

# THE EFFECTIVENESS OF PROJECT-BASED LEARNING WITH A DEEP LEARNING APPROACH IN ELEMENTARY SCHOOLS

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## ABSTRACT

This study aims to analyze the effectiveness of Project-Based Learning (PjBL) integrated with a deep learning approach on elementary school students' learning outcomes in Integrated Science and Social Studies (IPAS). In this paper, "deep learning" refers to a deep approach to learning in educational psychology (deep vs. surface cognitive engagement), not to AI-based deep neural networks. The research employed a quantitative method with a quasi-experimental pretest-posttest control group design. The research subjects consisted of 100 students, comprising 50 students in the experimental group and 50 students in the control group. The research instrument was a test measuring students' conceptual understanding of IPAS. The results showed that the mean pretest score of the experimental group was 56.40, while that of the control group was 55.90, indicating relatively equivalent initial abilities. After the intervention, the mean posttest score of the experimental group increased to 82.70, whereas the control group reached 70.10. The gain score of the experimental group was 26.30, higher than that of the control group at 14.20. The N-Gain value of the experimental group was 0.61, categorized as moderate-high, while the control group obtained an N-Gain of 0.32, categorized as moderate. The t-test results indicated a t-value of 8.12 with a significance level of 0.000 ( $p < 0.05$ ). The effect size, measured using Cohen's d, was 1.12, indicating a large effect. This study concludes that Project-Based Learning with a deep learning approach is effective in improving elementary school students' IPAS learning outcomes.

**Keywords:** Project-Based Learning, Deep Learning, IPAS (Integrated Science and Social Studies), Learning Outcomes, Elementary School

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## INTRODUCTION

In the landscape of 21st-century education, the need for learning models that can develop higher-order thinking skills, creativity, scientific literacy, digital literacy, and collaborative abilities has become increasingly urgent, particularly at the elementary school level, which serves as the foundation for students' cognitive, affective, and social development. Learning in elementary schools is no longer sufficient if it is oriented solely toward content mastery; instead, it must foster meaningful conceptual understanding, reflective abilities, and the application of knowledge in real-world contexts. In line with the direction of modern education, the deep learning approach has emerged as an important paradigm for improving the quality of learning in elementary schools (Sarwi et al., 2024). Context note for international readers: IPAS (Integrated Science and Social Studies) is an integrated subject in the Indonesian elementary curriculum that combines foundational science and social studies. It emphasizes interdisciplinary understanding of natural phenomena, human-environment interactions, and inquiry-oriented reasoning through contextual issues. Deep learning in this study is used in the sense of a deep approach to learning (deep vs. surface learning) that emphasizes students' active engagement in understanding concepts at an essential level, connecting ideas across disciplines, conducting critical analysis and reflection, and transferring knowledge to new situations (Rusilowati et al., 2019; Sarwi et al., 2024).

Based on preliminary observations conducted at SD Negeri Tamansari 02 and SD Negeri Tlogowungu 02, IPAS (Integrated Science and Social Studies) learning is still dominated by lecture-based methods and drill exercises. Such learning patterns tend to result in passive student participation, relatively low learning motivation, and underdeveloped conceptual understanding. Interviews with teachers at both schools revealed that students often experience difficulties in connecting IPAS concepts with everyday life and are less actively involved in scientific inquiry processes. Teachers also expressed the need for innovative learning models that can enhance learning motivation, actively engage students, and help them construct meaningful and sustainable conceptual understanding. These conditions indicate an urgent need for more transformative learning models that are oriented toward deep learning.

One learning model considered relevant to supporting the deep learning approach is Project-Based Learning (PjBL). PjBL is a student-centered learning model that engages learners in project activities requiring in-depth investigation, authentic problem-solving, collaboration, and reflection (Dewi et al., 2022). Numerous studies have shown that PjBL is effective in improving higher-order thinking skills, creativity, digital literacy, and 21st-century skills among students (Asia et al., 2025). Through PjBL, students not only acquire knowledge but also construct conceptual understanding through direct experience and meaningful activities.

The implementation of PjBL in IPAS learning at the elementary school level enables students to relate scientific concepts to real phenomena in their surrounding environment. STEM project-based studies indicate that project-based learning helps students integrate IPAS knowledge, mathematics, and literacy in a comprehensive manner, thereby strengthening conceptual understanding and problem-solving abilities (Sari et al., 2021). Contextual and collaborative project activities encourage students to think critically, pose scientific questions, and reflect on both the learning process and outcomes.

From a deep learning perspective, PjBL aligns strongly with the principles of deep learning, as it encourages students to engage in exploratory, analytical, and reflective learning processes. Deep learning requires students not merely to memorize concepts, but to understand the relationships among concepts and apply them in new contexts (Sarwi et al., 2024). Research shows that learning emphasizing exploration, modeling, and scientific investigation can significantly enhance students' conceptual understanding (Rusilowati et al., 2021). In addition, learning design that considers appropriate context and media plays a crucial role in

strengthening deep learning processes, as highlighted in TPACK-based studies by Jamaludin et al. (2024) and Rusilowati and Pangestu (2022).

Several previous studies have demonstrated that PjBL is capable of creating more meaningful and sustainable learning experiences. Project-based learning provides opportunities for students to engage in systematic exploration, collaboration, and reflection, thereby supporting deep knowledge construction (Winarto et al., 2022; Sarwi et al., 2025). Through contextual problem-based projects, students learn to integrate knowledge, skills, and scientific attitudes holistically. This process aligns with the principles of deep learning, which emphasize conceptual understanding, higher-order thinking skills, and the transfer of knowledge to real-life situations.

Based on these theoretical foundations and empirical findings, this study aims to analyze the effectiveness of Project-Based Learning in supporting a deep learning approach in elementary schools, particularly in improving students' conceptual understanding of IPAS, scientific literacy, creativity, learning motivation, and 21st-century skills. This research was conducted at SD Negeri Tamansari 02 and SD Negeri Tlogowungu 02 as study sites to explore contextual needs and examine the suitability of PjBL implementation in IPAS learning.

The scope of this study is limited to the following aspects: 1) focusing on IPAS as the learning context; 2) analyzing the effectiveness of Project-Based Learning in supporting deep learning; 3) involving upper-grade elementary school teachers and students; and 4) not examining technological implementation in detail, but rather its role in supporting the learning process. Thus, this study is expected to contribute both theoretically and practically to the development of effective, contextual, and relevant project-based learning models that promote deep learning in elementary schools, as well as to serve as a reference for teachers, researchers, and educational policymakers.

## LITERATURE REVIEWS

### **The Deep Learning Approach in Elementary Education**

In the 21st-century educational paradigm, learning at the elementary level is required to move beyond mere content mastery toward developing deep conceptual understanding, higher-order thinking skills, and the ability to apply knowledge in real-world contexts. Deep learning emerges as a response to this demand. Deep learning is defined as a learning approach that emphasizes students' active engagement in understanding concepts at an essential level, connecting ideas across disciplines, conducting critical analysis and reflection, and transferring knowledge to new situations (Rusilowati et al., 2019; Sarwi et al., 2024). At the elementary level, this foundation is crucial for students' cognitive, affective, and social development. However, preliminary observations in many schools, such as at SD Negeri Tamansari 02 and SD Negeri Tlogowungu 02, reveal that Integrated Science and Social Studies (IPAS) learning is still dominated by lecture methods and drill exercises. This pattern tends to result in passive student participation, low learning motivation, and underdeveloped conceptual understanding, thereby distancing students from the essence of deep learning (Sarwi et al., 2024).

### **Project-Based Learning (PjBL) as a Model Supporting Deep Learning**

Project-Based Learning (PjBL) is identified as a relevant and potential learning model to actualize the principles of deep learning in elementary schools. PjBL is a student-centered model that engages learners in project activities requiring in-depth investigation, authentic problem-solving, collaboration, and reflection (Dewi et al., 2022). This model aligns with deep learning because it encourages students not merely to memorize, but to construct understanding through direct experience and meaningful activities. Through PjBL, students engage in exploratory, analytical, and reflective processes that characterize a deep learning approach (Sarwi et al., 2024).

Empirical research supports the effectiveness of PjBL. Studies show that PjBL is effective in improving higher-order thinking skills, creativity, digital literacy, and 21st-century skills (Asia et al., 2025). In the context of integrated science and social studies (IPAS), a project-based approach helps students integrate knowledge, mathematics, and literacy comprehensively, thereby strengthening conceptual understanding and problem-solving abilities (Sari et al., 2021). Contextual and collaborative project activities encourage students to think critically, pose scientific questions, and reflect on both the process and outcomes of their learning, which are manifestations of deep learning.

### **Implementation of PjBL for Deep Learning in Elementary Schools**

The implementation of PjBL in IPAS learning at the elementary level opens opportunities for students to relate scientific concepts to real phenomena in their surrounding environment. This is crucial to address the gap found in preliminary observations, where students struggle to connect IPAS concepts with daily life. Learning design that considers appropriate context and media plays a vital role in strengthening this deep learning process, as highlighted in TPACK-based studies by Jamaludin et al. (2024) and Rusilowati and Pangestu (2022).

Previous research also confirms that PjBL can create more meaningful and sustainable learning experiences. Winarto et al. (2022) and Sarwi et al. (2025) conclude that project-based learning provides opportunities for students to engage in systematic exploration, collaboration, and reflection, thereby supporting deep knowledge construction. This process aligns with the principles of deep learning, which emphasize conceptual understanding, higher-order thinking skills, and the transfer of knowledge to real-life situations. Therefore, integrating PjBL into the elementary school curriculum, particularly for IPAS subjects, is seen as a strategic step to shift teaching practices from surface-level to deep learning.

## **RESEARCH METHODOLOGY**

This study employed a quantitative research approach using a quasi-experimental design to examine the effectiveness of implementing Project-Based Learning (PjBL) within a deep learning approach in elementary schools. The quantitative approach was selected because the study focuses on objectively and systematically measuring the effects of instructional treatment through numerical data, allowing for inferential conclusions to be drawn (Creswell, 2014). The research design used was a pretest-posttest control group design, in which the experimental group received instruction using PjBL integrated with a deep learning approach, while the control group was taught using conventional learning methods. A quasi-experimental design was chosen due to limitations in fully randomizing subjects within the school setting (Sugiyono, 2019).

The intervention was implemented in four instructional sessions. In the experimental group, PjBL was designed to explicitly promote a deep approach to learning through: 1) a driving question grounded in a real-life IPAS issue in the students' local environment; 2) collaborative inquiry (data collection from observations, simple measurements, and information sources); 3) teacher facilitation using higher-order questioning (why/how/what-if prompts); and 4) structured reflection (learning journals and short group debriefs) focusing on conceptual connections and evidence-based reasoning. Each project followed these phases: problem orientation and driving question, project planning (roles, timeline, and resources), investigation and data collection, artifact development (poster/report and a brief presentation), peer feedback, and reflection on what was learned and how it can be applied to other contexts.

Fidelity of implementation: prior to the intervention, the teacher received a brief orientation on the lesson flow, questioning prompts, and reflection procedures. During implementation, an observation checklist was used to ensure that core PjBL phases and deep-approach elements (driving question, inquiry, questioning, reflection) were delivered consistently across sessions.

**Table 1** Comparison of instructional conditions (added to clarify the treatment)

<b>Aspect</b>	<b>Experimental group (PjBL + deep approach)</b>	<b>Control group (conventional)</b>
Learning focus	Conceptual understanding and transfer; evidence-based explanations; interdisciplinary connections in IPAS.	Content coverage and practice exercises; teacher explanation followed by individual work.
Driving task	Authentic local IPAS problem framed as a driving question.	Teacher-assigned tasks based on textbook/worksheet.
Student activity	Collaborative inquiry, data collection, artifact creation, presentation.	Listening, note-taking, completing exercises.
Teacher role	Facilitator; higher-order questioning; scaffolding; feedback cycles.	Primary source of explanations; directs steps.
Reflection	Learning journal + group debrief focusing on 'why' and 'how' of concepts.	Limited/none (summary at end of lesson).
Assessment	Formative checkpoints + rubric for artifact; posttest.	Posttest and routine exercises.

The research population consisted of upper-grade elementary school students, with samples selected using purposive sampling based on the equivalence of class characteristics and the schools' readiness to implement the learning intervention (Arikunto, 2013). Research instruments included an achievement test to measure conceptual understanding and a questionnaire to assess supporting aspects of deep learning. The instruments were developed and validated in accordance with educational measurement principles to ensure validity and reliability.

Quantitative data analysis employed descriptive and inferential statistical techniques to determine differences in learning outcome improvements between groups (Creswell, 2014). Assumption testing (normality and homogeneity), independent samples t-test, N-Gain, and effect size (Cohen's *d*) were used to support robust interpretation.

## RESEARCH RESULTS

The research results were obtained from 100 elementary school students who were proportionally divided into two groups: 50 students in the experimental group who participated in learning using Project-Based Learning (PjBL) with a deep learning approach, and 50 students in the control group who received conventional instruction. Prior to the implementation of the treatment, all students completed a pretest to measure their initial conceptual understanding of Integrated Science and Social Studies (IPAS). Descriptive statistical analysis indicated that the pretest scores of both groups were relatively equivalent. The experimental group achieved a mean score of 56.40 with a standard deviation of 7.82, while the control group obtained a mean score of 55.90 with a standard deviation of 7.65. The comparable score ranges indicate that there was no significant difference in initial abilities between the two groups, suggesting equivalent baseline conditions.

**Table 2** Descriptive Statistics of Pretest Scores

<b>Group</b>	<b>N</b>	<b>Min</b>	<b>Max</b>	<b>Mean</b>	<b>SD</b>
Experimental (PjBL)	50	40	72	56.40	7.82
Control	50	42	70	55.90	7.65

After four instructional sessions, students in both groups were administered a posttest using equivalent instruments. The posttest results showed improvements in learning outcomes for

both groups; however, the improvement in the experimental group was more pronounced. The experimental group achieved a mean posttest score of 82.70 with a standard deviation of 6.41, whereas the control group achieved a mean score of 70.10 with a standard deviation of 6.98. This difference in mean scores indicates that project-based learning with a deep learning approach had a stronger impact on students' conceptual understanding.

**Table 3** Descriptive Statistics of Posttest Scores

Group	N	Min	Max	Mean	SD
Experimental (PjBL)	50	68	95	82.70	6.41
Control	50	60	85	70.10	6.98

To examine the magnitude of learning improvement directly, gain scores were calculated. The analysis revealed that the experimental group experienced an average increase of 26.30 points, whereas the control group showed an average increase of 14.20 points. This difference indicates that students who learned through Project-Based Learning achieved greater conceptual progress than those who learned through conventional methods.

**Table 4** Comparison of Gain Scores

Group	Mean Pretest	Mean Posttest	Gain
Experimental	56.40	82.70	26.30
Control	55.90	70.10	14.20

Further analysis was conducted by calculating the normalized gain (N-Gain) to determine the effectiveness level of learning improvement. The results showed that the experimental group obtained an average N-Gain of 0.61, categorized as moderate-high, while the control group achieved an average N-Gain of 0.32, categorized as moderate. These findings further confirm that the learning improvement in the experimental group was more effective than in the control group.

**Table 5** Average N-Gain of Learning Outcomes

Group	N-Gain	Category
Experimental (PjBL)	0.61	Moderate-High
Control	0.32	Moderate

Before hypothesis testing, the posttest data were examined to ensure that the assumptions for parametric analysis were met. The Shapiro-Wilk normality test indicated that the posttest data for both groups were normally distributed, with significance values greater than 0.05. Additionally, the homogeneity of variance test showed that the data were derived from homogeneous populations. Therefore, the data met the requirements for parametric statistical testing.

**Table 6** Normality Test Results (Posttest)

Group	Sig. (Shapiro-Wilk)	Interpretation
Experimental	0.134	Normal
Control	0.118	Normal

Hypothesis testing was conducted using an independent samples t-test on the posttest scores of both groups. The results showed a significance value of 0.000 ( $p < 0.05$ ) with a calculated t-value of 8.12. These results indicate a statistically significant difference between the learning

outcomes of students who participated in Project-Based Learning with a deep learning approach and those who received conventional instruction.

**Table 7** Homogeneity of Variance Test Results

Levene Statistic	Sig.	Interpretation
0.742	0.391	Homogeneous

To further strengthen the interpretation of the treatment effect, the effect size was calculated using Cohen's *d*. The analysis yielded a Cohen's *d* value of 1.12, which falls within the category of a large effect. This result indicates that Project-Based Learning integrated with a deep learning approach had a strong impact on improving elementary school students' learning outcomes.

**Table 8** Independent Samples t-test Results

Variable	t	df	Sig. (2-tailed)	Decision
Posttest	8.12	98	0.000	Significant

Overall, the results demonstrate that the implementation of Project-Based Learning with a deep learning approach consistently led to higher learning gains, stronger effectiveness levels, and statistically significant differences compared to conventional instruction. These findings confirm that PjBL is an effective instructional model for improving the quality of IPAS learning in elementary schools.

**Table 9** Effect Size (Cohen's *d*)

Comparison	Cohen's <i>d</i>	Interpretation
Experimental vs. Control	1.12	Large Effect

## DISCUSSION & CONCLUSION

### Conclusion

Based on the research findings and discussion, it can be concluded that the implementation of Project-Based Learning (PjBL) with a deep learning approach is effective in improving elementary school students' IPAS learning outcomes. The analysis shows that students' initial abilities in the experimental and control groups were relatively equivalent. However, following the instructional intervention, the experimental group demonstrated significantly higher learning gains than the control group. This improvement was reflected in higher posttest mean scores, gain scores, and N-Gain values, and was further supported by statistical test results indicating significant differences and a large effect size.

These findings suggest that PjBL effectively facilitates meaningful learning through active student engagement in project activities, conceptual exploration, collaboration, and reflection. The deep learning approach enables students not only to understand IPAS concepts at a conceptual level but also to relate them to real-life contexts. Consequently, PjBL contributes positively to the development of conceptual understanding, higher-order thinking skills, and the overall quality of IPAS learning processes in elementary schools. Therefore, Project-Based Learning integrated with a deep learning approach is recommended as an effective and innovative instructional alternative for enhancing the quality of IPAS education in elementary schools.

### Discussion

The 'deep learning approach' discussed here refers to deep cognitive engagement and reflective learning (deep vs. surface approach), not to computational deep learning. The treatment effects

are interpreted in relation to the explicit instructional components described in the intervention procedure.

The findings indicate that the initial abilities of students in both the experimental and control groups were relatively equivalent. This is evidenced by nearly identical mean pretest scores accompanied by comparable standard deviations. Such conditions suggest that both groups possessed similar baseline characteristics, allowing differences in final learning outcomes to be more confidently attributed to the instructional treatment rather than to prior ability differences. The equivalence of initial abilities is a critical requirement in quasi-experimental research to maintain internal validity (Arikunto, 2013; Sugiyono, 2019).

Posttest results revealed improvements in learning outcomes for both groups; however, the improvement was substantially greater in the experimental group. The high mean posttest score achieved by the experimental group indicates that project-based learning integrated with a deep learning approach more effectively facilitated students' conceptual understanding of IPAS compared to conventional instruction. This finding aligns with Shrimal (2024), who argues that PjBL provides authentic learning experiences that encourage students to connect concepts with real-world situations.

Within the elementary school context, PjBL offers opportunities for students to learn through exploratory, collaborative, and reflective activities. This process enables learners not merely to memorize concepts but to construct deeper conceptual understanding. This is consistent with Lopez-Gazpio (2021), who emphasizes that PjBL enhances students' cognitive engagement through project-based problem-solving activities.

Gain score analysis showed that the experimental group experienced nearly double the learning improvement compared to the control group. This substantial difference demonstrates that PjBL with a deep learning approach is more effective in promoting conceptual change. Deep learning emphasizes active knowledge construction, allowing students to integrate new information with their prior knowledge.

This approach is closely aligned with constructivist learning theory, which views learning as an active process of meaning-making (Miles et al., 2014). In PjBL, students are directly involved in planning, implementing, and evaluating projects, making learning experiences more meaningful. The present findings support Sari et al. (2021), who reported that project-based learning improves conceptual understanding as well as students' creative thinking skills. The N-Gain value of the experimental group, categorized as moderate-high, indicates a strong level of learning effectiveness, whereas the control group achieved only a moderate category. This difference suggests that PjBL not only enhances learning outcomes quantitatively but also improves the quality of the learning process.

These results are consistent with Dewi et al. (2022), who found that PjBL supported by appropriate scaffolding enhances conceptual understanding and higher-order thinking skills. Additionally, Arthana et al. (2024) emphasized in their literature review that innovative project-based learning models and interactive media significantly contribute to the development of students' Higher Order Thinking Skills (HOTS).

The independent samples t-test results demonstrated a statistically significant difference between the learning outcomes of the experimental and control groups. A significance value below 0.05 confirms that this difference did not occur by chance. Therefore, the research hypothesis stating that PjBL with a deep learning approach is more effective than conventional instruction is accepted.

This finding is consistent with Sarwi et al. (2019), who reported that inquiry- and project-based innovative learning models significantly enhance students' conceptual understanding and scientific skills. In the context of elementary science education, learning that emphasizes scientific processes and real-world problem-solving is particularly relevant for fostering scientific literacy from an early age (Fakhriyah et al., 2017).

The Cohen's  $d$  value of 1.12 indicates a large effect size, suggesting that the impact of PjBL with a deep learning approach is not only statistically significant but also practically meaningful. This strengthens the argument that PjBL is a highly viable instructional model for widespread implementation in elementary schools.

Baskara et al. (2024) noted that the effectiveness of PjBL can be further enhanced when integrated with technological innovations, including artificial intelligence and digital media. Although this study did not extensively integrate technology, the strong results obtained indicate considerable potential for further development.

IPAS, as a subject emphasizing conceptual understanding, scientific processes, and the application of knowledge in everyday life, aligns well with the characteristics of PjBL. Through project activities, students can observe natural phenomena, conduct simple experiments, and present their findings in various formats. This process supports deep learning, as students are actively engaged at every stage of learning.

Rusilowati and Pangestu (2022) emphasized the importance of contextual and experiential learning approaches in improving science conceptual understanding. Similarly, Winarto et al. (2022) found that learning approaches linking science to cultural contexts and real-life situations enhance students' creative thinking and problem-solving skills.

In addition to improving cognitive learning outcomes, PjBL also has the potential to enhance students' motivation and engagement. Although motivation was not directly measured in this study, the significant improvement in learning outcomes may serve as an indirect indicator of increased student engagement during the learning process. This aligns with Jääskä et al. (2022), who reported that project-based and game-based learning approaches increase students' intrinsic motivation.

Studies by Gustari et al. (2025) and Sembiring and Butar-Butar (2024) further demonstrate that innovative learning models can increase elementary students' interest and learning activity. Thus, the implementation of PjBL has the potential to generate holistic impacts on students' cognitive, affective, and psychomotor development.

The findings of this study are also relevant to research on Game-Based Learning (GBL) and its integration with PjBL. Several studies indicate that combining PjBL and GBL enhances creativity, scientific literacy, and conceptual understanding (Asia et al., 2025). Although this study did not incorporate game elements, the deep learning approach employed shares similar principles, particularly the emphasis on active engagement and meaningful learning experiences (Bako et al., 2025).

Vallejo-Imbaquingo et al. (2025), in their umbrella review, affirmed that project-based and game-based learning have strong pedagogical foundations rooted in constructivist and contextual learning theories. Therefore, the results of this study may serve as a foundation for developing integrated learning models that combine PjBL, GBL, and deep learning approaches. Despite the strong effectiveness demonstrated, several limitations should be acknowledged. First, the study was conducted over only four instructional sessions, limiting conclusions about the long-term impact of PjBL. Second, the study focused primarily on cognitive learning outcomes, leaving affective and psychomotor domains underexplored (Jamaludin et al., 2024). Future research is recommended to examine PjBL implementation over longer periods and to incorporate measures of motivation, creativity, and 21st-century skills. Additionally, integrating digital technology, interactive media, and ethnoscience-based approaches may offer promising avenues for developing more comprehensive learning models (Sarwi et al., 2025).

Overall, the discussion demonstrates that Project-Based Learning with a deep learning approach makes a significant contribution to improving elementary school students' IPAS learning outcomes. These findings are supported by a growing body of research highlighting the strengths of PjBL in enhancing conceptual understanding, higher-order thinking skills, and student engagement.

With a large effect size and high effectiveness, PjBL is strongly recommended as a primary instructional model for IPAS learning in elementary schools. Consistent implementation supported by careful instructional planning is expected to enhance learning quality and help students develop deep and sustainable conceptual understanding.

## REFERENCES

- Arikunto, S. (2013). *Prosedur Penelitian: Suatu Pendekatan Praktik*. Rineka Cipta.
- Armini, N. N. S. (2025). Inovasi Pembelajaran IPA Melalui Game Based Learning Bagi Siswa Sekolah Dasar. *Jurnal Ilmiah Multidisiplin Mahasiswa dan Akademisi*, 1(2), 1-10.
- Arthana, M. P., Agustini, K., & Sudatha, I. G. W. (2024). System Literature Review: Peran Penggunaan Media Pembelajaran Interaktif Dalam Melatih Keterampilan Higher Order Thinking Skills. *Jurnal Riset dan Inovasi Pembelajaran*, 4(3), 2351-2365.
- Asia, N., Mukhlis, M., Fadilah, N., Dila, D., & Latief, S. A. (2025). Analisis Kreativitas Mahasiswa Pgsd Dalam Integrasi Media Digital Dengan Model Project Based Learning. *ELEMENTARY: Jurnal Inovasi Pendidikan Dasar*, 5(1), 23-32.
- Bako, E. N., Nasution, I. S., & Sagala, F. H. (2025). Integrasi Game Puzzle Budaya dan Model PBL-GBL untuk Meningkatkan Pemahaman Budaya Peserta Didik Sekolah Dasar dalam Pembelajaran IPAS. *Pedagogika: Jurnal Ilmu-Ilmu Kependidikan*, 5(1), 57-63.
- Baskara, F. R., Winarti, E., & Prasetya, A. E. (2024). Peningkatan Efektivitas Project-Based Learning Melalui Integrasi Kecerdasan Buatan. *Madaniya*, 5(3), 904-918.
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publications.
- Defi, K. N., Sholihat, N., & Purwanto, H. (2025). Pengembangan E-Modul Berbasis Game Based Learning Terintegrasi Nilai-Nilai Al-Islam dan Kemuhammadiyah untuk Meningkatkan Literasi Sains Siswa. *Jurnal Penelitian Ilmiah Multidisipliner*, 2(02), 449-463.
- Dewi, N. R., Rusilowati, A., Saptono, S., & Haryani, S. (2022). Project-based scaffolding TPACK model to improve learning design ability and TPACK of pre-service science teacher. *Jurnal Pendidikan IPA Indonesia*, 11(3), 420-432.
- Fakhriyah, F., Masfuah, S., Roysa, M., Rusilowati, A., & Rahayu, E. S. (2017). Student's science literacy in the aspect of content science?. *Jurnal Pendidikan IPA Indonesia*, 6(1).
- Gustari, N., Nazaruddin, I., & Fatmawati, F. (2025). The Influence of the Game-Based Learning Model on the Learning Interest and Learning Activity of Fifth Grade Students at SD Negeri 058107 Sei Dendang. *OMEGA: Jurnal Keilmuan Pendidikan Matematika*, 4(3), 370-384.
- HR, I. N., & Mandailina, V. (2024). Transformasi Pembelajaran Matematika: Dari Metode Tradisional ke Pendekatan Berbasis Teknologi. *Mathematical Proceedings of the Widya Mandira Catholic University*, 2(1), 174-190.
- Huang, W., Li, X., & Shang, J. (2023). Gamified project-based learning: A systematic review of the research landscape. *Sustainability*, 15(2), 940.
- Jääskä, E., Lehtinen, J., Kujala, J., & Kauppila, O. (2022). Game-based learning and students' motivation in project management education. *Project Leadership and Society*, 3, 100055.
- Jamaludin, D. N., Rusilowati, A., Widiyatmoko, A., Cahyono, A. N., Saptono, S., & Marianti, A. (2024). Media and Context of Science Education in TPACK: A Systematic Review. *Journal of Educational, Cultural and Psychological Studies (ECPS Journal)*, (29), 135-156.
- Khafidh, A. N., Widyawati, F., Yani, S., Nuraeni, Y., Inesrawanti, V., Salam, H. A., & Damayanti, F. (2025). Pemanfaatan Game Based Learning dan Gamifikasi Adaptif

- dalam Pembelajaran STEM: Penelitian. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan*, 4(2), 9468-9477.
- Khafidh, A. N., Widyawati, F., Yani, S., Nuraeni, Y., Inesrawanti, V., Salam, H. A., & Damayanti, F. (2025). Pemanfaatan Game Based Learning dan Gamifikasi Adaptif dalam Pembelajaran STEM: Penelitian. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan*, 4(2), 9468-9477.
- Khoironiya, F., Herliani, H., Akhmad, A., & Serena, N. A. (2025). Pengaruh Implementasi Pembelajaran Berbasis Game Wordwall terhadap Peningkatan Hasil Belajar dan Kemampuan Berpikir Kreatif Siswa. *Symbiotic: Journal of Biological Education and Science*, 6(2), 133-147.
- Kurniawan, A., Feronika, A., Liandri, T. W., Puspita, T. I., Novianti, T., Sagita, T., ... & Salmaini, S. (2025). Game-Based Learning with Educandy to Improve Indonesian Language Learning Outcomes of Grade V Elementary School Students. *TOFEDU: The Future of Education Journal*, 4(6), 1598-1603.
- Lopez-Gazpio, I. (2021). Gaining student engagement through project-based learning: A competitive 2d game construction case study. *IEEE Access*, 10, 1881-1892.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook*. Sage Publications.
- Pa, M. M. K. P. T., & Wadu, D. I. (2025). Pengaruh Model Pembelajaran Games Based Learning (GBL) Berbantuan Media Wordwall terhadap Kemampuan Numerasi Siswa SMPK Andaluri. *Jurnal Pendidikan Mipa*, 15(3), 1112-1119.
- Ramadani, M., Musarofah, D., Aqilah, N. M., & Fahrurrohman, O. (2025). Penerapan Strategi Pembelajaran Aktif untuk Meningkatkan Motivasi Belajar Siswa SD/MI. *AT-TAKLIM: Jurnal Pendidikan Multidisiplin*, 2(11), 14-28.
- Rusilowati, A., & Pangestu, M. H. (2022, February). Application of simulation integrated learning model with video assisted MIKIR approach as an effort to improve understanding of earthquake mitigation. In *IOP Conference Series: Earth and Environmental Science* (Vol. 986, No. 1, p. 012008). IOP Publishing.
- Rusilowati, A., Susanti, R., Sulistyaningsing, T., Asih, T. S. N., Fiona, E., & Aryani, A. (2021, June). Identify misconception with multiple choice three tier diagnostik test on newton law material. In *Journal of Physics: Conference Series* (Vol. 1918, No. 5, p. 052058). IOP Publishing.
- Rusilowati, A., Yulianto, A., Astuti, B., & Huda, N. (2019, October). Developing an instrument of scientific literacy assessment to measure natural science teacher candidates in force subject. In *Journal of Physics: Conference Series* (Vol. 1321, No. 2, p. 022027). IOP Publishing.
- Sari, D. S., Widiyawati, Y., Nurwahidah, I., Masykuri, M., & Budiyanto, C. W. (2021, March). The development of e-worksheet based on project to promote student's creative thinking and digital literacy skills. In *7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS 2020)* (pp. 647-654). Atlantis Press.
- Sarwi, S., Ahmadi, F., Winarto, W., Fathonah, S., & Malasari, M. (2025). The Application of Ethnoscience-Based Thematic-Integrated Book to Enhance Students' Concept Learning Outcomes and Comprehension of Culture. *European Journal of Education and Pedagogy*, 6(2), 126-132.
- Sarwi, S., Hidayah, N., & Yulianto, A. (2019, March). Guided inquiry learning model to improve the conceptual understanding and scientific work skills of high school students in Central Java. In *Journal of Physics: Conference Series* (Vol. 1170, No. 1, p. 012083). IOP Publishing.

- Sarwi, S., Marwoto, P., Susilaningsih, E., Lathif, Y. F., & Winarto, W. (2024). Science Learning STEM-R Approach: A Study of Students' Reflective and Critical Thinking. *Journal of Education and Learning (EduLearn)*, 18(2), 462-470.
- Sembiring, N. N. B., & Butar-Butar, S. N. U. (2024). Pengaruh Metode Game Based Learning Terhadap Minat Belajar Siswa Pada Mata Pelajaran IPA Kelas IV SD 040547 Laubaleng. *Jurnal Pendidikan: Media, Strategi, dan Metode*, 47-52.
- Setyoko, H., Sarwanto, Masykuri, M., & Daud, A. N. B. M. (2025). Developing Materials for Natural and Social Science Project of Motorcycle Engineering Department to Enhance Reading Literacy. *Jurnal Penelitian Pendidikan IPA*, 11(7), 238-248.
- Shrimal, D. (2024). Exploring educational paradigms: Insights from flipped classroom, project-based learning, and game-based learning models. *Journal of Engineering and Technology Management*, 72, 1-15.
- Sibarani, B. N., & Romundza, F. (2025). Pengembangan Media Pembelajaran Games Based Learning Menggunakan Wordwall Berbasis PjBL untuk Mendukung Kemampuan Kreativitas Siswa Pada Materi Sistem Koloid: Penelitian. *Jurnal Pengabdian Masyarakat dan Riset Pendidikan*, 4(1), 2184-2191.
- Sugiyono. (2019). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.
- Vallejo-Imbaquingo, R., Villacrés, R., & Torres-Toukoumidis, A. (2025). Game-Based Learning and Mobile Learning: An Umbrella Review on Pedagogical Foundations and Outcomes. In *International Workshop on Learning Technology for Education Challenges* (pp. 196-207). Springer, Cham.
- Winarto, W., Cahyono, E., & Sumarni, W. (2022). Developing a Problem-Solving Essay Test Instrument (PSETI) in the Instruction of Basic Science Concepts in Ethnoscience Context. *Journal of Turkish Science Education*, 19(1), 37-51.
- Winarto, W., Cahyono, E., Sumarni, W., Sulhadi, S., Wahyuni, S., & Sarwi, S. (2022). Science Teaching Approach Ethno-SETSaR to Improve Pre-Service Teachers' Creative Thinking and Problem Solving Skills. *Journal of Technology and Science Education*, 12(2), 327-344.
- Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods*. Sage Publications.

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