

**Enhancing Creative Thinking Through Project Based Learning: Study of
Fourth-Grade Elementary Students**Ummu Khairiyah^{1*}, Dia Ayu Pramudita², Muchammad Bayu Tejo Sampurno³^{1,2} Universitas Islam Lamongan, Indonesia, ³ Sultan Idris Education University, Malaysia*e-mail: ummukhairiyah@unisla.ac.id*Submitted: Desember 17, 2024**Revised: November 6, 2025**Approved: November 29, 2025*

Abstrak: Keterampilan berpikir kreatif merupakan kompetensi esensial di abad ke-21 yang perlu dikembangkan sejak jenjang sekolah dasar. Studi ini dilakukan guna menelaah sejauh mana pengaruh penerapan model Project Based Learning (PjBL) dalam melatih keterampilan berpikir kreatif pada peserta didik kelas IV Sekolah Dasar. Metode penelitian yang digunakan adalah kuantitatif dengan desain one group pre-test post-test. Subjek dalam penelitian ini berjumlah 25 siswa dari satu sekolah dasar di Kabupaten Lamongan. Instrumen yang digunakan berupa tes esai untuk mengukur kemampuan berpikir kreatif, yang telah memenuhi uji validitas dan reliabilitas. Hasil uji normalitas Shapiro-Wilk menunjukkan bahwa data berdistribusi normal (pre-test = 0,061; post-test = 0,189). Analisis data dengan uji Paired Sample t-test pada SPSS versi 25 menghasilkan nilai signifikansi 0,000 ($p < 0,05$), yang mengindikasikan bahwa H_0 ditolak dan H_a diterima. Temuan ini membuktikan adanya pengaruh signifikan model PjBL terhadap peningkatan kemampuan berpikir kreatif siswa, yang tercermin dari kenaikan nilai rata-rata dari 43,4 (pre-test) menjadi 80,24 (post-test). Hasil penelitian ini mengimplikasikan bahwa PjBL dapat dijadikan sebagai model pembelajaran andal untuk menumbuhkan keterampilan berpikir kreatif siswa dalam konteks pembelajaran sains, khususnya pada materi transformasi energi.

Kata Kunci: Kemampuan berpikir kreatif, Pjbl, Transformasi energi

Abstract: Creative thinking skills are an essential 21st-century competency that needs to be developed from the elementary school level. This study aims to analyze the effect of implementing the Project Based Learning (PjBL) model on the creative thinking skills of fourth-grade elementary school students. The research employed a quantitative method with a one-group pre-test-post-test design. The participants consisted of 25 students from one elementary school in Lamongan. The instrument used was an essay test to measure creative thinking skills, which had met the validity and reliability tests. The results of the Shapiro-Wilk normality test indicated that the data were normally distributed (pre-test = 0.061; post-test = 0.189). Data analysis using a Paired Sample t-test in SPSS version 25 yielded a significance value of 0.000 ($p < 0.05$), indicating that H_0 was rejected and H_a was accepted. This finding proves a significant effect of the PjBL model on improving students' creative thinking skills, as reflected in the increase in the average score from

43.4 (pre-test) to 80.24 (post-test). These results imply that PjBL can be relied upon as an effective learning model to foster students' creative thinking skills in science learning contexts, particularly on the topic of energy transformation.

Keywords: Creative thinking skills, Energy transformation, Pjbl

INTRODUCTION

Era of globalization and rapid technological advancement, education holds a key role in preparing students to address the challenges of the 21st century. The demands of this era require every individual to not only excel in cognitive abilities but also master a set of fundamental competencies known as 21st-century skills, such as critical thinking, creativity, collaboration, and communication (Trilling & Fadel, 2021). Among these, creative thinking has increasingly been recognized as a key competency that enables learners to generate innovative ideas, solve complex problems, and adapt to a constantly changing world (Naharia et al., 2024). Therefore, fostering creative thinking skills from an early age, particularly in elementary schools, is essential for cultivating lifelong learners and preparing for future success. Education systems worldwide are encouraged to integrate learning approaches that actively engage students in creative processes and real-world problem-solving (Vaishali & Misra, 2020).

Despite the recognized importance of creative thinking skills, learning in elementary schools remains dominated by teacher-centered and result-oriented methods, rather than focusing on students' thinking processes (Ulfa et al., 2024). In science education, learning activities often emphasize theoretical mastery instead of providing opportunities for students to explore ideas, conduct experiments, or develop creative solutions related to daily life problems (Supriatna et al., 2024). This condition contributes to low levels of students' creative thinking and their limited engagement during learning. Therefore, innovation in learning approaches is needed approaches that encourage curiosity, meaningful engagement, and opportunities for students to develop new ideas. One such approach is Project-Based Learning (PjBL), which involves students actively in authentic, collaborative, and contextual projects (Nasution & Setyaningrum, 2024).

PjBL model provides a strong theoretical foundation for addressing learning processes that fail to foster students' creative thinking in depth. PjBL places students at the center of learning through direct involvement in real-world projects. During stages such as formulating essential questions, designing and implementing projects, and presenting results, learners are stimulated to think critically, collaborate, and develop creative solutions (Chusni, 2024). The model is grounded in constructivist theory, emphasizing that knowledge is built through direct experience and reflection (Egan et al., 2017). Implementing PjBL does not only

strengthen students' understanding of scientific concepts but also promotes their ability to create innovative and contextual solutions to real-life problems (Sutaryani et al., 2024; Ulfa et al., 2024). This approach aligns with twenty-first-century educational ideals, prioritizing active, collaborative learning and the development of higher-order thinking skills (Bell, 2010; Miterianifa et al., 2021).

Prior research consistently demonstrates the positive impact of PjBL on enhancing students' creative thinking skills (Khafah et al., 2023). However, most of these studies are still general and rarely focus on the application of PjBL within science learning contexts, particularly in dealing with abstract topics at the elementary level (Hidayat et al., 2025). Although several studies have examined the effects of PjBL on students' creative thinking, many were conducted in cross-disciplinary contexts or within broad scopes, leading to limited exploration of its potential in specific scientific topics (Putu et al., 2024). This presents a research gap, especially in applying PjBL to topics that require a more concrete and context-based approach.

One topic that represents such complexity is Energy Transformation. This fundamental concept in science is often perceived as abstract and difficult for elementary students to grasp. Consequently, classroom instruction tends to focus on theoretical explanations rather than hands-on experiences that enable contextual exploration (Munna & Kalam, 2021). The abstract nature of Energy Transformation highlights the need for learning models capable of making concepts more concrete, meaningful, and relevant to everyday life (Macrie-Shuck & Talanquer, 2020). PjBL fits this purpose well by creating opportunities for learners to participate in real-world projects that connect scientific theory with authentic contexts. Therefore, this study introduces a novel contribution by applying the Project-Based Learning model specifically to the Energy Transformation topic to evaluate its effectiveness in improving students' creative thinking skills through meaningful and contextual project activities.

Based on this reasoning, this study focuses on analyzing the effect of implementing the PjBL model on the creative thinking skills of elementary school students in learning about Energy Transformation. This approach is expected to enable students to not only strengthen their conceptual understanding but also enhance their creative thinking through a series of exploratory, collaborative, and reflective activities oriented towards solving authentic problems (Hidayat et al., 2025; Nasution & Setyaningrum, 2024; Suryandari et al., 2018). Theoretically, this research contributes to the growing literature on the effectiveness of PjBL in elementary science education, especially in abstract concepts. Practically, the findings can serve as an innovative learning alternative for teachers to develop students' creative thinking skills through authentic, meaningful, and contextual learning experiences.

METHOD

This study employed a quantitative approach with a quasi-experimental design in the form of a one-group pretest-posttest design. This design was selected to determine the effect of implementing the Project Based Learning (PjBL) model on students' creative thinking skills in the topic of Energy Transformation. The research population consisted of all 25 fourth-grade students at SDN 1 Sbj, the research site. The sampling technique used was saturated sampling, as all members of the population were included as research samples. This technique was chosen due to the small population size, homogeneous characteristics, and limited number of parallel classes (Sugiyono, 2016).

The instruments used in this study consisted of teaching modules, student worksheets (LKPD), learning implementation observation sheets, and a creative thinking skills test in the form of five essay questions. The creative thinking test was developed based on four main indicators: fluency, flexibility, originality, and elaboration, which were integrated into the syntax of the PjBL model. Each test item was assessed using a rubric with a 1–4 scale. The relationship between the creative thinking indicators and the PjBL stages is presented in Table 1.

Table 1. Relationship between Creative Thinking Indicators and PjBL Stages

PjBL Stages	Main Activities	Creative Thinking Indicators Developed
Determining the Fundamental Question	The teacher sparks students' curiosity through contextual problems about energy transformation	Fluency – generating various initial ideas or possible solutions.
Designing Project Plans	Students design methods to observe or create simple tools that demonstrate energy transformation.	Flexibility – generating diverse approaches and problem-solving strategies.
Creating Schedules and Implementing Projects	Students work in groups, conduct experiments, and discuss their findings	Elaboration – detailing and developing ideas to be more comprehensive.
Monitoring Project Progress	The teacher monitors and provides feedback during the activities.	Originality – producing unique ideas or products that differ from other groups.
Presenting Project Results	Students present their work results and explain their thought processes.	Fluency, Originality – communicating ideas in creative and open ways.

The content validity of the instrument was assessed through expert judgment by two science education and elementary education experts. The instrument's reliability was calculated using Cronbach's Alpha coefficient, yielding a result of 0.82, indicating a high level of reliability. Data obtained from pretest and posttest results were analyzed

quantitatively. Prior to the main analysis, prerequisite tests were conducted, including normality test (using Shapiro–Wilk) and homogeneity test (using Levene’s test). Furthermore, normalized gain (N-Gain) calculations were used to determine the level of improvement in students' creative thinking skills. The difference in creative thinking skills before and after the implementation of the PjBL model was analyzed using a paired samples t-test with SPSS 25 at a significance level of 0.05.

RESULTS AND DISCUSSION

Results

This study aims to determine the effect of implementing the Project Based Learning (PjBL) model on the creative thinking skills of elementary school students regarding the topic of Energy Transformation. The analysis was conducted based on pretest and posttest data, which illustrate the changes in students' creative thinking abilities after participating in project-based learning.

Table 2. Descriptive Statistics of Pretest and Posttest Scores for Creative Thinking Ability

	Lowest	Highest	Mean	SD
Pretest	29	51	43,4	5,12
Posttest	66	95	80,24	7,45

Table 2 shows an increase in the mean score of creative thinking ability from 43.40 to 80.24, with a difference of 36.84 points. This indicates that the application of the Project Based Learning (PjBL) model contributes significantly to improving students' creative thinking skills. In addition to the increase in the total score, a further analysis was conducted on the four indicators of creative thinking skills: fluency, flexibility, originality, and elaboration (Table 3).

Table 3. Achievement of Creative Thinking Skill Indicators

Creative Thinking Indicator	Average Pretest Score	Average Posttest	N-Gain Category	Score
Fluency	42,5	81,2	0,68	Moderate
Flexibility	40,8	79,6	0,67	Moderate
Originality	44,1	82,3	0,69	Moderate
Elaboration	46	83,7	0,71	Tinggi

The results show that all four indicators improved, with the gains categorized as moderate to high. The elaboration indicator showed the highest improvement, with an N-Gain of 0.71. This indicates that students became increasingly capable of developing and expanding their ideas in a more detailed and systematic manner. This was observed during

the project process as students refined their designs for simple devices to demonstrate energy transformation.

The results of the normality test using the Shapiro-Wilk test showed significance values of 0.061 (pretest) and 0.189 (posttest), both of which are greater than 0.05. This indicates that the data are normally distributed. The homogeneity test using Levene's Test yielded a significance value of 0.215 (> 0.05), demonstrating that the data have homogeneous variance and meet the prerequisites for inferential analysis.

The hypothesis test used in this study was a paired sample t-test, conducted using SPSS 25. The results of the test are presented in Table 4.

Table 4. The Result Of The Paired Sample t-test

	Paired Differences					t	df	Sig. (2-tailed)	Cohen's d	
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference						
				Lower	Upper					
Pair 1	pretest - posttest	-29,480	6,246	1,249	-32,058	-26,902	-23,600	24	,000	2,95

The results of the paired samples t-test show a significance value of 0.000 (< 0.05), indicating that there is a statistically significant difference between the pretest and posttest scores of students' creative thinking skills. A Cohen's d value of 2.95 indicates a very large effect size, confirming that the implementation of PjBL has a strong impact on improving creative thinking abilities.

Discussion

Creative thinking ability is a cognitive skill that provides individuals with the freedom to realize their imagination through thought processes to obtain new ideas (Suryandari et al., 2018). Factors influencing students' creative thinking skills include sensitivity in observing their environment, which refers to an awareness of what happens around them; freedom in observing the natural surroundings, indicating an ability to see problems from different perspectives; a strong commitment to succeed and advance, which means having great curiosity; courage and confidence in accepting risks, showing an interest in challenges; as well as perseverance in learning and possessing broad insight (Anas et al., 2023).

Selecting a realistic learning model plays a crucial role in student learning success. The PJBL learning model is a learning model that uses activities and projects to create products as learning tools for acquiring general skills (Chusni, 2024; Khafah et al., 2023; Mustamin et

al., 2024). The PjBL model provides opportunities for students to actively engage in the learning process through experimentation, discussion, and problem-solving, all of which support their cognitive development (Berhиту et al., 2020). PjBL also allows students to explore new ideas, think outside the box, and develop creative solutions without fear of making mistakes, thereby creating an environment that supports freedom of expression and innovation (Fitri et al., 2024).

The process within the Project-Based Learning (PjBL) model, particularly in the project development stage, is designed to hone students' creative thinking competence. By being actively involved in real-world projects, students are encouraged to design creative solutions, explore various new possibilities, and collaborate, thereby enabling their creative thinking abilities to develop continuously (Lesman et al., 2023). According to Guo et al., (2020), project creation encourages students to use their creativity in the process of planning and producing a product. This study aligns with constructivist learning theory, which emphasizes active and interactive learning by connecting new information with prior experiences and knowledge (Khairiyah et al., 2025).

The implementation of the PjBL model proved to have a positive effect on improving students' creative thinking skills, as indicated by a significant rise in the average posttest score. This finding is consistent with the view of Trilling & Fadel (2021), who state that 21st-century education requires students not only to master knowledge but also to be able to think creatively and apply new ideas in real-world contexts. PjBL encourages students to become active learners who are directly involved in the process of knowledge creation through exploration and collaboration (Mustamin et al., 2024).

In its process, PjBL provides space for students to ask questions, conduct experiments, discuss, and present their findings. These activities accustom students to thinking critically and creatively in finding solutions to a problem (Wulandari et al., 2025). This finding is consistent with the results of research by Zhang & Ma (2023), which showed that the application of project-based learning in science lessons can increase students' motivation, thought processes, and problem-solving abilities.

Furthermore, these results strengthen the meta-analysis conducted by Putu et al., (2024), which found that PjBL is proven effective in enhancing creative thinking skills across various educational levels. Providing contextual projects in learning encourages students to think divergently and develop new ideas based on real experiences (Sucilestari et al., 2023). Such projects challenge students to link the concepts they learn with everyday life, making learning more meaningful and relevant.

The topic of Energy Transformation used in this study is abstract and often difficult for elementary school students to understand. With PjBL, these abstract concepts can be

presented through real activities such as creating simple models of energy conversion, experiments on energy forms, and observing energy use in the surrounding environment (Lesman et al., 2023). This approach makes learning more concrete and helps students understand concepts through direct experience (Sucilestari et al., 2023).

The large effect size ($d = 2.95$) not only indicates a statistically significant difference but also demonstrates high pedagogical significance. This proves that PjBL is capable of providing a profound learning experience with a substantial impact on the improvement of higher-order thinking skills (Zhang & Ma, 2023). This finding supports constructivist theory, which forms the foundation of the PjBL model, stating that knowledge is built through active and reflective processes, not merely through the transfer of information from teacher to student (Khairiyah, 2025).

Furthermore, the PjBL model encourages students' emotional and social engagement in the learning process. Observation results showed an increase in motivation, teamwork, and self-confidence in expressing ideas. Students felt proud when their creations functioned well, creating a sense of ownership over their learning process. This is an important factor contributing to increased creativity, as a supportive learning environment that provides room for experimentation has been proven to strengthen creative thinking abilities (Lesman et al., 2023).

Overall, the implementation of PjBL is effective in enhancing the creative thinking skills of elementary school students, especially for abstract science topics like Energy Transformation. These results provide empirical evidence that the project-based learning approach not only deepens conceptual understanding but also develops creative thinking skills through exploratory, reflective, and collaborative activities (Sucilestari et al., 2023; Ulfa et al., 2024).

CONCLUSIONS

This study demonstrates that the implementation of the Project Based Learning (PjBL) model significantly enhanced the creative thinking skills of fourth-grade students on the topic of Energy Transformation, with a very large effect size (Cohen's $d = 2.95$), indicating both statistical and practical significance. These findings imply that PjBL is capable of creating a meaningful learning environment by transforming abstract science concepts into concrete and contextual learning experiences, thereby enabling students to explore, experiment, and innovate through authentic projects. This approach effectively trains the core dimensions of creative thinking: fluency, flexibility, originality, and elaboration within real-world learning situations.

Although this study has limitations, such as the absence of a control group, a small

sample size, and a focus on a single school and topic, its findings affirm the pedagogical potential of PjBL as an effective model for fostering creativity in elementary science education. Future research is recommended to implement PjBL across various other science topics and to integrate digital tools to further strengthen students' long-term creative and scientific competencies.

REFERENCES

- Anas, M., Harum, A., & Rusmayadi, R. (2023). Factors Influencing Students' Creative Thinking Skills. *Journal of Educational Science and Technology (EST)*, 9(1), 86. <https://doi.org/10.26858/est.v9i1.38752>
- Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 83(2), 39–43. <https://doi.org/10.1080/00098650903505415>
- Berhиту, M., Rehena, J. F., & Tuaputty, H. (2020). The Effect of Project-Based Learning (PjBL) Models on Improving Students' Understanding of Concepts, Retention, and Social Attitudes. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 10(2). <https://doi.org/10.30998/formatif.v10i2.5947>
- Chusni, M. M. (2024). Meta-analysis of the effect of project-based learning on enhancing 21st century skills. *Edu Sains: Jurnal Pendidikan Sains & Matematika*, 11(2), 174–186. <https://doi.org/10.23971/eds.v11i2.5934>
- Egan, A., Maguire, R., Christophers, L., & Rooney, B. (2017). Developing creativity in higher education for 21st century learners: A protocol for a scoping review. *International Journal of Educational Research*, 82, 21–27. <https://doi.org/10.1016/j.ijer.2016.12.004>
- Fitri, R., Lufri, L., Alberida, H., Amran, A., & Fachry, R. (2024). The project-based learning model and its contribution to student creativity: A review. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 10(1), 223–233. <https://doi.org/10.22219/jpbi.v10i1.31499>
- Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, 102, 101586. <https://doi.org/10.1016/j.ijer.2020.101586>
- Hidayat, M. W., Chamalah, E., & Kusumadewi, R. F. (2025). Implementation Of PjBL With Interactive Media For Teaching Instruction Texts To Grade IV Bakalrejo 2 Students . *Al-Irsyad: Journal of Education Science*, 4(2), 404–415. <https://doi.org/10.58917/aijes.v4i2.293>
- Khafah, F., Suprpto, P. K., & Nuryadin, E. (2023). The effect of project-based learning model on students' critical and creative thinking skills in the ecosystem concept. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 9(3), 244–255. <https://doi.org/10.22219/jpbi.v9i3.27461>
- Khairiyah, U. (2025). *Model Pembelajaran REA (Read, Explore, Application) Berbasis Etnosains*. Nawa Litera Publishing.
- Khairiyah, U., Suryanti, Widodo, W., & Mariati, P. (2025). Improving science literacy and communication skills: a study using development of the read, explore, application (REA) learning model based on ethnoscience. *Multidisciplinary Science Journal*, 8(1), 2026118. <https://doi.org/10.31893/multiscience.2026118>
- Lesman, I., Mulianti, M., Primawati, P., & Kassymova, G. K. (2023). Implementation of project-based learning (PjBL) model to increase students' creativity and critical

- thinking skill in vocational creative product subjects. *Jurnal Pendidikan Teknologi Kejuruan*, 6(3), 202–215. <https://doi.org/10.24036/jptk.v6i3.34023>
- Macrie-Shuck, M., & Talanquer, V. (2020). Exploring Students' Explanations of Energy Transfer and Transformation. *Journal of Chemical Education*, 97(12), 4225–4234. <https://doi.org/10.1021/acs.jchemed.0c00984>
- Miterianifa, M., Ashadi, A., Saputro, S., & Suciati, S. (2021). Higher Order Thinking Skills in the 21st Century: Critical Thinking. *Proceedings of the 1st International Conference on Social Science, Humanities, Education and Society Development, ICONS 2020*, 30 November, Tegal, Indonesia. <https://doi.org/10.4108/eai.30-11-2020.2303766>
- Munna, A. S., & Kalam, M. A. (2021). Teaching and learning process to enhance teaching effectiveness: a literature review. *International Journal of Humanities and Innovation*, 4(1), 1–4.
- Mustamin, K., Wahdah, W., Intiardy, D., Jumrah, A. M., & Pattiasina, P. J. (2024). The Impact of Project-Based Learning on Students' Collaboration Skills in Secondary Schools. *International Journal of Educational Research Excellence (IJERE)*, 3(2), 992–998. <https://doi.org/10.55299/ijere.v3i2.740>
- Naharia, O., Wullur, M., & Modigir, N. (2024). The Role Of Digital Technology To Enhance Creativity And Innovation Skills For Learners In The 21st Century Era. *Eduvest - Journal of Universal Studies*, 4(10), 9646–9653. <https://doi.org/10.59188/eduvest.v4i10.38826>
- Nasution, S. L. S., & Setyaningrum, W. (2024). Enhancing Higher-Order Thinking and Conceptual Understanding through STEM-PjBL: A Comprehensive Assessment of Its Impact on Education. *Indonesian Journal of Educational Research and Review*, 7(3), 656–666. <https://doi.org/10.23887/ijerr.v7i3.81285>
- Putu, W., Sudiarmika, A. A. I. A. R., Suma, K., & Suardana, I. N. (2024). Meta-Analysis: Effectiveness Of Project-Based Learning On Student Creativity. *Jurnal Pendidikan Fisika Undiksha*, 14(2), 498–506. <https://doi.org/10.23887/jjpf.v14i2.84812>
- Sucilestari, R., Ramdani, A., Sukarso, A., Susilawati, S., & Rokhmat, J. (2023). Project-Based Learning Supports Students' Creative Thinking in Science Education. *Jurnal Penelitian Pendidikan IPA*, 9(11), 1038–1044. <https://doi.org/10.29303/jppipa.v9i11.5054>
- Sugiyono. (2016). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.
- Supriatna, E., Fitriani, Y., Ali, I., & Hotimah, I. H. (2024). Implementation of Project-Based Learning Model to Improve Creative Thinking of Elementary School Teacher Education Students in Social Sciences Learning in Upper-Level Class Course. *EduBasic Journal: Jurnal Pendidikan Dasar*, 6(1), 95–104. <https://doi.org/10.17509/ebj.v6i1.67616>
- Suryandari, K. C., Fatimah, S., Sajidan, S., Rahardjo, S. B., & Prasetyo, Z. K. (2018). Project-Based Science Learning And Pre-Service Teachers' Science Literacy Skill And Creative Thinking. *Jurnal Cakrawala Pendidikan*, 37(3). <https://doi.org/10.21831/cp.v38i3.17229>
- Sutaryani, L. G., Pujani, N. M., & Tika, I. N. (2024). Project-Based Learning on Science Process Skills and Learning Outcomes in High School Physics: A Quasi-Experimental Study on the Topic of Fluids. *Journal of Education Research and Evaluation*, 8(4), 806–815. <https://doi.org/10.23887/jere.v8i4.83769>
- Trilling, B., & Fadel, C. (2021). *21st Century Skills: Learning for Life in Our Times*. Jossey-bass.

- Ulfa, M., Wahyudi, W., Gunawan, G., & Gunada, I. W. (2024). The Effect of Project-Based Learning on Student Creativity in Physics Learning. *Indonesian Journal of STEM Education*, 6(2).
- Vaishali, V., & Misra, P. K. (2020). Implications of Constructivist Approaches in the Classrooms: The Role of the Teachers. *Asian Journal of Education and Social Studies*, 7(4).
- Wulandari, A. M., Handoyo, E., Wardani, S., Subali, B., & Widiarti, N. (2025). Literature Study of E-Modules Based on Project-Based Learning to Improve Critical Thinking Skills of Students. *Edunesia : Jurnal Ilmiah Pendidikan*, 6(2), 1039–1054. <https://doi.org/10.51276/edu.v6i2.1241>
- Zhang, L., & Ma, Y. (2023). A study of the impact of project-based learning on student learning effects: a meta-analysis study. *Frontiers in Psychology*, 14. <https://doi.org/10.3389/fpsyg.2023.1202728>