

# Investigating the Impact of the Project-Based Learning Model on Creative Thinking Ability in Elementary Integrated Science

Emelda Thesalonika<sup>1</sup>  
{emeldathesalonika@gmail.com<sup>1</sup>}

Universitas HKBP Nommensen Pematangsiantar<sup>1</sup>

**Abstract.** Project-Based Learning (PjBL) model in enhancing fourth-grade students' creative thinking skills within the Integrated Science (IPAS) subject, specifically on the 'Indonesia's Rich Culture' topic, at UPTD SD Negeri 124401 Pematangsiantar. Employing a quantitative experimental approach with a One-Group Pretest-Posttest design (N=25), the research utilized validated essay tests to measure the learning outcomes. The data analysis, performed using the N-Gain formula, revealed a significant improvement in creative thinking skills, with an average pretest score of 48.08 and a posttest score of 88.00. The calculated N-Gain of 0.7832 (78.32%) falls into the 'High and Effective' category. These findings strongly suggest that the PjBL model is highly effective in significantly improving students' creative thinking abilities, thus recommending its implementation for developing higher-order thinking skills in IPAS instruction

**Keywords:** Project-Based Learning (PjBL), Thinking Skills, Integrated Science Education.

## 1 Introduction

The rapid transformation of global society in the 21st century has brought significant implications for education systems worldwide [1], [2], [3]. Advances in science, technology, and information have reshaped the skills required for individuals to participate effectively in social, economic, and professional contexts. As a result, contemporary education emphasizes not only the acquisition of factual knowledge but also the development of higher-order thinking skills, particularly creative thinking [4], [5], [6]. Creativity is increasingly recognized as a core competency that enables learners to generate novel ideas, adapt to complex situations, and solve multifaceted problems [7], [8], [9]. In science education, creative thinking plays a vital role in inquiry, experimentation, interpretation of data, and the application of scientific knowledge to real-world contexts.

Integrated science education has emerged as a strategic approach to address the complexity of real-life problems that transcend disciplinary boundaries. Rather than treating scientific concepts as isolated domains, integrated science encourages learners to connect knowledge from multiple fields and apply it holistically [10]. In Indonesia, this approach has been formalized through the Merdeka Curriculum, which introduces Integrated Science (IPAS) at the elementary level by combining natural sciences and social sciences into a unified subject. The integration aims to promote contextual learning, interdisciplinary understanding, and the development of

essential competencies such as critical and creative thinking. However, the successful implementation of integrated science learning requires instructional models that actively engage students and support the development of these competencies.

One instructional approach that has gained increasing attention for its potential to foster creative thinking is Project-Based Learning (PjBL) [11], [12], [13]. PjBL is a student-centered pedagogical model that engages learners in exploring authentic problems through extended projects, culminating in concrete products or presentations. Rooted in constructivist learning theory, PjBL emphasizes active learning, collaboration, inquiry, and reflection [14]. Students are encouraged to take responsibility for their learning by asking questions, investigating solutions, and constructing knowledge through meaningful experiences. These characteristics make PjBL particularly relevant for promoting creative thinking, as students are required to generate ideas, evaluate alternatives, and produce original outcomes.

Previous research has consistently reported positive effects of PjBL on various learning outcomes, including motivation, engagement, problem-solving skills, and higher-order thinking. In science education, PjBL has been shown to enhance students' understanding of scientific concepts by situating learning within real-world contexts [11], [15]. Moreover, PjBL has been widely associated with improvements in creative thinking skills, as project activities provide opportunities for idea fluency, flexibility in thinking, originality, and elaboration. Through collaborative inquiry and iterative design processes, students learn to approach problems from multiple perspectives and develop innovative solutions.

In recent years, the integration of PjBL with interdisciplinary learning has become a prominent trend in educational research. Studies indicate that when PjBL is implemented within interdisciplinary frameworks, students are more likely to develop creative problem-solving abilities and transferable skills relevant to contemporary challenges. The interdisciplinary nature of projects encourages learners to synthesize knowledge across domains, thereby supporting deeper understanding and creativity. These findings suggest that PjBL aligns well with the goals of integrated science education, where students are expected to connect scientific concepts with social, cultural, and environmental contexts.

Despite the growing body of literature on PjBL, several gaps remain, particularly in the context of elementary education and integrated curricula. Much of the existing research on PjBL and creative thinking has focused on secondary or higher education settings, often within single-discipline science instruction. Empirical studies examining the implementation of PjBL in elementary integrated science classrooms are still limited, especially in contexts where curriculum reform is in its early stages. Elementary learners possess unique cognitive and developmental characteristics that require carefully designed instructional approaches, making it essential to investigate how PjBL functions at this level.

In the Indonesian context, the implementation of the Merdeka Curriculum represents a major shift toward competency-based, student-centered learning. While the curriculum emphasizes creativity, critical thinking, and contextual learning, teachers often face challenges in translating these principles into classroom practice. The integration of natural and social sciences within IPAS further complicates instructional design, as teachers must balance content coverage with meaningful interdisciplinary learning experiences. Consequently, there is a need for empirical evidence that examines instructional models capable of supporting creative thinking development within elementary IPAS learning.

Project-Based Learning offers a promising solution to these challenges. By engaging students in interdisciplinary projects grounded in real-life contexts, PjBL has the potential to operationalize the goals of the Merdeka Curriculum in elementary classrooms. Through project activities, students can explore scientific concepts while simultaneously considering social and cultural dimensions, fostering holistic understanding and creativity. However, empirical evidence supporting the effectiveness of PjBL in enhancing creative thinking within elementary IPAS learning remains scarce. This lack of evidence highlights the importance of conducting context-specific studies to inform instructional practice and curriculum implementation.

Furthermore, assessing creative thinking in PjBL environments presents methodological challenges. Creative thinking is a multidimensional construct encompassing fluency, flexibility, originality, and elaboration. Capturing these dimensions requires appropriate assessment instruments and analytical approaches. Many previous studies rely on traditional assessments that may not fully reflect students' creative processes and outcomes. Therefore, research that employs validated instruments and systematic analysis, such as pretest–posttest designs and normalized gain measures, can provide valuable insights into the impact of PjBL on creative thinking development.

Given these considerations, this study aims to investigate the impact of the Project-Based Learning model on students' creative thinking ability in elementary Integrated Science (IPAS) learning. By examining changes in creative thinking performance before and after the implementation of PjBL, this study seeks to provide empirical evidence on the potential of project-based instruction to support creativity within an integrated curriculum framework. The study is situated in an authentic elementary classroom context during the implementation of the Merdeka Curriculum, offering insights into real-world instructional practices and learning outcomes.

The contribution of this study lies in its focus on elementary integrated science education, a context that has received limited attention in PjBL research. By aligning PjBL with the interdisciplinary structure of IPAS learning, the study extends existing literature on creative thinking development and project-based instruction. Additionally, the findings are expected to inform teachers, curriculum developers, and policymakers about the practical implications of implementing PjBL in elementary classrooms to foster creative thinking skills.

In summary, creative thinking is a crucial competency in contemporary education, particularly within integrated science learning environments. Project-Based Learning represents a pedagogical approach that aligns with constructivist principles and the goals of the Merdeka Curriculum. However, empirical evidence examining its impact on creative thinking in elementary IPAS learning remains limited. Addressing this gap, the present study investigates the effect of the PjBL model on students' creative thinking ability in elementary integrated science education, contributing to both theoretical understanding and practical application of innovative instructional models.

## **2 Method**

This study adopted a quantitative research approach utilizing a pre-experimental design, specifically the One-Group Pretest-Posttest Design. This design was chosen to efficiently

measure the effect of a particular treatment (X) by comparing the participants' initial ability (Pretest O1) against their ability after the intervention (Posttest O2).

This study employed a One-Group Pretest-Posttest design due to ethical, administrative, and contextual constraints within the elementary school setting, where the implementation of different instructional approaches across parallel classes was not permitted. This pre-experimental design was considered appropriate for generating preliminary empirical evidence on the potential impact of Project Based Learning (PjBL) on students' creative thinking skills in Integrated Science. By measuring the same participants before and after the intervention, the design allows for the control of individual differences in prior ability and learning characteristics, enabling a more sensitive detection of change attributable to the instructional treatment. Although causal inference is limited, several procedures were implemented to reduce threats to internal validity, including the use of standardized instructional materials, consistent teacher implementation, identical assessment instruments with adequate time intervals, and the calculation of effect sizes. Therefore, the findings are intended to provide initial insights that may inform future studies employing more rigorous experimental or quasi-experimental designs.

**Table 1.** Research Design *One Group Pretest-Posttest*

<b>Phase</b>	<b>Design Notation</b>	<b>Description</b>
Pre-Intervention	O1	Initial assessment of creative thinking skills.
Intervention	X	Implementation of the Project-Based Learning (PjBL) model.
Post-Intervention	O2	Final assessment of creative thinking skills.

## 2.1 Setting and Sample

The research was conducted at UPTD SD Negeri 124401 Pematangsiantar during the odd semester of the 2025/2026 academic year. This specific elementary school setting provided the necessary environment for a quasi-experimental study aimed at addressing initial findings of low student engagement and learning difficulties in the Integrated Science (IPAS) subject, particularly concerning the topic of "Indonesia's Rich Culture." The selection of this context ensured the intervention the Project-Based Learning (PjBL) model was tested on a population where the need for enhancing creative thinking skills was clearly identified.

The entire population of fourth-grade students at UPTD SD Negeri 124401 was designated as the sample using the census sampling technique (saturated sample). Consequently, the total sample size consisted of 25 students. Utilizing the entire population as the sample size maximized the data pool and eliminated sampling error, which is particularly suitable for small, specific populations in educational settings where generalizing findings back to that specific population is the primary objective.

## 2.1 Data Analysis Technique

The data were analyzed quantitatively to determine the effectiveness and impact of the PjBL model. **Analysis Method:** The **Normalized Gain (N-Gain)** formula was used to measure the difference and extent of improvement in creative thinking skills between the pretest and posttest scores.

$$N - Gain = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Ideal Score} - \text{Pretest Score}} \times 100$$

Table 2. N-gain Criteria

N-gain value	Criteria
$N-gain \geq 0,70$	High
$0,30 < N-gain < 0,70$	Medium
$N-gain \leq 0,30$	Low

This analysis provides preliminary evidence of an improvement in students' creative thinking skills following the implementation of the Project-Based Learning model.

## 3. Results And Discussion

### 3.1 Instrument Validity

The research instrument, a 10-item essay test designed to measure creative thinking, was rigorously validated by two experts (a lecturer and a teacher). All items demonstrated High Validity across content, construct, and linguistic dimensions, achieving an Aiken's V coefficient of 1.000. This outcome confirmed the reliability and suitability of the instrument for data collection.

### 3.2 Pretest and Posttest Scores

The study utilized a One-Group Pretest-Posttest design with N=25 fourth-grade students. The implementation of the Project-Based Learning (PjBL) model was the intervention applied over the subject "Indonesia's Rich Culture" (IPAS).

Table 3. Pretest and Posttest Scores

Assessment	Mean Score	Increase (Points)	Interpretation
Pretest (O1)	48.08	-	Below the target minimum competency
Posttest (O2)	88.00	+39.92	Significant improvement,

The results show a substantial increase in students' mean creative thinking scores from 48.08 (Pretest) to 88.00 (Posttest). This preliminary comparison suggests an observed improvement in creative thinking skills following the implementation of the PjBL intervention.

### 3.3 Effectiveness Analysis: Normalized Gain (N-Gain)

The effectiveness of the PjBL model was quantitatively confirmed using the Normalized Gain (N-Gain) analysis

**Table 4.** Metric Analysis: Normalized Gain (N-Gain)

Metric	Score	Classification
Average N-Gain Score ( $\bar{g}$ )	7,832	High
Average N-Gain Percent	78.32%	Effective

The high N-Gain score (0.7832) indicates a substantial improvement in students' creative thinking skills following the implementation of the PjBL model. Individual analysis further revealed that 92% of the students (23 out of 25) achieved a 'High' category increase, with no students falling into the 'Low' category

### 3.4 Discussion

The findings of this study indicate an observable and meaningful improvement in students' creative thinking skills following the implementation of the Project-Based Learning (PjBL) model in elementary Integrated Science (IPAS) learning [16]. The substantial increase in mean scores from the pretest to the posttest suggests that students demonstrated higher levels of creative thinking after participating in project-based instructional activities [17]. This improvement reflects not only quantitative score gains but also qualitative changes in how students approached learning tasks, particularly in generating ideas, exploring alternative solutions, and expressing originality within integrated science contexts.

The observed enhancement in creative thinking may be closely linked to the pedagogical characteristics of PjBL. By emphasizing active student engagement, inquiry-driven problem exploration, collaboration, and the production of meaningful learning artifacts, PjBL creates learning conditions that are conducive to creativity development [18]. Students are encouraged to take ownership of their learning, pose questions, test ideas, and revise their work based on feedback, all of which are essential processes in creative cognition. Unlike traditional teacher-centered instruction, PjBL positions students as active constructors of knowledge, enabling them to interact deeply with content and learning experiences in ways that stimulate creative thinking.

The high Normalized Gain (N-Gain) score further indicates that the improvement in students' creative thinking skills was not merely incremental but substantial for most participants. The fact that a large proportion of students achieved gains categorized as high suggests that PjBL may provide a supportive and inclusive learning environment in which students with varying initial abilities are able to improve meaningfully. Through collaborative project work, students are exposed to diverse perspectives and ideas, which may enhance cognitive flexibility and idea fluency. Moreover, opportunities to design, present, and refine project outputs may foster originality and elaboration, key dimensions of creative thinking.

From a theoretical standpoint, these findings are consistent with constructivist learning theory, which posits that knowledge and skills are constructed most effectively when learners actively engage with content through meaningful and contextualized experiences. In PjBL settings, learning occurs through interaction with problems that are authentic and relevant to students' lives, allowing them to integrate prior knowledge with new information. Such learning environments encourage experimentation, reflection, and social negotiation of meaning, all of which contribute to the development of creative thinking skills. The results of this study

therefore provide empirical support for the application of constructivist principles in elementary integrated science education.

Within the context of IPAS learning, which integrates concepts from both natural and social sciences, PjBL appears particularly well suited to supporting interdisciplinary thinking. The project theme used in this study, such as “Indonesia’s Rich Culture,” enabled students to connect scientific concepts with cultural and social realities, encouraging them to view knowledge as interconnected rather than compartmentalized. This interdisciplinary engagement may have helped students approach learning tasks from multiple perspectives, thereby strengthening core components of creative thinking, including fluency, flexibility, originality, and elaboration. By navigating the intersections between scientific understanding and social context, students were challenged to think beyond single-discipline solutions and develop more holistic and creative responses.

The findings of this study are consistent with previous research reporting positive associations between PjBL implementation and improvements in creative thinking skills in elementary education settings. Prior studies have demonstrated that project-based approaches can enhance students’ motivation, engagement, and creative output by providing opportunities for inquiry and authentic problem-solving. This study extends existing literature by offering contextual evidence from elementary IPAS learning, an integrated curriculum framework that has received limited empirical attention, particularly in the early stages of its implementation under the Merdeka Curriculum.

Despite these promising results, it is important to interpret the findings cautiously due to the limitations inherent in the One-Group pretest-posttest research design. The absence of a control group means that the observed improvements in creative thinking cannot be attributed exclusively to the PjBL intervention. Potential confounding factors, such as student maturation, familiarity with assessment instruments, or exposure to external learning experiences, may also have contributed to the increase in posttest scores. However, the use of validated measurement instruments, consistent instructional procedures, and N-Gain analysis enhances the credibility of the findings as preliminary empirical evidence of learning improvement.

Overall, this study contributes to the growing body of literature on Project-Based Learning by providing evidence of its potential to support creative thinking development in elementary Integrated Science (IPAS) learning. By situating PjBL within an interdisciplinary curriculum framework, the study highlights the relevance of project-based approaches for fostering creativity in complex learning environments. At the same time, the findings underscore the need for future research employing more rigorous experimental or quasi-experimental designs, larger samples, and longitudinal data to establish stronger causal inferences and to further explore how PjBL influences the development of creative thinking skills in integrated science education.

#### **4. Conclusion**

This study investigated the implementation of the Project-Based Learning (PjBL) model in elementary Integrated Science (IPAS) learning and examined observed changes in students’ creative thinking skills. The findings indicate a positive trend in students’ creative thinking performance following the implementation of PjBL, as evidenced by the increase in mean pretest–posttest scores and the high Normalized Gain (N-Gain) value. These results suggest that PjBL has the potential to facilitate creative thinking development by engaging students in active, contextual, and interdisciplinary learning experiences that align with the objectives of integrated science education under the Merdeka Curriculum.

The observed improvement in creative thinking can be attributed to several core characteristics of PjBL. First, PjBL situates learning within authentic and meaningful problem contexts, enabling students to connect scientific concepts with real-life situations and social phenomena. In IPAS learning, where natural and social sciences are integrated, project activities provide opportunities for students to explore issues holistically, encouraging flexibility, originality, and elaboration of ideas. Through collaborative inquiry, students are required to generate multiple solutions, negotiate perspectives, and refine their ideas—processes that are closely associated with creative thinking development. Thus, the findings reinforce theoretical perspectives that view creativity as a dynamic cognitive process nurtured through active engagement and interdisciplinary problem-solving. Furthermore, the interdisciplinary nature of IPAS learning appears to be well supported by the PjBL model. By integrating scientific inquiry with social and cultural contexts, PjBL allows students to perceive knowledge as interconnected rather than fragmented. This learning environment encourages students to move beyond rote memorization toward higher-order thinking, including the ability to reframe problems and propose innovative solutions. The results of this study therefore extend existing PjBL research by demonstrating its relevance and applicability within an integrated elementary curriculum, particularly during the early implementation phase of the Merdeka Curriculum. From a practical standpoint, the findings offer important implications for elementary school teachers. PjBL can be adopted as an effective instructional approach to promote student engagement, idea generation, and creative expression in IPAS learning. Teachers are encouraged to design interdisciplinary projects that are developmentally appropriate and closely aligned with learning objectives, while also allowing sufficient flexibility for student exploration. Clear project guidelines, scaffolding strategies, and continuous feedback are essential to support students throughout the creative process. Additionally, incorporating structured reflection activities such as journals, group discussions, or project presentations can help students articulate their thinking processes and deepen their creative engagement.

Assessment practices also play a critical role in supporting creative thinking development within PjBL environments. The use of open-ended and performance-based assessments, such as essay-based tasks, project reports, and presentations, enables teachers to capture multiple dimensions of creativity, including fluency, originality, and elaboration. Such assessments are particularly relevant in IPAS learning, where creative outcomes may manifest differently across scientific and social domains. By employing diverse assessment strategies, teachers can obtain a more comprehensive understanding of students' creative thinking progress and provide more meaningful feedback.

Despite these promising findings, several limitations must be acknowledged. The pre-experimental research design, which did not include a control or comparison group, limits the ability to draw strong causal conclusions regarding the effectiveness of PjBL. Improvements in creative thinking scores may have been influenced by extraneous factors such as student maturation, increased familiarity with test formats, or repeated exposure to similar tasks. Additionally, the relatively small sample size and short duration of the intervention may restrict the generalizability of the findings to other educational contexts or student populations. Therefore, the results of this study should be interpreted as preliminary empirical evidence rather than definitive proof of effectiveness. Future research is recommended to address these limitations by employing more rigorous experimental or quasi-experimental designs that include control groups and randomization where feasible. Studies with larger and more diverse samples would enhance the external validity of the findings and provide a clearer picture of PjBL's impact across different school settings. Longitudinal research designs are also needed to

examine the sustainability of creative thinking development over time and to explore how repeated exposure to PjBL influences students' creative trajectories. Furthermore, future studies may investigate additional variables, such as teacher pedagogical competence, project design quality, and student collaboration dynamics, to better understand the mechanisms through which PjBL supports creative thinking in integrated science education. In summary, this study contributes to the growing body of literature on Project-Based Learning by providing empirical insights into its implementation within elementary Integrated Science (IPAS) learning under the Merdeka Curriculum. While acknowledging its methodological limitations, the study highlights the potential of PjBL as a pedagogical approach that supports creative thinking development through interdisciplinary, contextual, and student-centered learning experiences. These findings underscore the need for continued research and pedagogical innovation to optimize PjBL implementation and to strengthen its role in fostering creativity in elementary integrated science education.

## References

- [1] L. I. González-Pérez and M. Soledad, "Components of Education 4.0 in 21st Century Skills Frameworks: Systematic Review," *Sustainability*, vol. 14, no. 3, p. 1493, 2022, doi: 10.3390/su14031493.
- [2] S. Kim, M. Raza, and E. Seidman, "Improving 21st-Century Teaching Skills: The Key to Effective 21st-Century Learners," *Research in Comparative and International Education*, vol. 14, no. 1, pp. 99–117, 2019, doi: 10.1177/1745499919829214.
- [3] A. R. Saavedra and V. D. Opfer, "Learning 21st-Century Skills Requires 21st-Century Teaching," *Phi Delta Kappan*, vol. 94, no. 2, pp. 8–13, 2012, doi: 10.1177/003172171209400203.
- [4] T. I. Aldosemani, "Investigating Students' Perceptions of Their Learning Experience and Self-Regulated Learning Skills During Emergency Remote Teaching," *International Journal of Web-Based Learning and Teaching Technologies*, vol. 17, no. 1, pp. 1–15, 2022, doi: 10.4018/ijwltt.302905.
- [5] S. Hermo, M. Päällysaho, D. Seim, and J. Shapiro, "Labor Market Returns and the Evolution of Cognitive Skills: Theory and Evidence," no. Query date: 2023-09-24 14:40:24, 2021, doi: 10.3386/w29135.
- [6] M. M. Mahmud, S. F. Wong, and C. R. Ramachandiran, "Deconstructing Self-Regulated Learning Skills in the Emergency Remote Learning," 2021 the 6th International Conference on Distance Education and Learning, no. Query date: 2023-09-24 14:27:37, 2021, doi: 10.1145/3474995.3475029.
- [7] E. Andriyani, M. Muhaimin, and S. Syaiful, "Pengaruh Model Self Regulated Learning dan Discovery Learning terhadap Kemampuan Berpikir Kreatif Matematis," *Edumatica : Jurnal Pendidikan Matematika*, vol. 11, no. 3, pp. 54–64, 2021, doi: 10.22437/edumatica.v11i03.14599.
- [8] Y. Dong, K. M. Bartol, Z. Zhang, and C. Li, "Enhancing Employee Creativity via Individual Skill Development and Team Knowledge Sharing: Influences of Dual-focused Transformational Leadership," *Journal of Organizational Behavior*, vol. 38, no. 3, pp. 439–458, 2016, doi: 10.1002/job.2134.
- [9] D.-J. Kim, S.-C. Bae, S. Choi, H. Kim, and W. Lim, "Creative Character Education in Mathematics for Prospective Teachers," *Sustainability*, vol. 11, no. 6, p. 1730, 2019, doi: 10.3390/su11061730.

- [10] A. Rambe, T. Tobroni, and J. Widodo, "Integrasi Etika Pendidikan Dan Keterikatan Sosial Dalam Pembelajaran Holistik," *Jurnal Ilmiah Muqoddimah Jurnal Ilmu Sosial Politik Dan Hummaniora*, vol. 8, no. 2, p. 697, 2024, doi: 10.31604/jim.v8i2.2024.694-700.
- [11] F. Akbar and A. Bahri, "Efektivitas Model PjBL (Project-Based Learning) dalam Meningkatkan Hasil Belajar Kognitif Peserta Didik dengan Gaya Belajar Berbeda," *Biology Teaching and Learning*, vol. 1, no. 1, 2019, doi: 10.35580/btl.v1i1.9255.
- [12] M. Rafik, V. P. Febrianti, A. Nurhasanah, and S. N. Muhajir, "Telaah Literatur: Pengaruh Model Pembelajaran Project Based Learning (PjBL) terhadap Kreativitas Siswa Guna Mendukung Pembelajaran Abad 21," *Jurnal Pembelajaran Inovatif*, vol. 5, no. 1, pp. 80–85, 2022, doi: 10.21009/jpi.051.10.
- [13] N. Riani, "Efektifitas Project Based Learning (Pjbl) Sebagai Bentuk Implementasi Kurikulum Merdeka Dalam Pembelajaran Matematika," *All Fields of Science Journal Liaison Academia and Society*, vol. 3, no. 3, pp. 24–31, 2023, doi: 10.58939/afosj-las.v3i3.615.
- [14] G. Faihah, R. E. Wulandari, S. Wahyuni, and D. Kusumaningtyas, "Penggabungan PJBL, Demonstrasi, Pembelajaran Berbasis Video Untuk Meningkatkan Pemahaman Dan Keterampilan Siswa," *Jurnal Praktik Baik Pembelajaran Sekolah Dan Pesantren*, vol. 3, no. 01, pp. 19–27, 2024, doi: 10.56741/pbpsp.v3i01.478.
- [15] H. Haryanto, H. R. Widarti, A. Mashfufah, R. S. I. Dewi, and S. R. Kusumaningrum, "Flipbook-Based Project-Based Learning: An Opportunity to Improve Science Literacy," *Jurnal Penelitian Pendidikan Ipa*, vol. 10, no. 7, pp. 4004–4009, 2023, doi: 10.29303/jppipa.v10i7.7916.
- [16] A. Doyan, A. Harjono, and M. Qadafi, "Trends Research Project Based Learning (PjBL) Model to Improve Problem Solving Skills in Students' Science Learning (2015-2024): A Systematic Review," *Jurnal Penelitian Pendidikan Ipa*, vol. 10, no. 7, pp. 498–507, 2024, doi: 10.29303/jppipa.v10i7.8280.
- [17] M. Mariam, I. Ismet, and K. Kistiono, "Analisis Kebutuhan Desain Pembelajaran Termodinamika Menggunakan Model Project Based Learning (PjBL) Untuk Meningkatkan Kreativitas Peserta Didik SMA," *Jiip - Jurnal Ilmiah Ilmu Pendidikan*, vol. 6, no. 6, pp. 4467–4471, 2023, doi: 10.54371/jiip.v6i6.2197.
- [18] L. Pohan and J. Maulina, "Blended Learning Integrated with Project-Based Learning: Its Effect on Learning Outcomes, Perception, and Self-Regulated Learning," *Jurnal Pendidikan Kimia Indonesia*, vol. 6, no. 2, pp. 97–106, 2022, doi: 10.23887/jpki.v6i2.48213.