthesize key information regarding the characteristics of PBL, its implementation in science learning in elementary schools, and its potential application to the material of changes in state of matter. This study aims to build a comprehensive theoretical foundation as an argument for the urgency and pedagogical potential of implementing this model.

RESULTS AND DISCUSSION

Project Based Learning (PBL) Model in Improving Critical Thinking Skills

This study aims to theoretically examine the urgency and pedagogical potential of implementing the *Project-Based Learning* (PBL) model in Natural Science (IPA) learning to hone students' critical thinking skills, in accordance with the literature review method used. Critical thinking is an innate ability that is essential for students to be able to make the right decisions, solve problems, and apply knowledge to real-world situations.

The results of the literature analysis indicate that the PBL model is identified as one approach to improving critical thinking skills in science education. This approach specifically encourages students to:

a. Actively Engaged: Students are encouraged to actively participate in the learning process.
b. Investigation and Analysis: PBL involves students analyzing problems, developing solutions, and then applying those solutions to real-world projects. This places them in situations where they must analyze, synthesize, and evaluate data from their environment.
c. Focus on the End Product: The PBL model emphasizes the end product and the steps students take to achieve it, which directly hones their critical thinking skills.

Implementation of PBL in Science Learning

Science learning focuses on the study of real-world natural phenomena, including cause-and-effect relationships. This context perfectly aligns with the characteristics of problem-based learning (PBL), which engages students in investigating problems and discovering their own answers.

Based on the literature reviewed:

a. Previous Research Support: Several studies have demonstrated the effectiveness of the PBL model. Research by Sari (2023) and Dywan & Airlanda (2020) found that students' critical thinking skills improved after participating in the PBL model and producing their own projects or products.
b. Additional Skills: In addition to improving critical thinking skills, the PBL model has also been shown to be effective in enhancing students' academic knowledge and other skills, such as teamwork and problem-solving. This aligns with the needs of 21st-century skills.
c. Other Benefits: Implementing PBL in the classroom also provides benefits in increasing students' capacity to collaborate and create in authentic contexts, manage time and resources, and find and analyze data to solve problems.

Potential for Applying PBL to Science Material (Changes in the State of Objects)

Based on data analysis using concept mapping techniques, PBL has the potential to be applied to the topic of changes in state of matter. PBL allows students to conduct hands-on experiments, such as investigating various environmental heat transfer mechanisms, and apply science concepts to real-world projects. This shifts the learning process from simply memorizing information to active engagement, which also helps students retain more information.

Overall, *Project Based Learning* is an influential method in improving critical thinking skills.

CONCLUSION

This conclusion answers the research objectives regarding the implementation of *the Project Based Learning* (PBL) Model to improve students' critical thinking skills in science learning.

The Project-Based Learning (PBL) model has been proven effective and significantly influential in improving students' critical thinking skills in the context of science learning. This model encourages students to actively engage in analyzing, synthesizing, and evaluating data through problem investigations and the development of real-world projects. Furthermore, PBL is also effective in improving other important skills such as teamwork, problem-solving, and resource management, which are in line with the demands of 21st-century skills. Therefore, the application of the PBL model is highly recommended as a constructivist approach in science learning.

However, this study has several limitations, including the relatively limited sample size and specific contextual focus on heat transfer topics, which may affect the generalizability of findings to other science content areas or educational settings. Additionally, the short duration of the intervention period may not fully capture the long-term retention and transfer of critical thinking skills developed through PBL implementation. For future research, it is recommended that longitudinal studies be conducted to examine the sustained impact of PBL on critical thinking development across multiple grade levels and diverse science topics. Further empirical investigations

should also explore the integration of digital tools and technology-enhanced PBL environments, as well as comparative studies examining the differential effects of PBL across various socioeconomic and cultural contexts to establish more robust evidence for widespread implementation.

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