Indonesian Journal of Educational Innovation (IJEI)
Volume 1, Issue, August 2025
Pages: 61-65

ISSN : 3109-0176
E-ISSN : 3109-0168

The Influence of The Project-Based Learning Model on Students' Creativity and Understanding of Science Concepts

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Article Info

Article History
Received: June 3, 2025
Revised: June 10, 2025
Accepted: June 30, 2025
Published: August 31, 2025

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Abstract

The importance of Project-Based Learning (PjBL) in learning lies in its ability to increase student engagement, develop various important skills, and make learning more meaningful. This study aims to investigate the effect of the Project-Based Learning (PjBL) model on the creativity and understanding of physics concepts among grade XI students. Involving 35 students studying Temperature and Heat material, this study used a one-group pretest-posttest design. Data were collected through a concept understanding test and a creativity questionnaire covering indicators of fluency, originality, flexibility, and elaboration. The results showed that the average value of concept understanding increased from 65 in the pretest to 82 in the posttest. Additionally, the creativity questionnaire revealed a significant increase in all aspects, with the average total creativity score rising from 70.5 to 85.5. These findings indicate that the implementation of the PjBL model not only improves students' concept understanding but also encourages their creativity. Therefore, the PjBL model is recommended as an effective method for enhancing student engagement and improving learning outcomes in physics education.

Keywords: Project-based learning; creativity; conceptual understanding; science.

INTRODUCTION

Learning involves engaging in a process of interaction between students, educators, and learning resources in a learning environment. Learning is also facilitated by educators, enabling the process of acquiring knowledge, mastering skills, forming attitudes, and building trust in students (Samadun et al., 2023). It is interpreted as a process of behavioural change resulting from the interaction of individuals with their environment, involving planning, implementation, and evaluation stages (Warburton, 2003). In the 21st century, learning is not only expected to transfer knowledge, but also to develop students' creativity, problem-solving skills, and critical thinking, preparing them for global challenges (Lestari & Ilhami, 2022). Education should equip students with a mastery of content and the ability to collaborate, monitor learning strategies, and critically and creatively achieve learning outcomes (Dinantika, 2019, pp. 73-80). Creativity is thus viewed as a key aspect of individual well-being (Cropley et al., 2010) and becomes vital in supporting students' success in mastering material.

Creativity and conceptual understanding are closely linked. Students with higher creativity tend to find it easier to associate new ideas with prior knowledge, which deepens their understanding (Yulaikah et al., 2022). On the other hand, low levels of student creativity often stem from confusion in developing imagination and fear of being wrong (Betaubun et al., 2018). According to Torrance, creativity involves identifying problems, formulating hypotheses, and testing solutions (Asmawati, 2017). Nevertheless, in many cases, students tend to only imitate examples without truly understanding the concepts (Richardson & Mishra, 2018). This results in weak conceptual understanding, which is foundational in science learning—particularly physics—because it supports higher-order thinking and future learning (Verawati et al., 2020; Aledya, 2019). Conceptual understanding does not merely mean remembering; it includes classification, giving examples, comparison, and differentiation of concepts (Busyairi & Verawati, 2022).

Despite the demands of 21st-century learning, problems persist in the classroom. Many students continue to struggle with understanding the material, particularly in science subjects (Utomo, 2023). These difficulties are exacerbated by the lack of adequate teaching facilities and suitable learning media that can help them comprehend abstract scientific content (Ginting, 2024). Monotonous teaching methods hinder creativity and reduce engagement (Taliak et al., 2024), while limited teacher-student interaction narrows opportunities for deeper exploration (Ayub et al., 2021). Teaching that is centred more on explanation rather than student understanding makes it hard for students to relate concepts to real-world applications (Primadoni & Muslim, 2023). Moreover, a lack of student involvement, feedback, and varied instructional approaches results in decreased motivation and learning outcomes (Yulaikah et al., 2022). Students often find lessons difficult and uninteresting, which can lead to disinterest and fear (Suarjana et al., 2018), negatively affecting their conceptual mastery and creativity.

To address these issues, many researchers have recommended the use of engaged learning models such as Project-Based Learning (PjBL). PjBL facilitates creativity and improves conceptual understanding by encouraging students to work on meaningful projects (Doyan et al., 2023). The George Lucas Educational Foundation outlines six steps of the PjBL model, beginning with a broad question, planning a project, establishing a timeline, and overseeing progress, followed by assessing the outcome and evaluating the learning experience (Salman et al., 2017). This is supported by Wena (2016), who notes that PjBL encompasses problem identification, process design, information management, evaluation, and the creation of a final product. According to Kemendikbud (2013), a structured implementation of PjBL—from project planning to final evaluation—can enhance the quality of learning. Maysyaroh and Dwikoranto (2021:44-53) found that PjBL enables students to engage in various learning methods and design-based activities that strengthen their understanding. Similarly, Utami (2018) emphasised that the structured stages in PjBL help students take responsibility for their learning and creativity.

Based on this state-of-the-art approach, this study offers novelty in combining creativity development and conceptual understanding enhancement through the application of Project-Based Learning in science education. The purpose of this analysis is to examine the effectiveness of PjBL in enhancing both creativity and conceptual understanding among students, particularly in learning scientific material that is typically abstract and challenging to grasp.

MATERIALS AND METHODS

Time and Place

This research was conducted at SMAN 4 Mataram from April to May. The objective of this analysis is to assess the impact of the PjBL model on enhancing students' creativity and conceptual understanding.

Research Design

The study utilised a quasi-experimental approach. A quasi-experiment is a research approach that resembles an actual experiment but does not involve random assignment of subjects to groups (Abraham & Supriyati, 2022). This method allows the researcher to investigate the effects of an educational intervention within more practical and realistic school settings. This study adopted a one-group pretest-posttest design. Students were given:

- A pretest on conceptual understanding before the treatment.
- A posttest after the implementation of the PjBL model to assess any changes in understanding.
- A creativity questionnaire was administered post-intervention to measure students' creative development.

The PjBL was applied through the following stages (Salman et al., 2017):

1. Determining,
2. Structuring the project plan,
3. Establishing a project timeline,
4. Tracking student and project development,
5. Measuring results,
6. Reviewing the overall learning experience.

Population and Sample

The population of this study consisted of students from Class XI at SMAN 4 Mataram. The sampling method employed was purposive sampling, a method in which participants are chosen according to particular criteria relevant to the research objectives (Lenaini, 2021). This technique enables the researcher to select a class that best aligns with the research design and objectives.

Research Variables

The variables in this study comprise:

- Independent Variable: The use of the Project-Based Learning (PjBL) model.
- Dependent Variables: Students' creativity and conceptual understanding, which serve as the primary focus for measurement and evaluation in the research.

Instrument

The instruments used in data collection were a creativity questionnaire to assess students' creative thinking skills. These tools were designed to capture accurate data reflecting changes in students' abilities before and after the PjBL intervention.

Research Procedure

The implementation procedure of this study was divided into three main stages:

- Preparation Stage: The researcher designed instruments and gathered materials.
- Planning Stage: Preparation of lesson plans based on the PjBL model and scheduling the learning activities.
- Completion Stage: Conducting data collection, analyzing results, and preparing the final research report.

Data Analysis Techniques

The data were analysed using the following statistical procedures:

- Normality Test: To check if the data conformed to a normal distribution.
- Homogeneity Test: To check the uniformity of variance between data groups.
- Hypothesis Testing (t-test): To compare the pretest and posttest results for both conceptual understandings. The maximum average value of the final student creativity score is obtained by dividing the total score by the maximum score.
- Hypothesis Testing (t-test): To compare the pretest and posttest results for both conceptual understandings. The maximum average value of the final student creativity score is obtained by dividing the total score by the maximum score.

The use of the t-test helped determine whether the improvements observed in students' performance after applying the PjBL model were statistically significant.

RESULTS AND DISCUSSION

Result

The implementation of the PjBL model is designed to increase student interaction with learning materials and encourage them to participate actively in the learning process. Data obtained from the pretest and posttest, as well as the creativity questionnaire, offer a vivid representation of the positive impact of this method. The findings of this study suggest that the use of the PjBL model has a significant impact on students' creativity and comprehension of physics concepts. This study involved 35 grade XI students who learned about Temperature and Heat material. Data obtained from the pretest and posttest, as well as the creativity questionnaire, are presented in the following table:

Table 1. Results of Pretest and Posttest Concept Understanding

Category	Pretest	Posttest
Average	65	82
Number of Students	35	35

The table above shows that the average score of students' conceptual understanding increased from 65 (pretest) to 82 (posttest). This 17-point increase indicates significant progress in students' understanding of physics concepts after the implementation of the PjBL model.

Table 2. Creativity Questionnaire Results

Category	Before	After
Fluency	68	84
Originality	70	86
Flexibility	69	85
Elaboration	71	87
Total	70.5	85.5

The questionnaire results show that the average value for all indicators has increased significantly. The increase in fluency from 68 to 84, originality from 70 to 86, flexibility from 69 to 85, and elaboration from 71 to 87 indicates that students are more creative and actively participate during the learning process. To obtain the maximum average score of the final value of student creativity, the total score is divided by the maximum score, resulting in a value of 85.5, as shown in Table 2.1, which displays the questionnaire response criteria.

Table 3. Questionnaire Criteria

Skor	Criteria
85% - 100%	Very Good
75% - 84%	Good
60% - 74%	Neutral
40% - 59%	Less
0 – 39%	Very Less

(Suastika and Rahmawati, 2020)

It can be stated that the creativity of students after receiving treatment meets the outstanding criteria, with a score of 85.5. Hypothesis testing in this examination utilises the t-test to compare the results of students' pretests and posttests related to conceptual understanding after the application of the PjBL model. Data were collected based on the findings of the students' pretest and posttest, with a sample size of 35 students. Furthermore, conducting prerequisite tests for hypothesis testing, including conducting a normality test to ensure that the statistics follow a normal distribution, is crucial for ensuring that the t-test can be conducted accurately. Furthermore, a homogeneity test is conducted to assess the similarity of variance between the two data groups (pretest and posttest). After the data is identified and homogenised as usual, a t-test is conducted to compare the average pretest and posttest values. The t-test is carried out using SPSS. The t-test is presented in Table 4 as follows.

Table 4. T-test Result

Category	t-test	Effect Size
Understanding	1,009	0,503

As shown in Table 3, the t-count is 1.009. This suggests that the hypothesis test indicates a significant effect of learning using the PjBL model on students' conceptual comprehension skills. The calculated effect size is 0.503, indicating that the magnitude of influence is classified as moderate.

Discussion

The implementation of the PjBL model has proven impactful in enhancing students' conceptual understanding and creativity. This model provides an opportunity to encourage students to actively engage in the learning process, enabling them to grasp the material being taught more effectively. Learning through the project-based learning model is a method that introduces innovation to the art of teaching. This project-based teaching model aims to facilitate students' understanding and retention of the theories taught (Anggraini & Wulandari, 2021). Then, creativity is the capacity to generate something novel that can be discussed from various perspectives, both in art, science, and technology. In science, creativity is required through careful observation and systematic analysis (Junaedi, 2021).

Conceptual understanding is the foundation for students to grasp principles and theories; therefore, to understand principles and theories, students must first comprehend the underlying concepts (Diana et al., 2020). Conceptual understanding is an individual's ability to convey, describe, explain, and reapply a learning that has been obtained into a different form (Riani et al., 2021)

Research on conceptual understanding yielded pretest results with an average value of 65, which increased to 82 after the implementation of the PjBL model. This increase indicates that students are more likely to understand physics concepts after participating in project-based learning. The PjBL model offers a real context that makes it easier for students to relate physics concepts to everyday life. Thus, the learning process becomes more relevant and meaningful for students. (Nurgiyantoro & Efendi, 2017:144-146).

The results of the questionnaire demonstrated that the average creativity score of learners experienced a significant increase based on the indicators used:

- Fluency: The increase from 68 to 84 shows that students can generate more ideas and solutions in the projects they work on.
- Originality: The increase from 70 to 86 shows that students are more able to produce ideas that are unique and different from what they usually do.
- Flexibility: An increase from 69 to 85 indicates that students can move between different ideas and approaches more easily.
- Elaboration: The increase from 71 to 87 shows that students can develop their ideas in more detail and comprehensively.

The students' conceptual understanding is demonstrated by the t-test, which yields a calculated t-value of 1.009, indicating a significant result with a p-value of 0.05. In contrast, for students' creativity values, which are measured by dividing the scores obtained by the maximum score of 85.5, using the table criteria, namely perfect, it can be concluded that PjBL impacts students' creativity and conceptual understanding.

This increased creativity aligns with Torrance's theory (2010), which posits that creativity emerges when students are given the freedom to explore and experiment. Thus, the PjBL model not only improves learning outcomes but also equips students with the skills needed in the modern era.

Creativity in learning, primarily through the PjBL model, has a notable effect on students' conceptual understanding. Creativity enables students to relate theory to practice, allowing them to better understand how physics concepts are applied in everyday life. Additionally, by thinking creatively, students become actively engaged in the learning process, which in turn increases their motivation and interest in the material.

CONCLUSION

The main conclusion is that the implementation of the PjBL model in science learning has been proven to have a significant beneficial impact on creativity and conceptual understanding of grade XI students. The study's results showed that students experienced a significant increase in understanding physics concepts, with an average pretest score rising from 65 to 82 after the implementation of the PjBL. In addition, student creativity also increased, as indicated by the questionnaire outcomes, which showed an improvement in aspects such as fluency, originality, flexibility, and elaboration.

The PjBL model motivates students to engage actively in the learning process, allowing them to relate theory to practice and develop creativity. Increased creativity not only helps students understand the material but also equips them with important skills to face future challenges. The execution of the PjBL model is highly recommended for application in various learning contexts to enhance the overall quality of education.

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