

Contextual problem-based project-based learning as an effective strategy to improve science process skills and science achievement

Nyoman Maesha Bramanda*, I Gusti Ngurah Pujawan , I Dewa Ayu Made Budhyani

Educational Research and Evaluation, Universitas Pendidikan Ganesha

Jl. Udayana No. 11, Banjar Tegal, Singaraja, Buleleng Regency, Bali 81116

**Corresponding author, e-mail: maeshabramanda@gmail.com*

ARTICLE INFO

Article history:

Received: 14-02-2026

Revised: 27-02-2026

Accepted: 25-03-2026

Keywords:

Project based learning; science process skills; science learning achievement; elementary school



This is an open access article under the [Creative Commons Attribution-ShareAlike 4.0 International](https://creativecommons.org/licenses/by-sa/4.0/) license.

Copyright © 2026 by Authors. Published by Universitas Negeri Malang.

ABSTRACT

This study examines the effect of a contextual problem-based *Project-Based Learning* (PjBL) model, assisted by E-LKPD, on the science process skills and science learning achievement of fifth-grade elementary school students. This research employed a quasi-experimental method with a posttest-only control group design involving two intact classes in the Diponegoro Cluster, West Denpasar. Data were collected using a science achievement test and an observation sheet of science process skills, and analysed using MANOVA. The results indicate that students learned through contextual problem-based PjBL, assisted by E-LKPD, achieved significantly higher science process skills and science learning achievement than those learned using conventional instruction, both partially and simultaneously. Practically, this learning model supports the implementation of the current competency-based curriculum by promoting student-centered learning, strengthening scientific inquiry skills, and facilitating meaningful science learning through contextual project activities in elementary schools.

INTRODUCTION

In the era of the Industrial Revolution 4.0 and the demands of 21st-century competencies, the field of education faces challenges in developing critical thinking skills, problem-solving abilities, collaboration, and digital literacy (Fahrozy et al., 2022; Handayani & Wulandari, 2021). The Merdeka Curriculum in Indonesia responds to these challenges by emphasising competency-based and contextual learning. However, in practice—particularly in Natural Science (*IPA*) learning at the elementary school level—this orientation is often not fully reflected. Teaching practices are still dominated by conventional models such as teacher-centered direct instruction, which limits opportunities for students to develop science process skills and achieve optimal learning outcomes (Firdaus, 2025; Istiqomah et al., 2025).

Science process skills are a set of abilities vital to students to acquire knowledge through scientific procedures. These skills include observing, classifying, measuring, predicting, concluding, and communicating findings. These skills are essential in science learning because they emphasise not only mastery of concepts but also the processes through which scientific

knowledge is obtained. Meanwhile, science learning achievement in this study refers to students' cognitive attainment based on the revised Bloom's Taxonomy, particularly at the levels of understanding (C2), applying (C3), and analysing (C4). Therefore, improving the quality of science learning should be simultaneously directed toward strengthening both process and product domains of learning.

This condition is exacerbated by Indonesia's still concerning level of scientific literacy. The results of the Trends in International Mathematics and Science Study (TIMSS) 2019 placed Indonesia's science score at 397, far below the international average of 487 (Richardson et al., 2020). Meanwhile, the Programme for International Student Assessment (PISA) 2022 reported that Indonesia ranked 68th with a science score of 398. Data from the 2023 National Assessment also revealed that more than 60% of elementary school students had not yet achieved the minimum competency in science (Wang et al., 2023). These low achievements are particularly evident in materials requiring conceptual understanding and practical exploration, such as magnetism, electricity, and technology. Observations in the Diponegoro Cluster, West Denpasar, confirmed that the main constraints include limited teacher time, facilities, and mastery in applying interactive learning models and contextual teaching materials, which ultimately result in lecture-based and one-way demonstration learning.

These conditions reflect the challenges experienced by educators in implementing 21st-century learning that requires direct student involvement in the learning process. Educational transformation in the 21st century demands instructional innovations that are not only oriented towards cognitive learning outcomes but also towards developing higher-order thinking skills, collaboration, and problem-solving abilities. Teacher-centered learning conditions have not been able to encourage active student participation and instead emphasise theoretical mastery and memorisation. In fact, the development of science process skills is closely related to students' active engagement in learning activities.

One learning model that aligns with these demands is Project-Based Learning (PjBL). Theoretically, PjBL is rooted in the constructivist paradigm, which views learning as an active process of constructing knowledge through experience. Piaget's constructivist perspective emphasises the importance of exploratory activities that align with the concrete operational cognitive development stage of elementary school students. Meanwhile, Vygotsky highlights the role of social interaction and scaffolding within the zone of proximal development. Based on these foundations, PjBL provides students opportunities to build understanding through meaningful and collaborative project activities.

The Project-Based Learning (PjBL) model is one instructional model proven to be effective in developing students' critical thinking and scientific skills (Awal et al., 2023). PjBL encourages students to learn through the completion of projects based on real and contextual problems (Ahmad & Rachmawaty, 2025). According to Erdi & Padwa (2021) and Fitri et al. (2024), the implementation of PjBL, supported by technology-based teaching materials, is able to create more meaningful and interactive learning. The success of the PjBL model is determined not only by the learning model itself but also by the teaching materials used (Habibah, 2024; Mahtumi et al., 2022). Interactive Electronic Student Worksheets (E-LKPD) serve as an alternative solution to support PjBL implementation, as they present material in digital, visual, and contextual formats. Research by De Aulia & Rukmana (2023) shows that the development of problem-solving-based E-LKPD in science learning effectively improves students' understanding of the material and their engagement in the learning process.

Recent studies increasingly strengthen empirical evidence regarding the effectiveness of integrating the Project-Based Learning (PjBL) model with Electronic Student Worksheets (henceforth, E-LKPD) in science learning through various approaches. These studies show that specially designed E-LKPD—such as those based on Problem-Based Learning (PBL) for creative thinking skills (Safitri et al., 2022; Ahmad & Rachmawaty, 2025), integrating local wisdom to foster critical thinking (Agnafia & Anfa, 2025), oriented towards Higher Order Thinking Skills (HOTS) (Surahman et al., 2018), or adopting discovery learning and STEM approaches—are proven to significantly improve students' competencies, including scientific thinking skills, problem-solving, collaboration, and scientific literacy. These cumulative findings, including

studies by [Safitri & Purnomo \(2025\)](#) and [Tarisna et al. \(2023\)](#), collectively confirm the relevance and urgency of the PjBL approach supported by interactive digital media such as E-LKPD in creating contextual, adaptive, and meaningful learning.

These studies demonstrate that the development of PjBL-based E-LKPD can increase motivation and learning outcomes. Furthermore, the integration of contextual problems into teaching materials is believed to enhance the relevance and meaningfulness of learning. According to [Putri et al. \(2025\)](#), the Contextual Teaching and Learning (CTL) approach helps students connect abstract concepts with real-life experiences, thereby stimulating greater interest and deeper understanding, as also supported by studies ([Asri, 2025](#); [Rohmahh & Rosyidi, 2022](#)). The combination of these three elements: PjBL as a pedagogical framework, E-LKPD as a digital medium, and contextual problems as content, offers a holistic solution with strong potential to address the challenges of science learning in elementary schools.

Despite its considerable potential, previous studies integrating these three elements continue to have numerous drawbacks. First, most studies on PjBL and E-LKPD focus on secondary or higher education levels ([Ansyah, 2023](#); [Sutaryani et al., 2024](#); [Resmanti et al., 2024](#)). In fact, the cognitive characteristics, interests, and learning needs of elementary school students differ significantly, requiring specifically adapted instructional and media designs. Second, existing E-LKPD developments often do not deeply and systematically integrate authentic contextual problems relevant to elementary students' daily lives. Third, a lack of quantitative research that simultaneously examines the effects of this integrated model on two key aspects: science process skills as the process domain and science learning achievement as the product domain, remains a challenge. Most studies focus on only one aspect or are limited to product development without rigorous experimental effect testing ([Pratiwi, 2024](#); [Haryanti et al., 2025](#)).

Based on these conditions, this study is decisive in addressing the limitations of previous research. This study is specifically designed for science learning in Grade 5 elementary schools by considering the concrete operational cognitive development characteristics of students. The study not only integrates PjBL and E-LKPD but also explicitly designs and implements E-LKPD containing contextual problems. The contextual problems are directly linked to themes of magnetism, electricity, and technology in students' daily lives within the Diponegoro Cluster environment, aiming to create more relevant and meaningful learning experiences. This study also adopts a quasi-experimental quantitative approach to simultaneously analyse the effects of the proposed model on two main dependant variables: science process skills and science learning achievement. Thus, this research not only tests the effectiveness of a learning innovation but also provides comprehensive empirical evidence of its impact on both the process and outcome domains of learning. The results of this study are expected to make significant contributions to both theoretical and practical educational fields.

METHOD

This study employed a quantitative method with a quasi-experimental approach. The research design applied was the Posttest-Only Control Group Design. In this design, two randomly selected groups experienced different treatments. The experimental group learned using the Project-Based Learning (PjBL) model, assisted by E-LKPD, containing contextual problems. Meanwhile, the control group received conventional instruction using the Direct Instruction model combined with the lecture method. The effectiveness of the treatment was measured by comparing the posttest scores of both groups after the intervention was completed.

The research subjects were fifth-grade elementary school students in the Diponegoro Cluster, West Denpasar District. The population consisted of 408 students distributed across 13 classes from 7 schools. Sample selection was carried out using random sampling with intact groups, in which two intact classes were randomly selected to represent the experimental and control groups. Based on the lottery results, Grade 5 of SD Negeri 1 Pemecutan (N = 31) was selected as the experimental group and Grade 5 of SD Negeri 7 Pemecutan (N = 31) as the control group. Prior to the treatment, a population equivalence test was conducted using one-way ANOVA on baseline ability data obtained from students' daily test scores at each school. The results indicated no significant differences between groups, confirming that the samples were equivalent.

The research instruments consisted of two types: non-test instruments and test instruments. The non-test instrument was an observation sheet for science process skills, completed by the teacher during learning activities. This instrument was developed based on indicators of basic science process skills, including observing, classifying, measuring, predicting, concluding, and communicating. The observation sheet used a Likert scale with a score range of 1–5. The test instrument consisted of 45 multiple-choice items designed to measure science learning achievement on the topics of magnetism, electricity, and technology. The test items were developed based on a blueprint aligned with Curriculum Learning Outcomes and Learning Objectives, and covered cognitive dimensions from C1 to C5. All instruments underwent content validation by two experts using the Gregory formula, yielding a high validity coefficient (1.00) for both instruments. In addition, the test instrument was subjected to item validity, reliability, discrimination index, and difficulty level analyses. Of the 45 items, 40 were declared valid, with a very high reliability coefficient (0.946) using the Kuder–Richardson 20 (KR-20) test.

Prerequisite assumption tests were conducted before hypothesis testing. The normality test results showed that data on science process skills and learning achievement were normally distributed. In addition, the homogeneity of variance and homogeneity of variance–covariance matrix tests indicated that the data between groups were homogeneous. Furthermore, correlation testing between dependant variables showed no high correlation, thus meeting the assumptions for MANOVA analysis. Therefore, all statistical assumptions were fulfilled, and the analysis proceeded to the hypothesis testing stage.

The data collection procedure began with a preparation stage, including the development of learning tools (lesson plans, modules, and E-LKPD) and instrument try-outs. The implementation stage was conducted over six meetings for each group. The experimental group followed the PjBL syntax assisted by E-LKPD, which consisted of six stages: (1) determining the project or contextual problem, (2) planning the project, (3) implementing the project, (4) developing the final product, (5) presentation and evaluation, and (6) reflection (Dinda & Sukma, 2021). Meanwhile, the control group learned through conventional methods involving lectures, demonstrations, and structured exercises. Data on science process skills were collected periodically through participant observation during project activities in the experimental class. At the end of the intervention (the seventh meeting), learning achievement data were collected from both groups through the administration of the same posttest. The data collected in this study included: (1) science process skills and (2) students' science learning achievement.

Data analysis was conducted in stages. First, the data were described using descriptive statistics (mean, standard deviation, and maximum and minimum scores). Second, prerequisite analysis tests took place, including data distribution normality testing using the Kolmogorov–Smirnov test, variance homogeneity testing using Levene's Test, and correlation testing between dependant variables using Pearson's Product-Moment correlation. Third, hypothesis testing employing multivariate statistical techniques, namely Multivariate Analysis of Variance (MANOVA) with SPSS, was performed. The rationale behind choosing this technique was that the study involved two potentially related dependant variables (science process skills and learning achievement). MANOVA was used to test for simultaneous significant differences between the experimental and control groups across both dependant variables. If the MANOVA results were significant, further analysis was conducted using one-way Analysis of Variance (ANOVA) separately for each dependant variable to determine the partial effects of the treatment. All statistical tests were conducted at a significance level of $\alpha = 0.05$.

RESULT

Descriptive statistical analysis was used to analyse the data by describing or illustrating the collected data in terms of the mean score and standard deviation. The results of the descriptive analysis are presented in [Table 1](#). [Table 1](#) shows a clear difference in achievement between the experimental group and the control group for both research variables, namely science learning achievement and science process skills. For the science learning achievement variable, the mean score of the experimental group that implemented the Project-Based Learning (PjBL) model

assisted by E-LKPD, containing contextual problems (77.80), was higher than that of the control group (67.93). In addition, the score range of the experimental group was higher (60 to 93) compared to that of the control group (50 to 88). For the science process skills variable, the experimental group also showed better achievement than the control group. The mean score of science process skills in the experimental group was 84.93 with a standard deviation of 8.06, while the control group obtained a mean score of 77.03 with a standard deviation of 9.91. The minimum and maximum scores in the experimental group were 67 and 98, respectively, while those in the control group ranged from 58 to 96.

Table 1. Descriptive test results

Variable	Group	N	Mean	SD	Min	Max
Learning achievement	Experimental	31	77,80	8,38	60	93
	Control	31	67,93	10,25	50	88
Science process skills	Experimental	31	84,93	8,06	67	98
	Control	31	77,03	9,91	58	96

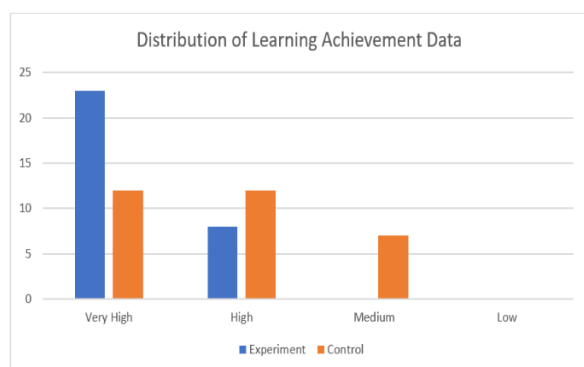


Figure 1. Distribution of learning achievement data

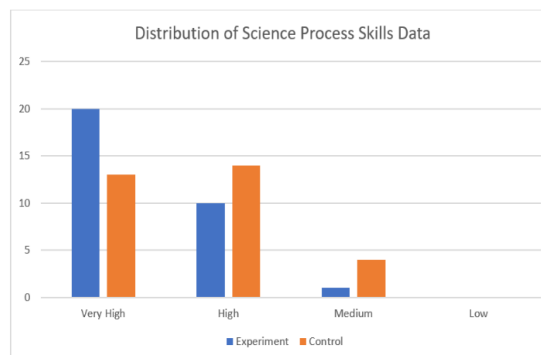


Figure 2. Distribution of science process skills data

Figure 1 presents the distribution of science learning achievement data, implying a noticeable difference in qualification distribution between the experimental class and the control class. In the experimental class, most students were in the very high qualification category (74.2%, $F = 23$ students) and the high qualification category (25.8%, $F = 8$ students), and there were no students classified as moderate, low, or very low. The categorisation of science process skills scores in this study used a criterion-referenced assessment (CRA) with a five-category scale. The category ranges were determined based on the percentage of the ideal score obtained by students relative to the maximum score. The criteria included: very high ($\geq 85\%$), high (70%–84%), moderate (55%–69%), low (40%–54%), and very low ($< 40\%$). Based on these criteria, most students in the experimental class were categorised as very high (74.2%, $F = 23$ students) and high (25.8%, $F = 8$ students), with no students in the moderate, low, or very low categories. These findings indicate that the science learning achievement of students in the experimental class was generally at a very good level. In contrast, the control class showed a more varied distribution of science learning achievement, consisting of very high (38.7%, $F = 12$ students), high (38.7%, $F = 12$ students), and moderate (22.6%, $F = 7$ students), with no students categorised as low or very low. This distribution pattern indicates that although some students in the control class achieved high learning achievement, a considerable proportion remained in the moderate category.

Figure 2 demonstrates the distribution of science process skills data. The results show that student achievement in the experimental class was dominated by the very high qualification category (64.5%, $F = 20$ students), followed by the high category (32.3%, $F = 10$ students) and the moderate category (3.2%, $F = 1$ student), with no students in the low or very low categories. This indicates that students' science process skills in the experimental class were generally in the high to very high category. Meanwhile, in the control class, the distribution of science process skills data was more evenly spread, dominated by the high category (45.2%, $F = 14$ students), followed

by the very high category (41.9%, F = 13 students) and the moderate category (12.9%, F = 4 students), with no students classified as low or very low.

The next statistical analysis was hypothesis testing to determine the effect of implementing the Project-Based Learning (PjBL) model assisted by E-LKPD containing contextual problems on students' science learning achievement and science process skills simultaneously. The statistical analysis used to test the hypothesis was Multivariate Analysis of Variance (MANOVA). This study examined the effect of one independent variable on two dependent variables at a 5% significance level. The results of the MANOVA test are presented in [Table 2](#).

Table 2. MANOVA test results

	Effect	Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0,994	4812,301b	2,000	59,000	0,000
	Wilks' Lambda	0,006	4812,301b	2,000	59,000	0,000
	Hotelling's Trace	163,129	4812,301b	2,000	59,000	0,000
	Roy's Largest Root	163,129	4812,301b	2,000	59,000	0,000
Class	Pillai's Trace	0,352	16,010b	2,000	59,000	0,000
	Wilks' Lambda	0,648	16,010b	2,000	59,000	0,000
	Hotelling's Trace	0,543	16,010b	2,000	59,000	0,000
	Roy's Largest Root	0,543	16,010b	2,000	59,000	0,000

Based on the MANOVA results shown in [Table 2](#), the significance value (p-value) obtained was 0.000 for all multivariate statistics (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root) for the class factor. This p-value is less than 0.05, indicating that H_0 is rejected and H_1 is accepted. This result shows a significant effect of implementing the Project-Based Learning (PjBL) model assisted by E-LKPD containing contextual problems on students' science learning achievement and science process skills simultaneously. Thus, it can be concluded that differences in instructional treatment between the experimental and control groups have a significant impact on both dependent variables simultaneously. Therefore, the Project-Based Learning (PjBL) model, assisted by E-LKPD containing contextual problems, is effective in improving science learning achievement and science process skills of fifth-grade students in public elementary schools within the Diponegoro Cluster, West Denpasar District.

In addition to simultaneous hypothesis testing, this study also formulated partial hypothesis tests to determine the effect of implementing the Project-Based Learning (PjBL) model assisted by E-LKPD containing contextual problems on each dependent variable, namely science learning achievement and science process skills. The results of the partial hypothesis tests are presented in [Table 3](#).

Table 3. Partial hypothesis test results

Dependant Variable	F	Sig.
Learning achievement	17,218	0,000
Science process skills	11,853	0,001

Based on [Table 3](#), the science learning achievement variable obtained an F value of 17.218 with a significance value (p-value) of 0.000 (<0.05). This result indicates that the null hypothesis was rejected and the alternative hypothesis was accepted, meaning that there was a significant effect of implementing the Project-Based Learning (PjBL) model, assisted by E-LKPD, containing contextual problems, on students' science learning achievement. For the science process skills variable, an F value of 11.853 was obtained with a significance value (p-value) of 0.001 (<0.05), indicating that the null hypothesis is rejected and the alternative hypothesis is accepted. These results show that the implementation of the Project-Based Learning (PjBL) model assisted by E-LKPD containing contextual problems has a significant effect on students' science process skills.

DISCUSSION

The effect of the PjBL model assisted by contextual problem-based E-LKPD on science process skills

The results of statistical analysis confirm that the Project-Based Learning (PjBL) model assisted by E-LKPD containing contextual problems significantly improves the science process skills of fifth-grade elementary school students compared to conventional learning. The mean score of the experimental group (84.93) clearly exceeded that of the control group (77.03), with the qualification distribution showing a greater number of students achieving the very high category. Inferential testing ($F = 11.853$; $p = 0.001$) led to the rejection of the null hypothesis, indicating a significant difference in science process skills between the two groups. These findings confirm that differences in instructional treatment have a tangible impact on the development of students' science process skills.

Theoretically, this effectiveness is consistent with the cognitive developmental characteristics of elementary school students. According to Piaget's theory, fifth-grade students are at the concrete operational stage; therefore, experience-based learning through projects is highly appropriate for developing basic scientific skills. In this study, each phase of PjBL specifically trained indicators of science process skills. During the problem orientation stage, students observed magnetic phenomena in their surrounding environment through simple demonstrations, thereby developing observation skills. In the project planning stage, students classified types of magnetic objects. Subsequently, during the investigation and product development stages, students conducted simple electrical circuit experiments that trained measuring, predicting, and data interpretation skills. During the presentation and reflection stages, students concluded the experiments and communicated their findings orally and in writing. This sequence of activities prove that PjBL not only improves learning outcomes but also directly trains each indicator of science process skills.

The role of E-LKPD in this study functioned as digital scaffolding that systematically guided students in carrying out each stage of investigation, in line with Vygotsky's concept of the zone of proximal development. The E-LKPD provided procedural steps, guiding questions, observation sheets, and reflection spaces, making students' scientific activities more structured and directed. In addition, the inclusion of contextual problems in the E-LKPD enhanced the meaningfulness of learning. This aligns with Ausubel's theory of meaningful learning, which emphasises that learning becomes more effective when new information is linked to learners' existing knowledge structures. The presentation of real-life contexts—such as the use of magnets on refrigerator doors or electrical circuits in flashlights—helped students connect abstract concepts with everyday experiences, thereby improving conceptual understanding as well as observation and analysis skills.

The results of this study are consistent with previous empirical findings. [Pratiwi \(2024\)](#) and [Rahman \(2022\)](#) also reported the effectiveness of PjBL and E-LKPD in improving science process skills. Furthermore, a meta-analysis by [Setiyadi et al. \(2024\)](#) reinforced that PjBL has a significant effect on the mastery of scientific skills. Thus, the integration of PjBL, digital media, and a contextual approach has been proven to create an optimal learning environment for the development of science process competencies in elementary schools.

The effect of the PjBL model assisted by contextual problem-based E-LKPD on science learning achievement

The research findings indicate that the PjBL model, assisted by E-LKPD, containing contextual problems, significantly improves students' science learning achievement. The experimental group obtained a mean score of 77.80, which was higher than that of the control group (67.93). The smaller standard deviation of the experimental group (8.38) compared to the control group (10.25) indicates more evenly distributed learning outcomes among students. Inferential testing ($F = 17.218$; $p = 0.000$) confirms a significant difference between the two groups.

Theoretically, these findings are consistent with the nature of science learning, which emphasises the integration of scientific products, processes, and attitudes. From a constructivist perspective, knowledge is actively constructed through meaningful learning experiences. In the

context of this study, the improvement in learning achievement occurred through several pathways. First, PjBL fostered active student engagement in problem-solving, thereby deepening cognitive processing. Second, the E-LKPD presented learning materials in a systematic and structured manner through stages of exploration, elaboration, and confirmation, facilitating better knowledge organisation. Third, contextual problems supported learning transfer by helping students understand the relevance of science concepts to real-life situations. In accordance with Ausubel's theory, linking new knowledge with prior experiences strengthens retention and conceptual understanding.

These findings are consistent with studies by [Antari et al. \(2023\)](#) and [Ansyah \(2023\)](#), which reported that integrating PjBL with digital media significantly improves science learning outcomes. Thus, this integrative model has been proven to create active, contextual, and meaningful learning experiences that optimise science academic achievement in elementary schools.

Simultaneous effects on science process skills and science learning achievement

The Multivariate analysis (MANOVA) indicates that the PjBL model assisted by E-LKPD containing contextual problems has a significant simultaneous effect on science process skills and science learning achievement ($p = 0.000$). The significance values for all multivariate statistics (Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root) were below 0.05, leading to the rejection of the null hypothesis. This result indicates that both aspects of learning develop in an integrated manner within the framework of project-based learning.

Conceptually, this simultaneous effect occurs because PjBL integrates scientific activities and conceptual understanding within a single learning cycle. Project activities train process skills, while reflection and meaning-making through E-LKPD strengthen conceptual mastery. Contextual problems serve as meaningful connectors that enable meaningful learning, as proposed by Ausubel. In addition, the analysis results indicate a tendency towards a positive relationship between science process skills and science learning achievement, suggesting that improvements in the quality of students' scientific processes align with improvements in learning outcomes.

These findings are consistent with studies by [Sutaryani et al. \(2024\)](#) and the meta-analysis by [Setiyadi et al. \(2024\)](#), which confirm that PjBL has simultaneous effects on process skills and learning outcomes. Therefore, the PjBL model assisted by E-LKPD containing contextual problems has proven effective in creating balanced science learning that integrates both process and product domains at the elementary school level.

CONCLUSION

The analysis and discussion concluded that the implementation of the Project-Based Learning (PjBL) model assisted by E-LKPD containing contextual problems significantly affects both science process skills and science learning achievement of fifth-grade elementary school students. Partially, this model is proven to be more effective than conventional learning in improving science process skills and learning achievement. Simultaneously, both variables show integrated improvement, indicating that strengthening scientific processes goes hand in hand with enhancing learning outcomes. Theoretically, these findings reinforce the constructivist perspective, Piaget's cognitive development theory, Vygotsky's zone of proximal development theory, and Ausubel's theory of meaningful learning, all of which emphasise that active, structured, and contextual learning optimises the development of scientific knowledge and skills in elementary school students. The integration of PjBL, digital E-LKPD, and contextual problems has been proven to form a complementary learning framework that facilitates meaningful learning. Practically, the results of this study imply that elementary school teachers are encouraged to implement the PjBL model assisted by E-LKPD containing contextual problems as a strategic alternative to improve the quality of science learning. For schools, these findings can serve as a basis for developing innovative digital-based learning policies. For future researchers, this model has the potential to be further examined across different subject contexts, educational levels, or experimental designs to broaden the generalisability of the findings. Thus, the PjBL model assisted by E-LKPD containing contextual problems is proven to be an effective and relevant innovation in elementary

school science learning that balances the development of both learning process and product domains.

Author contributions

The authors made significant contributions to the study's conception and design. The authors was in charge of data analysis, interpretation, and discussion of results. The final manuscript was read and approved by the authors.

Funding

There was no specific grant for this research from any funding organisation in the public, private, or nonprofit sectors.

Conflict of interest

The authors declare that there is no potential conflict of interest.

Data availability statement

All data are available from the authors.

REFERENCES

- Agnafia, D. N., & Anfa, Q. (2025). Development of project-based learning electronic student worksheets integrating Ngawi local wisdom to enhance critical thinking skills and environmental caring attitudes. *BIO-INOVED: Jurnal Biologi-Inovasi Pendidikan*, 7(1), 37–49. <https://doi.org/10.20527/bino.v7i1.20611>
- Ahmad, S. N. M., & Rachmawaty, R. (2025). Innovation in the development of project-based learning-oriented e-LKPD integrated with STEAM in biology learning. *Jurnal Penelitian Pendidikan IPA*, 11(6), 625–634. <https://doi.org/10.29303/jppipa.v11i6.11391>
- Ani, S. I., & Rosyidi, A. H. (2021). Planning contextual problem solving: Guided by formulas or context? *Edumatica: Jurnal Pendidikan Matematika*, 11(2), 73–84. <https://doi.org/10.22437/edumatica.v11i02.13344>
- Ansya, Y. A. (2023). Efforts to improve learning interest and achievement of fourth-grade elementary students in science learning using the PjBL strategy. *Jurnal Ilmu Manajemen dan Pendidikan*, 3(1), 43–52.
- Antari, P. L., Widiana, I. W., & Wibawa, I. M. C. (2023). Project-based learning electronic modules for IPAS learning to improve elementary school students' learning outcomes. *Jurnal Ilmiah Pendidikan dan Pembelajaran*, 7(2), 266–275. <https://doi.org/10.23887/jipp.v7i2.60236>
- Asri, A. Z. (2025). Development of contextual teaching and learning-based e-modules assisted by Liveworksheet to train students' higher-order thinking skills in biology [Unpublished thesis]. UIN Raden Intan Lampung.
- Awal, R., Rosadi, K. I., Hakim, L., & Dipranta, A. W. (2023). The effect of the project-based learning model on critical thinking attitudes: Analysis, problem-solving, and evaluation skills. *Jurnal Manajemen Pendidikan dan Ilmu Sosial*, 4(2), 691–698. <https://doi.org/10.38035/jmpis.v4i2>
- Dantes, N., & Handayani, N. N. L. (2021). Improving school literacy and numeracy literacy through blended learning models among fifth-grade elementary students in Singaraja City. *Widyalya: Jurnal Ilmu Pendidikan*, 1(3), 269–283.
- De Aulia, R., & Rukmana, D. (2023). Problem-solving-based E-LKPD with a contextual approach in fifth-grade elementary science learning. *Jurnal Ilmiah Pendidikan Profesi Guru*, 6(3), 636–650. <https://doi.org/10.23887/jippg.v6i3.66459>
- Erdi, P. N., & Padwa, T. R. (2021). The use of e-modules with a project-based learning system. *JAVIT: Jurnal Vokasi Informatika*, 1(1), 21–25.
- Fahrozy, F. P. N., Iskandar, S., Abidin, Y., & Sari, M. Z. (2022). 19th–20th century learning and 21st century learning in Indonesia. *Jurnal BasicEdu*, 6(2), 3093–3101.
- Firdaus, M. C. (2025). Elementary school teachers' perceptions of project-based IPAS learning. *JADIKA: Jurnal Pendidikan Guru Sekolah Dasar*, 1(2), 26–34.
- Fitri, R. A., Setiana, E., Pribadi, I. N., & Andikos, A. F. (2024). The success of project-based learning models with the aid of technology. *TOFEDU: The Future of Education Journal*, 3(5), 1883–1890. <https://doi.org/10.61445/tofedu.v3i5.319>

- Habibah, U. (2024). Penerapan model pembelajaran projec based learning untuk meningkatkan kemampuan siswa SMK Al Musyawirin. *Journal of Comprehensive Science (JCS)*, 3(4), 770-782. <https://doi.org/10.59188/jcs.v3i4.661>
- Handayani, R., & Wulandari, D. (2021). Modern assessment in facing 21st-century learning and its challenges in developing countries. *Jurnal Pendidikan Ekonomi Undiksha*, 13(1), 13–21. <https://doi.org/10.30734/jpe.v8i1.1363>
- Haryanti, Y. D. H., et al. (2025). Enhancing project-based learning through digital e-modules in elementary schools. *Jurnal Ilmiah Sekolah Dasar*, 9(2), 263–277. <https://doi.org/10.23887/jisd.v9i2.93786>
- Istiqomah, N., Yuliani, S., Scorviana, N., Fatgehipon, A. H., Agustin, F. R., Yani, N. L., & Sari, J. N. (2025). Implementasi Pembelajaran IPAS di Sekolah Penggerak SDN 02 Mampang Prapatan. *Jurnal Dunia Pendidikan*, 5(5), 1691-1702. <https://doi.org/10.55081/juridip.v5i5.3137>
- Mahtumi, I., et al. (2022). *Project-based learning*. Uwais Inspirasi Indonesia.
- Pratiwi, P. (2024). *Development of interactive PjBL-based E-LKPD integrated with scientific literacy in science learning* [Unpublished thesis]. UIN Raden Intan Lampung.
- Putri, M. A., et al. (2025). Implementing the contextual teaching and learning (CTL) model in Indonesian language learning in elementary schools. *Jurnal Penelitian dan Pengembangan Pendidikan*, 9(2), 253–262. <https://doi.org/10.23887/jppp.v9i2.93665>
- Resmanti, P., et al. (2024). Development of project-based learning e-modules for flat pattern design courses. *Journal of Innovation in Educational and Cultural Research*, 5(3), 408–416. <https://doi.org/10.46843/jiecr.v5i3.1505>
- Richardson, M., Isaacs, T., Barnes, I., Swensson, C., Wilkinson, D., & Golding, J. (2020). Trends in International Mathematics and Science Study (TIMSS) 2019: National Report for England. Research Report. *UK Department for Education*.
- Rohmahh, D. I., & Rosyidi, A. H. (2022). Analisis kegagalan siswa SMA dalam pemecahan masalah kontekstual materi kesebangunan. *MATHEdunesa*, 11(3), 765-778. <https://doi.org/10.26740/mathedunesa.v11n3.p765-778>
- Safitri, M. I., & Purnomo, T. (2025). The feasibility of project-based learning e-worksheets on ecosystems to train problem-solving skills. *Berkala Ilmiah Pendidikan Biologi*, 14(3), 563–573. <https://doi.org/10.26740/bioedu.v14n3.p563-573>
- Setiyadi, M. W., et al. (2024). Meta-analysis: The effect of project-based learning on science process skills. *Jurnal Pembelajaran dan Biologi Nukleus*, 10(1), 52–62. <https://doi.org/10.36987/jpbn.v10i1.5227>
- Surahman, E., Wedi, A., Soepriyanto, Y., & Setyosari, P. (2018, December). Design of peer collaborative authentic assessment model based on group project based learning to train higher order thinking skills of students. In *International Conference on Education and Technology (ICET 2018)* (pp. 75-78). Atlantis Press.
- Sutaryani, L. G., et al. (2024). Project-based learning on science process skills and learning outcomes in physics. *Journal of Education Research and Evaluation*, 8(4), 806–815. <https://doi.org/10.23887/jere.v8i4.83769>
- Tarisna, M. M., et al. (2023). Effectiveness of project-based learning E-LKPD in fifth-grade elementary science learning. *Jurnal Ilmiah Pendidikan Profesi Guru*, 6(2), 276–287.
- Wang, C., Zhang, M., Sesunan, A., & Yolanda, L. (2023). Peran teknologi dalam transformasi pendidikan di Indonesia. *Kemdikbud*, 4(2), 1-7.