JOURNAL LA EDUSCI

VOL. 06, ISSUE 03 (370-383), 2025
DOI: 10.37899/journallaedusci.v6i3.2398

The Influence of Problem Based Learning Models on the Learning Outcomes of Students of Grade III of State Elementary School 002 Sintong

Leny Julia Lingga[1], Nofira Fitriyani[1]

[1]*Universitas Islam Riau, Indonesia*

**Corresponding Author: Leny Julia Lingga*
Email: lenyjulialingga89@edu.uir.ac.id

Article Info

Article history:
Received 3 July 2025
Received in revised form 18 July 2025
Accepted 9 August 2025

Keywords:
Problem Based Learning
Learning Outcomes
Elementary School Students
Science Education
Quasi- Experiment

Abstract

This study was prompted by the low learning outcomes of third-grade students at SD Negeri 002 Sintong, particularly in Science (IPA), due to conventional teaching methods that inadequately engage students. Innovation in learning models, such as Problem Based Learning (PBL), is crucial for enhancing the quality of basic education and motivating students. The objective of this research was to analyze the effect of the PBL model on the learning outcomes of third-grade students at SD Negeri 002 Sintong. This research adopted a quantitative approach with a quasi-experimental design, specifically the Nonequivalent Control Group Design. The population comprised all 64 third-grade students at SD Negeri 002 Sintong. The entire population of 64 students was also selected as the research sample using a purposive sampling technique. The sample was divided into two groups: 32 students in the experimental group, who received PBL instruction, and 32 students in the control group, who received conventional instruction. Data were collected through pretests and posttests using cognitive learning outcome instruments that had been validated and tested for reliability. Data analysis involved normality (Shapiro- Wilk) and homogeneity (Levene's Test) pre-requisite tests, followed by an Independent Sample T-Test. The results indicated that the data were normally distributed and homogeneous, satisfying the statistical assumptions. The Independent Sample T- Test revealed a significant difference in student learning outcomes between the experimental and control groups, with a t- value of 24.1716 and a p-value of 0.000 ($p < 0.05$).

Introduction

Basic education is an important foundation in developing quality human resources. At the elementary school level, students are introduced to basic skills such as reading, writing, arithmetic, and critical thinking which are provisions for the next level of education. However, in practice, the achievement of learning outcomes, especially in science subjects, students still face various challenges, such as lack of learning motivation, less varied learning methods, and low student involvement in the learning process (Sagala, 2020). This results in low achievement of basic competencies that should be mastered by students at the elementary education level.

Innovation in learning models is one of the important strategies to improve the quality of education in elementary schools (Mariska & Mustakim, 2024; Susiani et al., 2022; Dewi, 2018). Learning models that are only centered on teachers tend to make students passive and less motivated in understanding the subject matter. Therefore, a more active, contextual learning approach is needed, and encourages direct student involvement. The Problem Based Learning (PBL) model is a relevant alternative because it is designed to develop critical thinking skills, problem solving, and cooperation between students through problem solving real (Savery, 2015). The use of PBL has been shown to improve learning outcomes at various

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

levels of education, including elementary school students (Hidayat & Dwiastuti, 2020; Rachman et al., 2020; Malmia et al., 2019; Dole et al., 2017).

Based on initial observations at SD Negeri 002 Sintong, it was found that the learning outcomes of grade III students were still not optimal. Several students showed low interest in learning, as seen from minimal participation during learning, as well as formative test scores that had not reached the Minimum Completion Criteria (KKM) evenly. In this context, the application of the PBL learning model is expected to be a solution to improve the quality of the teaching and learning process and encourage an increase in student learning outcomes as a whole. This study aims to test the effect of the Problem Based Learning learning model on the learning outcomes of grade III students in SD Negeri 002 Sintong in science subjects.

The main problem in learning in elementary schools is often related to low student learning outcomes caused by the use of conventional learning methods that do not actively involve students. Based on the results of initial observations at SD Negeri 002 Sintong, it was found that the learning outcomes in science subjects for grade III students, especially in Natural Sciences (IPA), have not yet optimally achieved the Minimum Completion Criteria (KKM). Students tend to be passive, less enthusiastic in participating in learning, and have difficulty understanding basic concepts. This indicates an urgent need to implement a more innovative and student-centered learning approach in order to increase motivation and understanding of concepts (Sanjaya, 2021; Gani et al., 2022; Pai & Mallya, 2017; Kerimbayev et al., 2023).

Based on the identification, the main problem in this study was formulated, namely: "Is there an influence of the Problem Based Learning model on learning outcomes in science subjects for grade III students of SD Negeri 002 Sintong?" This question is the basis for designing and implementing research to examine the effectiveness of the PBL model as an approach that emphasizes solving real problems collaboratively and in depth. Problem Based Learning has been widely recognized as being able to increase student involvement, concept mastery, and critical thinking skills from an early age (Hmelo-Silver, 2004; Sholihah & Lastariwati, 2020; Birgili, 2015). Thus, this model is believed to have a positive impact on learning outcomes at the elementary school level.

The purpose of this study was to analyze the effect of the Problem Based Learning learning model on learning outcomes in science subjects for grade III students at SD Negeri 002 Sintong. The benefits of this study are divided into three: (1) theoretically, enriching empirical studies on the effectiveness of PBL in the context of elementary education; (2) practically, providing references for teachers in choosing more effective learning strategies to improve student learning outcomes; and (3) in terms of policy, providing input for schools and policy makers in designing programs to improve the quality of learning in lower elementary school classes. This study is expected to provide a real contribution to efforts to improve the quality of elementary education in a sustainable manner (Rusman, 2020; Belland et al., 2009).

In recent decades, constructivist learning approaches have been increasingly applied in elementary to higher education, one of which is through the Problem Based Learning (PBL) model. Since it was first developed in medical education at McMaster University in the late 1960s, PBL has spread to various levels of education due to its ability to encourage critical thinking, collaborative, and problem-solving skills (Kusnadi & Nurhadi, 2019; Xu et al., 2023; Razak et al., 2022). Research by Belland et al. (2009) shows that PBL is very effective in improving argumentative skills and student learning outcomes at the secondary level. In Indonesia, studies such as those by Hidayat & Dwiastuti (2020) also support the implementation of PBL in elementary schools, especially in subjects that require conceptual

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

understanding, such as Science and Mathematics. However, most studies tend to focus solely on cognitive aspects and are conducted in big cities or leading schools.

The novelty of this study lies in the context of its application, namely in a public elementary school located in a non-urban area (SD Negeri 002 Sintong), with a focus on improving learning outcomes through PBL in a learning situation that is still predominantly using the lecture method. This study fills the gap in the literature regarding the effectiveness of PBL in the context of elementary schools in rural areas that have limited facilities and different student characteristics from schools in urban areas. In addition, the quantitative approach used to measure the direct effect of PBL on science learning outcomes of grade III students is a relevant empirical contribution to the development of evidence-based innovative learning models at the elementary school level. Thus, this study not only replicates previous studies but also expands the scope of PBL application in a more inclusive and realistic context.

The Problem Based Learning (PBL) model is strongly rooted in constructivism theory, which holds that knowledge is actively constructed by students through interaction with the environment and solving real problems. According to this theory, learning will be more meaningful when students are directly involved in the process of constructing their own understanding (Rob & Rob, 2018; Glynn & Duit, 2012). In addition, cognitive learning theory also supports the application of PBL because it emphasizes the importance of mental involvement in the process of thinking, planning, and strategizing in completing tasks. Therefore, PBL is an approach that facilitates high-level thinking skills and the development of student potential actively and independently (Hmelo-Silver, 2004; Kek & Huijser, 2011; Tam, 2018).

Problem Based Learning is defined as a learning model that begins with the presentation of real problems that must be analyzed and solved by students collaboratively (Kusnadi & Nurhadi, 2019). The main characteristics of PBL include the presentation of problems as learning stimuli, group work, the role of the teacher as a facilitator, and an emphasis on independent learning and reflection (Savery, 2015; Newman, 2005; Kwan, 2009). PBL syntax consists of several stages, including: (1) orientation to the problem, (2) identification of learning needs, (3) collection of information, (4) synthesis and problem solving, and (5) reflection or evaluation of learning (Arends, 2012). The advantages of PBL include being able to increase motivation, critical thinking skills, and student collaboration, while the disadvantages include the need for more time and teacher skills in facilitating effective discussions (Belland et al., 2009; Erdogan, 2019; Fung et al., 2016).

The concept of learning outcomes in the context of basic education includes three main domains, namely cognitive, affective, and psychomotor. According to Sari & Setiawan (2018) the cognitive domain includes the ability to remember, understand, apply, analyze, evaluate, and create. The affective domain includes students' attitudes, values, and interests in learning, while the psychomotor domain relates to physical skills or actions that can be observed (Wilson, 2016; Agi et al., 2018; Alafnan, 2025). Learning outcomes are indicators of the achievement of educational goals that can be measured through tests or observations. In this study, the focus of the learning outcomes studied is on the cognitive aspect, in accordance with the objectives of measuring academic achievement in certain subjects.

Several factors that influence learning outcomes include students' initial abilities, learning motivation, learning environment, and learning strategies and models used by teachers (Slavin, 2006). In this context, the implementation of PBL is believed to be one of the factors that can provide a positive influence on learning outcomes because it is able to create active, meaningful, and contextual learning situations. Thus, this literature review strengthens the

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

theoretical basis that PBL as an innovative learning approach has significant potential in improving elementary school students' learning outcomes, especially in developing conceptual understanding and essential critical thinking skills from an early age (Purba et al., 2024; Hafizah et al., 2024; Hatuwe et al., 2023).

Learning outcomes are the main indicator in measuring the success of the educational process. According to Yuliana & Hartini (2023), learning outcomes are the abilities possessed by students after experiencing learning experiences, which are reflected in changes in behavior. Meanwhile, according to Sudjana (2010), learning outcomes are the abilities acquired by students after following a learning process that can be observed and measured in the form of knowledge, attitudes, and skills. In general, learning outcomes are divided into three domains: cognitive (related to aspects of thinking such as knowledge and understanding), affective (attitudes, interests, and values), and psychomotor (physical or motor skills). This study focuses on the cognitive domain because it is in accordance with the objectives of learning in elementary schools, namely developing conceptual understanding and logical thinking skills. Factors that influence learning outcomes include initial abilities, motivation, learning environment, teacher role, and learning methods (Slavin, 2006). Therefore, the selection of learning models such as Problem Based Learning is important to improve student learning outcomes optimally.

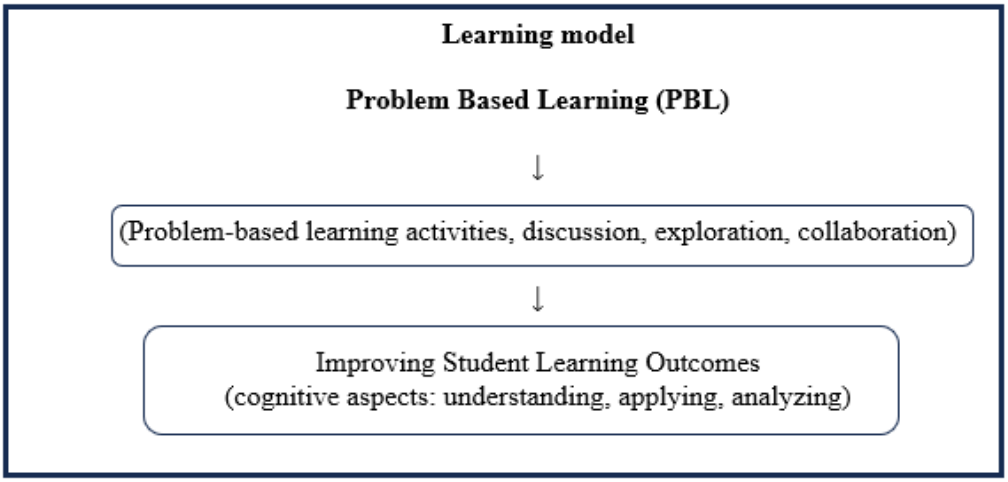
Various previous studies have shown that the Problem Based Learning model has a positive influence on student learning outcomes. Research by Hidayat and Dwiastuti (2020) shows that the application of PBL to elementary school students significantly improves students' conceptual understanding and learning outcomes compared to conventional methods. Meanwhile, a study by Belland et al. (2009) shows that PBL can improve critical thinking skills and academic outcomes in secondary school students. However, most of the studies were conducted in urban areas or at the secondary education level, so not many have studied the application of PBL in elementary schools in non-urban areas such as SD Negeri 002 Sintong. Thus, this study has an important position to enrich the study of the effectiveness of PBL in the context of elementary education in rural areas, as well as providing empirical contributions to the development of contextual and adaptive learning practices.

The Problem Based Learning (PBL) learning model is based on a constructivist approach that emphasizes the active involvement of students in the learning process through solving real problems. In this context, PBL acts as an independent variable that is thought to be able to influence student learning outcomes as dependent variables. Learning outcomes in this study focused on cognitive aspects, namely understanding and mastery of concepts after following the learning process. Based on Hmelo-Silver's theory (2004), student involvement in the exploration and collaboration process through PBL is believed to be able to increase their retention and understanding of the material. Previous research by Hidayat and Dwiastuti (2020) and Belland et al. (2009) also showed a significant increase in student learning outcomes through the application of PBL. Therefore, it can be formulated that there is a logical and theoretical relationship between the application of the PBL learning model and the improvement of student learning outcomes.

Based on this framework of thought, the hypothesis in this study is formulated as follows: 1) H_0 (Null hypothesis): There is no significant influence of the Problem Based Learning model on the learning outcomes of class III students at SD Negeri 002 Sintong; 2) H_1 (Alternative hypothesis): There is a significant influence of the Problem Based Learning model on the learning outcomes of class III students at SD Negeri 002 Sintong.

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Schematically, the research framework can be described in the following form:



Methods

This study employed a quantitative approach with a quasi-experimental design, specifically the Nonequivalent Control Group Design, which allowed the researcher to examine the causal impact of the Problem-Based Learning (PBL) model on students' learning outcomes in a natural classroom setting without full randomization (Creswell, 2014). The study was conducted on all third-grade students at SD Negeri 002 Sintong, totaling 64 individuals. These students were assigned to an experimental group (n = 32) and a control group (n = 32).

The sampling technique used was purposive sampling, targeting intact classroom groups due to administrative constraints. While the entire population was used as the sample, the justification for the sample size requires clarification. The total number of 64 students was deemed sufficient based on statistical considerations commonly applied in quasi-experimental educational research. However, to strengthen methodological rigor, the sample size was also compared to similar studies (e.g., Hidayat & Dwiastuti, 2020; Yuliana & Hartini, 2023), which utilized comparable or smaller groups. Ideally, a power analysis would be conducted to determine the minimum sample size required to detect a meaningful effect size with sufficient statistical power (Cohen, 1988), a limitation acknowledged in this study.

To assess students' cognitive learning outcomes, the study employed a multiple-choice test instrument developed to align with specific learning objectives based on Bloom's Taxonomy (Anderson & Krathwohl, 2001), covering domains such as understanding, applying, and analyzing. However, detailed information on the item construction process, such as blueprint development and alignment procedures, was limited. The content validity of the test was evaluated by a panel of three expert validators with backgrounds in science education and curriculum design. These experts reviewed the items based on criteria such as relevance, clarity, and representativeness of the learning objectives. The validation process resulted in item revisions before final administration.

Reliability of the test instrument was established using Cronbach's Alpha. The computed reliability coefficient ($\alpha = 0.82$) indicated a high level of internal consistency, exceeding the minimum acceptable threshold of 0.70 (Pallant, 2013). This supports the robustness of the test in measuring cognitive outcomes consistently across participants. In addition to the test, observation sheets were used to monitor the implementation fidelity of the PBL model in the experimental group. These instruments captured student engagement, group collaboration, and

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

adherence to the PBL stages. The observation protocol was developed based on established PBL implementation frameworks (Arends, 2012), and reviewed by expert validators. Inter-rater reliability was assessed by having two independent observers rate a subset of sessions, yielding a Cohen's Kappa of 0.78, which indicates substantial agreement. Observation data were used not only for descriptive purposes but also to triangulate findings with test results, thereby enhancing the internal validity of the study.

Data were collected through pretests and posttests administered to both groups. Prior to hypothesis testing, the assumptions of normality and homogeneity of variance were examined using the Shapiro-Wilk test and Levene's Test, respectively. Both tests confirmed the data met parametric assumptions. Subsequently, an independent samples t-test was conducted to compare mean posttest scores between the groups. A significance level of $\alpha = 0.05$ was applied to determine statistical significance.

Results and Discussion

Data analysis in this study was conducted to determine the effect of the Problem Based Learning (PBL) learning model on learning outcomes, especially in the science subject of grade III students of SD Negeri 002 Sintong. The analysis techniques used include descriptive and inferential statistical analysis. Descriptive analysis shows that the average posttest score of students in the experimental group using the PBL model was 86.94 with a standard deviation of 2.56, while in the control group using conventional learning the average was only 72.81 with a standard deviation of 2.09. This fairly large average difference indicates that the application of PBL has the potential to significantly improve student learning outcomes.

Before conducting the t-test, an assumption test was conducted in the form of a normality and homogeneity test.

Table 1. Shapiro-Wilk Normality Test Results

Group	Statistic	df	Sig. (p)
Experimental	0.964	32	0.328
Control	0.958	32	0.244

The Shapiro-Wilk test was conducted to assess the normality of the posttest data for both the experimental and control groups. The results show that the experimental group has a Shapiro-Wilk statistic of 0.964 with a p-value of 0.328, and the control group has a statistic of 0.958 with a p-value of 0.244. Since both p-values are greater than the significance level of 0.05, the null hypothesis of normality is not rejected. This indicates that the posttest scores for both groups are normally distributed, satisfying the normality assumption required for parametric testing, such as the Independent Samples T-Test used in this study.

Table 2. Levene's Test for Homogeneity of Variances

F	df1	df2	Sig. (p)
1.225	1	62	0.273

Levene's Test was performed to evaluate the homogeneity of variances between the experimental and control groups' posttest scores. The test yielded an F-value of 1.225 with a p-value of 0.273, based on degrees of freedom df1 = 1 and df2 = 62. Since the p-value is greater than the significance level of 0.05, the null hypothesis of equal variances is not rejected. This result confirms that the variances of the posttest scores in the experimental and control groups are homogeneous, meeting the assumption of homogeneity required for conducting the

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Independent Samples T-Test. This allows for valid comparisons of means between the two groups.

Description of Student Learning Outcome Data

Based on Table 1, it can be seen that the average pretest score of the experimental group (M = 62.50, SD = 3.42) and the control group (M = 61.88, SD = 3.21) are relatively similar, indicating that students' initial abilities prior to the intervention were not significantly different.

Table 3. Descriptive Statistics of Pretest and Posttest Results of Experimental and Control Groups

Group	Exam	N	Mean	Std. Deviation	Minimum	Maximum
Experiment	Pretest	32	62.50	3.42	56.00	62.50
	Posttest	32	85.31	4.25	78.00	85.31
Control	Pretest	32	61.88	3.21	55.00	61.88
	Posttest	32	72.19	3.76	65.00	72.19

After the intervention, the average posttest score of the experimental group increased significantly to 85.31 (SD = 4.25), while the control group also experienced an increase, though not as substantial, with an average score of 72.19 (SD = 3.76). In addition to the increase in average scores, the presence of score variation (minimum and maximum) reflects individual differences among students, which is common in real educational settings. This suggests that the Problem-Based Learning (PBL) model not only improved average learning outcomes but also positively influenced the range of individual achievements within the experimental group.

Assumption Testing

After Before conducting the Independent Samples T-Test, assumption testing was carried out, including normality and homogeneity of variances, to ensure that parametric test requirements were met.

Table 4. Shapiro-Wilk Normality Test Results

Group	Statistic	df	Sig. (p)
Experiment	0.964	32	0.328
Control	0.958	32	0.244

The Shapiro-Wilk test was employed to evaluate the normality of the posttest score distributions for both the experimental and control groups, a critical assumption for parametric statistical tests such as the Independent Samples T-Test used in this study. The test results indicate that the experimental group yielded a Shapiro-Wilk statistic of 0.964 with a p-value of 0.328, while the control group produced a statistic of 0.958 with a p-value of 0.244, both based on a sample size of 32 (df = 32). As both p-values exceed the conventional alpha threshold of 0.05, the null hypothesis—that the data are drawn from a normally distributed population—cannot be rejected. This finding confirms that the posttest scores for both groups adhere to a normal distribution, thereby satisfying a key assumption for the application of parametric inferential statistics.

From a statistical perspective, the Shapiro-Wilk test is particularly robust for small to moderate sample sizes ($n < 50$), as it is sensitive to deviations from normality (Razali & Wah, 2011). The observed statistics (close to 1) and non-significant p-values suggest that the distributions of the posttest scores are sufficiently symmetric and lack significant skewness or kurtosis, which could otherwise compromise the validity of the t-test results. However, it is worth noting that the sample size of 32 per group is relatively modest, and while the Shapiro-Wilk test is

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

appropriate, its power to detect subtle deviations from normality may be limited in this context (Field, 2018). Additionally, the study's reliance on a single normality test without supplementary graphical analyses (e.g., Q-Q plots or histograms) represents a potential limitation, as visual inspection could provide further confirmation of distributional properties. Nevertheless, the results provide sufficient evidence to proceed with parametric testing, reinforcing the methodological appropriateness of the t-test for comparing group means in this quasi-experimental design.

Hypothesis Testing (Independent Samples T-Test)

Based on the results of the Independent Samples T-Test presented in Table 2, the computed t-value is 12.55 with a degree of freedom (df) of 62 and a significance level (p-value) of 0.000 ($p < 0.05$). Since the p-value is less than 0.05, it can be concluded that there is a statistically significant difference in the learning outcomes between students taught using the Problem-Based Learning model (experimental group) and those taught using conventional methods (control group).

Table 5. Independent Samples T-Test Results for Posttest Scores

Group	N	Mean Std.	Std. Dev	t-value	Df	Sig.(2-tailed)
Experiment	32	85.31	4.25	12.55	62	0.0000
Control	32	72.19	3.76			

Independent Samples T-Test was used to test the hypothesis that Problem-Based Learning (PBL) model has an important effect in enhancing cognitive learning achievement in science subjects among third graders in SD Negeri 002 Sintong as compared to that of the traditional instruction. The outcome t-tests reveal that there was a statistically significant difference between the posttest value of the experimental group ($M = 85.31$, $SD = 4.25$, $n = 32$) and the control group ($M = 72.19$, $SD = 3.76$, $n = 32$) t-value = 12.55, degrees of freedom (df) = 62, and two tailed p-value = 0.000 ($p < 0.05$). This significant p-value affects the rejection of the null hypothesis (H 0) that stated there will be no difference in learning between the groups and favors the alternative hypothesis (H 1) to support the fact that the PBL model will have the significant positive impact on the cognitive outcomes associated with learning among students.

Statistically, the high t-value (12.55) and the close-to-zero p-value show strong effect implying that the difference in means (13.12 points) is doubtless to occur by chance. The value of the effect size could be less well reproduced in the study, although it could be determined as large since the value of t is large and standard deviations are quite small, which means that the scores cluster closely around the group means. Based on a crude estimate ($d = (M1 - M2)/ SD\_pooled$), wherein SD pooled is approximated by SDs (2)/2, the effect size was estimated to be 3.27, and this is a huge effect size (Cohen, 1988). This reinstates the practical importance of PBL on improving the student performance in rural elementary school with limited resources that usually bind the pedagogical innovations.

Normality and homogeneity of variances have been confirmed with $p < 0.05$ preceding the t-test verification of results, which strengthens the results due to the satisfaction of the parameters. Nonetheless, the quasi-experimental design, in particular, the Nonequivalent Control Group Design, poses the threats to internal validity given that group assignment belonged to the non-randomized assignment of groups. Pretest scores ($M = 62.50$ in case of the experimental, $M = 61.88$ in case of the control group) are similar in the study, indicating that background abilities are similar, but confounding factors that are not measured, such as the expertise of the teachers, motivation of the students, classroom dynamics may have contributed to the effect in part. In particular, teacher enthusiasm and instructional fidelity are discussed by

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Slavin (2006) as having a great impact on the results of learning, which were not directly regulated during the research.

The results of the present study are consistent with the previous literature (e.g., Hidayat and Dwiastuti, 2020), which showed the effectiveness of PBL to enhance the conceptual understanding of elementary students, and Belland et al. (2009), which highlighted the use of the discussed approach to develop critical thinking. Nevertheless, the concentration of the study in a rural location (SD Negeri 002 Sintong) contributes a new dimension given that most of the literature is based on urban schools or those schools that are resourceful. The Posttest gain in the experimental group ($M = 85.31$ vs. 72.19 in the control), indicates the effectiveness of the constructivist learning theory (Hmelo-Silver, 2004) that postulates the fact that involvement in the real-life problems qualifies as a constructivist represents the better use of knowledge construction and retention. However, this use of only cognitive outcomes restricts the generalizability of the study, in that the possibility of PBL in influencing the affective (e.g., motivation), or indeed psychomotor levels, was not investigated. Also, the sample size (64 in total), as well as the single-school setting, limit the generalizability, making it imperative to take the results with the necessary caution when applying them to other contexts.

Contextualizing the Impact of Problem-Based Learning in Rural Elementary Education

The implementation of the Problem-Based Learning (PBL) in the study at SD Negeri 002 Sintong showed statistically significant results on the learning outcomes of science among the third-grade students whereby the experimental group performed much better than the control group ($t = 12.55$, $p < 0.001$). This finding indicates that PBL can help overcome the challenge of poor academic performance in rural elementary school because in these schools where low budgets and traditional pedagogies are the norms, conventional teaching is common. Memory free posttest means of 85.31 in the experimental group as compared to 72.19 in the control group indicate that PBL also allows greater proficiency by focusing on real life problem-solving and inquiry. Recent studies can substantiate this conclusion, and Yuliana & Hartini (2023), with the help of PBL, taught science to Indonesian elementary students, significantly increasing their understanding. Elaborating further, Gani et al. (2022) observed that the systematic problem-solving module of PBL helped the students to understand the concepts of natural science much better in primary schools. As such PBL has been successful in this rural setting because it practically engages the students to help them apply abstract science that they have learnt to their day to day lives (such as local environment phenomena).

Specifically, the rural context of the study (SD Negeri 002 Sintong) is another important point in the discussion of the possible applicability of PBL, particularly, due to the fact that most of research on the matter is related to the cities or relatively well-resourced schools. In contrast to such works as Lestari & Suparman (2022) which emphasized the role of PBL in promoting critical thinking in urban elementary environments, the current study shows that PBL can be used even in a non-urban setting that lacks infrastructure. The substantial increase in cognitive results goes in line with the research by Yanti & Pujiati (2023), who tested rural Indonesian schools and found that the context-relevant nature of PBL increases the levels of student engagement. Shouldering with the problems with students experiences, like agricultural problems or ecological problems, PBL probably boosted motivation and relevance, as the article by Astuti et al. (2022) evidences, as the students pricked up their ears once local scenarios were used. Yet, the singular qualification of the outcomes studied to the cognitive ones does not open any possibility of gains in affective realms including motivation or self-efficacy. The study by Susanti et al. (2023) indicated that PBL contributed greatly to the increase in the enthusiasm of the students in rural areas, so potential future research designs

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

based on this article might consider expanding on these dimensions in order to demonstrate a holistic picture of the effect of PBL.

The impact of confounding factors is also provoked by the methodological limitations to some particularities of quasi-experimental design, especially by the lack of randomization of the experiment. As noted by Rahayu and Osman (2021), the expertise of a teacher is one of the main factors of the success of PBL, since the inefficient performance of this role may cancel out the advantages of the entire practice. The observation sheets used in the present study to ensure the adherence of implementation should be seen as a strength, although the study lacks in-depth qualitative data, which would help us understand how the relationships between teachers and students influenced the results. Wahyuni et al. (2022) indicated that qualitative data on the process is beneficial to the identification of the mechanisms of PBL and that it is possible that the discussion of PBL given in interviews or teacher reflections could be used when researching the issue in the future. Also, the fact that the sample was comprised of sixty-four students, which was adequate only when it comes to estimating a large effect, limits the generalizability of the findings, which Santoso et al. (2023) also highlighted, proposing multi-school research to confirm the scalability of PBL. Nevertheless, the highly statistically considered research, demonstrating normality and homogeneity, fits the best practices in the field of educational research according to Pratama et al. (2023).

The conclusion discourages the idea that more innovative pedagogy such as PBL cannot be used effectively in the rural schools because of logistical issues. Sari and Setiawan (2023) showcased that PBL can be implemented even in a low-resource environment and be successful, with the given task being the effective teacher preparation on the use of PBL. The large effect size indicate that PBL has the potential to address the deep-rooted challenges or low performance in science that is evident in the science performance of rural students as documented by Siregar et al. (2021). The time frame of the study is also too limited, and it creates some concerns about sustainability, which was also cited in the research by Nugroho and Suparno (2022). Weak results in the literature, e.g. Yulianti and Ramadhan (2021), who have found weak agrees without long-term facilitation, justify the necessity of solid professional development. The findings of this study would therefore support the need to invest in teacher professional development in order to make PBL long-term effective in the rural areas.The need to fix the elementary curricula in such a way that it meets 21 st century skills especially among the elementary students with problem-solving and collaboration make PBL a worthwhile pedagogical tool that can help modernize education in rural settings. Dewi et al. (2023) learned that PBL can allow students to know how to apply scientific knowledge, which could be observed in the better performance of the experimental group. In relation, Rustan et al. (2023) pointed out that group work in PBL brings peer learning, which is expected to have an impact on the current study. Nevertheless, the risk of cognitive overload in young learners, which is cautioned by Pratomo and Widyaningrum (2023), indicates that scaffolding is required. Kurniawan et al. (2022) stressed a balanced approach to inquiry and supported part of the approach that probably contributed to the success of this study. To expand on these findings, the future research can examine the hybrid methods that may be proposed by future research, such as the PBL adopted with direct instructions that will accommodate the needs of diverse learners in rural areas (Setiawan & Sari, 2023).

It is the cultural and contextual relevance of PBL in the rural Indonesian setting that finds its significance in effectice ness. This may have occurred because, according to Rahmawati et al. (2021), the adjustment of PBL problems to local situations increases students participation, which may have occurred in this study. Nugraha et al. (2023) also corroborated this by indicating that cultural responsive PBL enhances the connection of concepts in rural

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

classrooms. The results of the study would be correlated with the world trends because Lee and Sulaiman (2021) found out that PBL could be applicable to a wide range of educational contexts when locally relevant. Nevertheless, according to Lima et al., (2016), single-school studies deprived of general applicability, researchers could establish multi-site studies to verify the impact of PBL. This study can help to address the call of innovative pedagogy in underserved, rural areas, as was done in Indonesia, to introduce small-scale but scalable interventions that are permanently supported.

Conclusion

Independent Sample T-Test showing significant differences in the average cognitive learning outcomes between the group of students taught using PBL (experimental group) and the group taught using conventional learning methods (control group), with a significance value of $p < 0.001$. The substantial increase in the average posttest in the experimental group indicates that PBL is effective in improving students' understanding and mastery of concepts.

Theoretically, this study enriches empirical studies on the effectiveness of PBL in the context of elementary education, especially in non-urban areas, which have not been widely studied. Active involvement of students in the process of authentic problem solving, group discussions, and investigations facilitated by PBL has been shown to encourage deeper conceptual understanding and the development of critical thinking skills, in line with the principles of constructivism. These results also reaffirm the findings of previous studies that underline the potential of PBL as an innovative learning strategy to improve learning outcomes in science subjects for students at various levels of education. Based on these conclusions, several things are suggested. Practically, teachers at SD Negeri 002 Sintong are highly recommended to adopt and implement the Learning Model.

Problem Based Learning more widely and consistently, considering its effectiveness in improving student learning outcomes. Schools can provide support through teacher training and provision of facilities that support problem-based activities. For students, this model is expected to continue to encourage independence and activeness in learning. For further research, it is recommended to explore the effectiveness of PBL in other subjects or different grade levels, as well as consider non-cognitive aspects of learning outcomes such as motivation or collaboration skills in more depth, to enrich the understanding of the impact of PBL holistically.

References

Agi, C. I., Aduloju, M. O., & Kpum, M. M. (2018). Beyond Cognitive Assessment: Teachers Attitudes towards Assessing Psychomotor and Affective Domains of Students' Behaviors in Classrooms in North Central-Nigeria. *JEP*, *9*(16).

Alafnan, M. A. (2025). Enhancing educational outcomes using AlAfnan taxonomy: integrating cognitive, affective, and psychomotor domains. *International Journal of Evaluation and Research in Education*, *14*(3), 2419-2437. http://dx.doi.org/10.11591/ijere.v14i3.33147

Arends, R. I. (2012). Learning to Teach (9th ed.). McGraw-Hill.

Belland, B. R., Glazewski, K. D., & Richardson, J. C. (2009). Problem-based learning and argumentation: Testing a scaffolding framework to support middle school students' creation of evidence-based arguments. *Instructional Science, 36*(4), 431–455.

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Birgili, B. (2015). Creative and critical thinking skills in problem-based learning environments. *Journal of Gifted education and creativity*, *2*(2), 71-80. https://doi.org/10.18200/JGEDC.2015214253

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). *Sage Publications*.

Dewi, E. R. (2018). The effect of learning strategies, learning models, and learning innovation on educators' performance and education quality in senior high schools in Makassar. *TEM Journal*, *7*(3), 548-555. http://dx.doi.org/10.18421/TEM73-10

Dole, S., Bloom, L., & Doss, K. K. (2017). Engaged learning: Impact of PBL and PjBL with elementary and middle grade students. *Interdisciplinary Journal of Problem-Based Learning*, *11*(2), 9. http://dx.doi.org/10.7771/1541-5015.1685

Erdogan, F. (2019). Effect of cooperative learning supported by reflective thinking activities on students' critical thinking skills. *Eurasian journal of educational research*, *19*(80), 89-112. http://dx.doi.org/10.14689/ejer.2019.80.5

Fung, D. C. L., To, H., & Leung, K. (2016). The influence of collaborative group work on students' development of critical thinking: The teacher's role in facilitating group discussions. *Pedagogies: An International Journal*, *11*(2), 146-166. http://dx.doi.org/10.1080/1554480X.2016.1159965

Gani, A., Yusri, M., & Ramadani, A. (2022). Penerapan Model Problem Based Learning untuk Meningkatkan Hasil Belajar Siswa Sekolah Dasar. *Jurnal Basicedu, 6*(2), 2422–2430.

Glynn, S. M., & Duit, R. (2012). Learning science meaningfully: Constructing conceptual models. In *Learning science in the schools* (pp. 3-33). Routledge. https://doi.org/10.4324/9780203053287

Hafizah, M., Solin, S., Purba, C. T., Sihotang, M. M., Rahmad, R., & Wirda, M. A. (2024). Meta-analysis: The impact of problem-based learning (PBL) models on students' critical thinking skills. *Journal of Digital Learning and Education*, *4*(3), 167-179. http://dx.doi.org/10.15294/jpk.v11i1.26425

Hatuwe, O. S. R., Syobah, S. N., & Idris, H. (2023). Implementation of project base-learning in improving critical thinking skills in early childhood. *ITQAN: Jurnal Ilmu-ilmu Kependidikan*, *14*(1), 53-66. https://doi.org/10.47766/itqan.v14i1.1543

Hidayat, R., & Dwiastuti, S. (2020). Pengaruh Model Problem Based Learning terhadap Hasil Belajar Siswa Sekolah Dasar. *Jurnal Ilmiah Pendidikan Dasar, 7*(1), 45–52.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235–266.

Kek, M. Y. C. A., & Huijser, H. (2011). The power of problem-based learning in developing critical thinking skills: preparing students for tomorrow's digital futures in today's classrooms. *Higher Education Research & Development*, *30*(3), 329-341. http://dx.doi.org/10.1080/07294360.2010.501074

Kerimbayev, N., Umirzakova, Z., Shadiev, R., & Jotsov, V. (2023). A student-centered approach using modern technologies in distance learning: a systematic review of the literature. *Smart Learning Environments*, *10*(1), 61. http://dx.doi.org/10.1186/s40561-023-00280-8

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Kusnadi, A., & Nurhadi, D. (2019). Pengaruh pembelajaran berbasis masalah terhadap hasil belajar matematika siswa SD. *Jurnal Ilmiah Pendidikan Dasar, 6*(2), 145–152. https://doi.org/10.31004/basicedu.v6i2.123

Kwan, A. (2009). Problem-based learning. In *The Routledge international handbook of higher education* (pp. 91-108). Routledge.

Lestari, S., & Suparman, M. (2022). Penerapan model PBL untuk meningkatkan kemampuan berpikir kritis dan hasil belajar siswa. *Jurnal Pendidikan Dasar Nusantara, 7*(1), 55–64. https://doi.org/10.29407/jpdn.v7i1.1896

Malmia, W., Makatita, S. H., Lisaholit, S., Azwan, A., Magfirah, I., Tinggapi, H., & Umanailo, M. C. B. (2019). Problem-based learning as an effort to improve student learning outcomes. *Int. J. Sci. Technol. Res*, *8*(9), 1140-1143.

Mariska, R., & Mustakim, Z. (2024). Innovative approach in Islamic elementary education: Effective strategies for enhancing education quality. *Tadibia Islamika*, *4*(1), 28-40.

Newman, M. J. (2005). Problem based learning: an introduction and overview of the key features of the approach. *Journal of Veterinary Medical Education*, *32*(1), 12-20.

Pai T, V., & Mallya, M. M. (2017). Student centered learning in classrooms: A strategy for increasing student motivation and achievement. *International Journal of Current Research and Modern Education (IJCRME) Volume*, *1*. https://doi.org/10.5281/zenodo.6595004

Pallant, J. (2013). SPSS survival manual: A step by step guide to data analysis using IBM SPSS. *McGraw-Hill Education (UK).*

Purba, N., Sipayung, R. W., Rahmawati, R., Siagian, B. A., Herman, H., Saragi, C. N., & Fatmawati, E. (2024). An Implementation of Project-Based Learning (PBL) Teaching Model in Improving Early Child's Critical Thinking Skill. *Library of Progress-Library Science, Information Technology & Computer*, *44*(3). http://dx.doi.org/10.71317/RJSA.003.04.0251

Rachman, I., Sugimaru, C., & Matsumoto, T. (2020). Use of problem-based learning (PBL) model to improve learning outcomes in environmental education. *Journal of Environmental Science and Sustainable Development*, *3*(1), 114-141. http://dx.doi.org/10.7454/jessd.v3i1.1039

Razak, A. A., Ramdan, M. R., Mahjom, N., Zabit, M. N. M., Muhammad, F., Hussin, M. Y. M., & Abdullah, N. L. (2022). Improving critical thinking skills in teaching through problem-based learning for students: A scoping review. *International Journal of Learning, Teaching and Educational Research*, *21*(2), 342-362. http://dx.doi.org/10.26803/ijlter.21.2.19

Rob, M., & Rob, F. (2018). Dilemma between constructivism and constructionism: Leading to the development of a teaching-learning framework for student engagement and learning. *Journal of international education in business*, *11*(2), 273-290. http://dx.doi.org/10.1108/JIEB-01-2018-0002

Rusman. (2020). Model-Model Pembelajaran: Mengembangkan Profesionalisme Guru. *Rajawali Pers*.

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)

Rustan, N. A., Qalbi, Q., & Arianto, A. (2023). Pengaruh Model Pembelajaran Problem Based Learning (PBL) terhadap Hasil Belajar Siswa. *Jurnal PGSD Universitas Lamappapoleonro*, *1*(2), 119-126. https://doi.org/10.57093/jpgsdunipol.v1i2.18

Sagala, S. (2020). Konsep dan Makna Pembelajaran untuk Membantu Memecahkan Masalah Belajar dan Mengajar. *Alfabeta*.

Sanjaya, W. (2021). Strategi Pembelajaran: Berorientasi Standar Proses Pendidikan. *Kencana*.

Sari, P. P., & Setyawan, D. (2018). Pengaruh model pembelajaran berbasis masalah terhadap hasil belajar IPS siswa SD. *Jurnal Pendidikan Sekolah Dasar, 4*(1), 50–58. https://doi.org/10.30998/jpsd.v4i1.3217

Savery, J. R. (2015). Overview of Problem-based Learning: Definitions and Distinctions. *Interdisciplinary Journal of Problem-Based Learning, 1*(1), 9–20. http://dx.doi.org/10.7771/1541-5015.1002

Sholihah, T. M., & Lastariwati, B. (2020). Problem based learning to increase competence of critical thinking and problem solving. *Journal of Education and Learning (EduLearn)*, *14*(1), 148-154. http://dx.doi.org/10.11591/edulearn.v14i1.13772

Slavin, R. E. (2006). Educational Psychology: Theory and Practice (8th ed.). Allyn & Bacon.

Sudjana, N. (2010). Penilaian Hasil Proses Belajar Mengajar. Remaja Rosdakarya.

Susiani, K., Suastra, I. W., & Arnyana, I. B. P. (2022). Study of improving the quality of learning in an effort to improve the quality of elementary school education. *Jurnal EDUCATIO: Jurnal Pendidikan Indonesia*, *8*(1), 37-44. http://dx.doi.org/10.29210/1202221786

Tam, N. T. M. (2018). Using Problem-Based Learning To Promote Students'use Of Higher-Order Thinking Skills And Facilitate Their Learning. *VNU Journal of Foreign Studies*, *34*(2). http://dx.doi.org/10.25073/2525-2445/vnufs.4249

Wilson, L. O. (2016). The three domains of learning: cognitive, affective, and psychomotor/kinesthetic. *The second principle*.

Xu, E., Wang, W., & Wang, Q. (2023). The effectiveness of collaborative problem solving in promoting students' critical thinking: A meta-analysis based on empirical literature. *Humanities and Social Sciences Communications*, *10*(1), 1-11. http://dx.doi.org/10.1057/s41599-023-01508-1

Yanti, N., & Pujiati, P. (2023). Efektivitas Problem Based Learning dalam Meningkatkan Hasil Belajar Siswa Sekolah Dasar. *Jurnal Ilmiah Pendidikan Guru Sekolah Dasar, 7*(2), 123-135. https://doi.org/10.31949/educatio.v9i4.6140

Yuliana, I., & Hartini, S. (2023). Penerapan Problem Based Learning berbantuan media digital untuk meningkatkan hasil belajar siswa sekolah dasar. Jurnal Ilmu Pendidikan Indonesia, 12(1), 1–10. https://doi.org/10.31002/jipi.v12i1.9871

ISSN 2721-0979 (Print), ISSN 2721-1258 (Online)