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The Effectiveness of Problem-Based Learning on Elementary Students' Critical Thinking and Problem-Solving Skills

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ABSTRACT

The development of critical thinking and problem-solving skills is a central objective of contemporary elementary education. This study examined the effectiveness of Problem-Based Learning (PBL) in enhancing the critical thinking and problem-solving abilities of fourth-grade students within integrated IPAS instruction. A quantitative quasi-experimental design employing a nonequivalent control group pretest–posttest approach was used. The participants consisted of 46 fourth-grade students, divided into an experimental group (PBL, n = 23) and a control group (Project-Based Learning, PjBL, n = 23). Data were collected using validated pretest and posttest instruments measuring critical thinking and problem-solving skills. Descriptive and inferential analyses were conducted, including paired samples t-tests and effect size calculations using Cohen's d. The results indicated that students in the PBL group demonstrated statistically significant improvements in critical thinking ($t(22) = -7.40$, $p < .001$, $d = 1.42$) and problem-solving skills ($t(22) = -6.67$, $p < .001$, $d = 1.45$), representing very large effects. In contrast, the PjBL group showed only modest and non-significant gains. These findings suggest that PBL is more effective than PjBL in fostering higher-order cognitive skills among elementary students. The study contributes empirical evidence supporting the integration of problem-centered learning approaches in primary education to enhance essential 21st-century skills.

Keywords
Critical Thinking Skills
Elementary Education
Higher-Order Thinking Skills
Problem-Based Learning
Problem-Solving Skills
Quasi-Experimental Study

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Introduction

Education serves as a fundamental mechanism for developing individuals' intellectual capacity and competencies necessary to navigate the complexities of contemporary society [1]. In an era characterized by rapid technological advancement, information abundance, and increasing social and environmental challenges, educational systems are required to move beyond traditional knowledge transmission toward pedagogical approaches that cultivate higher-order cognitive skills. Among these skills, critical thinking and problem-solving are widely regarded as core competencies for learners, enabling them to analyze information, evaluate evidence, and make reasoned decisions in both academic and real-world contexts [2].

Conventional teacher-centered instructional practices, which emphasize memorization and procedural knowledge, are increasingly viewed as insufficient for preparing learners to meet these demands. As a result, learner-centered pedagogies that promote active engagement, inquiry, and cognitive autonomy have gained prominence. One such approach is Problem-Based Learning (PBL), which situates learning around authentic, ill-structured problems that mirror the complexity of real-life situations. Rather than positioning students as passive recipients of information, PBL encourages learners to identify problems, generate hypotheses, seek relevant information, collaborate with peers, and reflect on the solutions they construct. Through these processes, students are expected to develop not only conceptual understanding but also transferable skills such as reasoning, collaboration, and self-directed learning [2].

The effectiveness of PBL is strongly supported by its theoretical foundations, which draw upon multiple complementary learning theories. From a constructivist perspective, learning is understood as an active process in which learners construct knowledge through interaction with meaningful tasks rather than passively absorbing information [3], [4]. PBL aligns closely with this view by engaging students in authentic problem situations that require them to integrate prior knowledge with new information. Social constructivist theory further emphasizes the role of social interaction and dialogue in cognitive development, suggesting that learning occurs most effectively within collaborative environments where learners

negotiate meaning and share perspectives [5], [6]. In PBL settings, group discussion and peer collaboration are integral components that support this form of socially mediated learning.

Experiential learning theory, as articulated by Dewey, also provides a strong rationale for PBL by highlighting the importance of reflective inquiry and learning through experience. Dewey argued that meaningful learning arises when learners actively engage with problems and reflect on their experiences to generate understanding. Similarly, Piaget's theory of cognitive development explains how exposure to challenging situations can create cognitive disequilibrium, prompting learners to reorganize existing mental schemas and achieve higher levels of conceptual understanding [7]. PBL deliberately introduces such cognitive challenges by presenting learners with problems that cannot be solved through routine procedures alone. In addition, Vygotsky's concept of the zone of proximal development underscores the importance of scaffolded support, whereby learners can achieve higher levels of performance through guidance from teachers or more capable peers [8]. In PBL, teachers act as facilitators who provide strategic guidance, while peer interaction supports collective problem-solving. Together, these theoretical perspectives establish PBL as a pedagogically robust approach for fostering cognitive development and higher-order thinking skills [9].

Empirical research has provided substantial evidence supporting the effectiveness of PBL in enhancing critical thinking and problem-solving abilities across various educational contexts. Numerous studies conducted at the secondary and tertiary levels have reported that PBL contributes to deeper conceptual understanding, improved analytical skills, and greater learner autonomy compared to traditional instructional approaches [10]. These findings suggest that PBL is particularly well-suited to developing complex cognitive skills that are essential for academic success and lifelong learning. However, despite this growing body of evidence, research on PBL implementation at the elementary education level remains relatively limited.

This gap is noteworthy because elementary education represents a critical stage in cognitive development. Fourth-grade students, typically aged 9–10 years, are in a transitional phase between concrete operational thinking and the early emergence of abstract reasoning. At this stage, learners begin to demonstrate greater capacity for logical reasoning, perspective-taking, and systematic problem-solving, yet they still require structured support to engage effectively with complex cognitive tasks. While some educators may perceive PBL as too cognitively demanding for younger learners, developmental theory suggests that this period offers a strategic opportunity to introduce guided problem-solving experiences that can lay the foundation for advanced thinking skills. Nevertheless, systematic empirical investigations examining whether and how PBL can be effectively adapted for elementary learners remain scarce, particularly within integrated curricular contexts.

In the Indonesian educational context, this issue is especially relevant due to the implementation of integrated subjects such as IPAS, which combines natural and social sciences into a unified learning experience. Integrated curricula require instructional approaches that help students make connections across disciplines and apply knowledge to real-world situations. PBL, with its emphasis on contextualized problems and interdisciplinary inquiry, appears well aligned with these curricular goals. However, empirical evidence examining the impact of PBL on elementary students' critical thinking and problem-solving skills within integrated IPAS instruction is still limited. This lack of evidence constrains educators' ability to make informed decisions about pedagogical innovation at the primary level.

To address this gap, the present study investigates the effectiveness of PBL in improving fourth-grade students' critical thinking and problem-solving abilities within integrated IPAS instruction. By employing a quasi-experimental design that compares PBL with Project-Based Learning, this study seeks to provide empirical insights into the relative effectiveness of these learner-centered instructional models. The significance of this research lies in three main contributions. First, it extends the existing literature on PBL by providing evidence from a developmentally foundational stage of education. Second, it offers practical implications for elementary educators seeking instructional strategies that support higher-order cognitive development. Third, it contributes to broader discussions on pedagogical innovation by examining the adaptability of problem-centered learning approaches within primary education settings. Through this investigation, the study aims to inform both theoretical understanding of early cognitive development and evidence-based instructional practices in elementary education.

Literature Review

A. Integrated Natural and Social Sciences in the Independent Curriculum

Integrated Natural and Social Sciences (*Ilmu Pengetahuan Alam dan Sosial* or IPAS) is a multidisciplinary subject that combines concepts from natural sciences and social sciences within a unified learning framework. In the context of Indonesia's Independent Curriculum (*Kurikulum Merdeka*), IPAS is designed to introduce students to interconnected phenomena related to nature, technology, environment, history, and culture. Rather than treating scientific and social knowledge as separate domains, IPAS emphasizes their interdependence in explaining real-world situations [9]. Through this integration, students are encouraged to understand how natural processes influence social structures and how human activities, in turn, affect the environment.

IPAS learning places strong emphasis on developing curiosity toward everyday

phenomena. Students are guided to observe, question, and analyze interactions between humans and their surroundings, both as individuals and as members of society. This approach aligns with the Independent Curriculum's vision of nurturing learners who are critical, reflective, and responsive to contextual challenges. By embedding learning within students' lived experiences, IPAS seeks to make abstract concepts more meaningful and relevant, thereby enhancing conceptual understanding and learning motivation [12].

Furthermore, IPAS serves as a foundational subject for building scientific literacy and social awareness at the basic education level. It introduces students to essential concepts and reasoning processes that enable them to interpret natural and social events critically. Through integrated learning experiences, students are expected not only to acquire knowledge but also to develop values such as environmental responsibility, social empathy, and cultural awareness, which are essential for addressing contemporary societal challenges [13].

B. Learning Objectives and Inquiry Orientation in IPAS

The primary objectives of IPAS learning are to develop students' conceptual understanding, inquiry skills, and ability to apply scientific knowledge in everyday contexts [12]. IPAS is not merely content-oriented but process-oriented, emphasizing how knowledge is constructed through observation, questioning, investigation, and reflection. This inquiry-based orientation positions students as active participants in learning rather than passive recipients of information.

Through inquiry-based activities, IPAS encourages students to explore real-world issues related to environmental sustainability, technological development, and social dynamics. Learners are guided to identify problems, collect and analyze information, and propose solutions grounded in scientific and social reasoning. Such learning processes support the development of higher-order thinking skills, particularly critical thinking and problem-solving, which are increasingly emphasized in contemporary education [2].

In addition, IPAS learning promotes awareness of complex environmental and social challenges, such as resource management and social inequality. By engaging with these issues from an early age, students learn to recognize problems as multidimensional phenomena requiring interdisciplinary perspectives. This view aligns with the argument that real-world problems cannot be effectively addressed through a single disciplinary lens but instead require integrated approaches combining natural and social sciences [11]. Consequently, IPAS provides a suitable platform for cultivating systems thinking and interdisciplinary understanding among elementary students.

C. Problem-Based Learning as a Pedagogical Approach for IPAS

PBL is a student-centered pedagogical approach that aligns closely with the objectives and characteristics of IPAS learning. PBL emphasizes learning through engagement with

meaningful, real-life problems, enabling students to actively construct knowledge through inquiry and the application of scientific reasoning [3]. In this approach, problems function as the starting point of learning, prompting students to identify what they need to know to propose appropriate solutions.

Within the context of IPAS, PBL supports contextual learning by situating scientific and social concepts within authentic issues familiar to students' daily environments. This relevance enhances student engagement and motivation while fostering deeper conceptual understanding. Previous studies have shown that PBL effectively improves critical thinking and problem-solving skills by encouraging students to analyze information, evaluate alternatives, and justify solutions collaboratively [4], [14].

Moreover, PBL contributes to the development of learner autonomy by encouraging students to take responsibility for their learning processes. As students work collaboratively to investigate problems, they learn to evaluate information sources, negotiate meaning, and reflect on their reasoning. These competencies are essential for lifelong learning and align with the Independent Curriculum's emphasis on learner agency and meaningful learning experiences [1], [8]. Therefore, integrating PBL into IPAS instruction offers strong pedagogical potential to support interdisciplinary learning, inquiry skills, and the development of scientifically and socially literate students.

Material and Methods

A. Research Design

This study employed a quantitative approach using a quasi-experimental design to examine the effect of instructional models on students' critical thinking and problem-solving skills. Specifically, a nonequivalent control group pretest–posttest design was adopted, which is appropriate when random assignment of participants is not feasible but causal inferences are still sought through systematic comparison of intact groups [15]. The design involved two existing classes that were measured before and after the instructional intervention. The experimental group received instruction using the PBL model, while the control group was taught using the Project-Based Learning (PjBL) model. Pretests were administered to both groups to establish baseline equivalence, followed by posttests to assess learning gains attributable to the respective instructional treatments. This design enabled the examination of within-group changes over time as well as the comparison of learning outcomes between instructional models. The structure of the research design is presented in Table 1.

Table 1. Nonequivalent Control Group Pretest–Posttest Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	X_1 (PBL)	O_2
Control	O_3	X_2 (PjBL)	O_4

B. Participants and Research Context

The study was conducted in August 2023 at an elementary school implementing an integrated IPAS curriculum. The research population consisted of all fourth-grade students enrolled in two intact classes. A purposive sampling technique was employed, in which all students from both classes were included as research participants to maintain ecological validity.

The experimental group comprised 23 students, while the control group also consisted of 23 students, resulting in a total sample size of 46 participants. The two groups were comparable in terms of grade level, curriculum exposure, and instructional time. Pretest results confirmed that there were no substantial differences in baseline critical thinking and problem-solving skills between groups, supporting the comparability required for quasi-experimental analysis.

C. Instructional Procedures

The instructional intervention was implemented over four weeks during regular classroom instruction. Both groups received instruction covering identical IPAS content and learning objectives, with the primary difference lying in the instructional model employed.

In the experimental group, instruction followed the principles of PBL. Learning activities began with the presentation of authentic, contextually relevant problems related to the lesson content. Students worked collaboratively in small groups to analyze the problems, identify relevant information, propose solution strategies, and evaluate possible outcomes. Throughout the process, the teacher acted as a facilitator, providing guidance and scaffolding as needed while encouraging student autonomy and peer interaction.

In the control group, instruction was conducted using the Project-Based Learning model. Students engaged in learning activities centered on completing structured projects aligned with the instructional objectives. While collaboration was encouraged, the learning process emphasized product completion rather than iterative problem analysis. The teacher provided instruction and feedback according to standard classroom practices. Consequently, opportunities for sustained critical inquiry and systematic problem-solving were relatively limited, potentially constraining the depth of students' cognitive engagement and reflective reasoning.

D. Instruments

Data were collected using identical pretest and posttest instruments designed to measure students' critical thinking skills and problem-solving abilities. The tests consisted of multiple-choice items aligned with the learning objectives and cognitive indicators of each construct. Critical thinking items assessed students' abilities to analyze, evaluate, and draw conclusions, while problem-solving items measured skills related to understanding problems, selecting

appropriate strategies, and evaluating solutions.

Instrument validity was established through item–total correlation analysis, which indicated that all test items met the minimum validity criteria. Reliability analysis confirmed that the instruments were suitable for use in pretest–posttest comparisons.

E. Data Analysis

Data analysis was conducted using statistical software. Descriptive statistics, including means and standard deviations, were calculated to summarize students' performance before and after the intervention. Before inferential analysis, the assumptions of normality and homogeneity of variance were examined using the Shapiro–Wilk test and Levene's test, respectively. The results indicated that all assumptions for parametric testing were satisfied.

To examine changes in students' critical thinking and problem-solving skills within each group, paired samples *t*-tests were performed. Effect sizes were calculated using Cohen's *d* to determine the magnitude of the observed changes. Effect size values were interpreted using conventional benchmarks to assess the educational significance of the findings.

Results

A. Descriptive Statistics of Students' Critical Thinking and Problem-Solving Skills

Descriptive statistics were calculated to examine students' performance in critical thinking and problem-solving skills before and after the instructional intervention. Table 1 presents the mean scores, standard deviations, and gain scores for both the experimental (Problem-Based Learning) and control (Project-Based Learning) groups.

As shown in Table 2, before the intervention, the experimental and control groups demonstrated comparable pretest scores in both measured variables. For critical thinking skills, the experimental group obtained a mean pretest score of M = 63.48 (SD = 11.91), while the control group achieved a mean of M = 62.61 (SD = 24.35). Similarly, in problem-solving skills, the experimental group scored M = 60.43 (SD = 10.65), and the control group scored M = 60.87 (SD = 25.03). These results indicate that the two groups were equivalent at baseline.

Following the intervention, both groups showed improvements in posttest scores. However, the magnitude of improvement differed substantially between groups. The experimental group demonstrated a marked increase in critical thinking skills, with a posttest mean of M = 80.00 (SD = 11.28), corresponding to a gain of 16.52 points. In contrast, the control group showed only a modest increase to M = 66.09 (SD = 24.07), with a gain of 3.48 points.

A similar pattern was observed for problem-solving skills. The experimental group achieved a posttest mean of M = 77.83 (SD = 13.13), reflecting a gain of 17.39 points, whereas the control group reached M = 65.22 (SD = 25.38), with a gain of 4.35 points. Overall, the descriptive results indicate substantially greater learning gains among students taught using

PBL.

Table 2. Descriptive Statistics of Pretest and Posttest Scores for Critical Thinking and Problem-Solving Skills

Variable	Group	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Gain
Critical Thinking	PjBL (Control)	23	62.61	24.35	66.09	24.07	+3.48
	PBL (Experimental)	23	63.48	11.91	80.00	11.28	+16.52
Problem Solving	PjBL (Control)	23	60.87	25.03	65.22	25.38	+4.35
	PBL (Experimental)	23	60.43	10.65	77.83	13.13	+17.39

B. Assumption Testing for Inferential Analysis

Before conducting inferential statistical analyses, the assumptions of normality and homogeneity of variance were examined. The Shapiro–Wilk normality test indicated that pretest and posttest scores for both critical thinking and problem-solving skills in the experimental and control groups were normally distributed, with significance values ranging from p = .059 to p = .178 (all $p > .05$).

In addition, Levene's test for equality of variances confirmed that the assumption of homogeneity was met for all variables, with significance values ranging from p = .151 to p = .958. These results demonstrate that the data satisfied the assumptions required for parametric testing. A summary of the normality and homogeneity test results is presented in Table 3.

Table 3. Summary of Normality and Homogeneity Assumption Testing

Variable	Test	Group	Statistic	p-value	Decision
Critical Thinking	Shapiro–Wilk	PBL	W = 0.964	.231	Normal
		PjBL	W = 0.958	.184	Normal
Problem Solving	Shapiro–Wilk	PBL	W = 0.971	.318	Normal
		PjBL	W = 0.952	.146	Normal
All variables	Levene's Test	Both	F = 1.084	.351	Homogeneous

C. Effects of Problem-Based Learning on Critical Thinking Skills

To examine changes in students' critical thinking skills within each group, paired samples *t*-tests were conducted. The results of these analyses are presented in Table 4. For the experimental group, the paired samples *t*-test revealed a statistically significant improvement in critical thinking skills after the implementation of PBL, $t(22) = -7.40$, $p < .001$. The magnitude of this improvement was substantial, with a very large effect size (Cohen's $d = 1.42$). In contrast, the control group did not show a statistically significant improvement in critical thinking skills following Project-Based Learning, $t(22) = -0.57$, $p = .575$, with a negligible effect size ($d = 0.14$). These findings indicate that the observed improvement in critical thinking skills can be primarily attributed to the PBL intervention rather than to general instructional

exposure.

Table 4. Paired Samples t-test and Effect Size Results for Critical Thinking Skills

Group	Mean Difference	t	df	p
PjBL (Control)	+3.48	–0.569	22	.575
PBL (Experimental)	+16.52	–7.401	22	< .001

D. Effects of Problem-Based Learning on Problem-Solving Skills

Paired samples *t*-tests were also conducted to examine changes in students' problem-solving skills, with the results summarized in Table 5. The experimental group exhibited a statistically significant increase in problem-solving skills after participating in PBL, $t(22) = -6.67$, $p < .001$, accompanied by a very large effect size (Cohen's $d = 1.45$). This result suggests that PBL had a strong positive impact on students' ability to analyze and solve problems.

Conversely, the control group showed no statistically significant improvement in problem-solving skills, $t(22) = -0.72$, $p = .478$, with a small effect size ($d = 0.17$). The contrast between groups further underscores the effectiveness of PBL in fostering higher-order cognitive skills.

Table 5. Paired Samples t-test and Effect Size Results for Problem-Solving Skills

Group	Mean Difference	t	df	p	Cohen's d
PjBL (Control)	+4.35	–0.722	22	.478	0.17 (Small)
PBL (Experimental)	+17.39	–6.667	22	< .001	1.45 (Very Large)

E. Summary of Result

Taken together, the findings indicate that although both instructional models contributed to learning improvements, PBL resulted in substantially greater gains in students' critical thinking and problem-solving skills. The large effect sizes observed in the experimental group provide strong empirical support for the effectiveness of PBL in fostering higher-order cognitive development among elementary school students, highlighting its pedagogical value for promoting deep learning and analytical reasoning at the primary education level.

Discussion

A. Effectiveness of Problem-Based Learning in Enhancing Critical Thinking Skills

The findings of this study demonstrate that PBL is highly effective in improving elementary students' critical thinking skills. The experimental group exhibited a substantial increase in critical thinking performance, with mean scores rising from 63.48 to 80.00, accompanied by a very large effect size (Cohen's d = 1.42). In contrast, the control group taught using Project-Based Learning (PjBL) showed only a modest and statistically non-significant improvement (from 62.61 to 66.09, $d = 0.14$).

These results support the core principle of PBL, which positions students as active problem solvers who engage in analysis, evaluation, and reflection throughout the learning process [16].

By orienting learning around real-world problems, PBL encourages learners to construct knowledge independently while developing higher-order cognitive skills. This finding aligns with previous studies indicating that PBL significantly enhances critical thinking by requiring students to explore information, justify reasoning, and evaluate alternative solutions [19], [20].

Moreover, the magnitude of the observed effect size suggests that PBL not only produces statistically significant gains but also yields educationally meaningful improvements, a criterion increasingly emphasized in international journals. The results corroborate earlier findings in IPAS and science-related subjects, where PBL was shown to foster critical thinking through contextualized and inquiry-driven learning experiences [18], [21].

B. Impact of Problem-Based Learning on Problem-Solving Skills

In addition to critical thinking, the present study found that PBL significantly improved students' problem-solving abilities. The experimental group's mean problem-solving score increased from 60.43 to 77.83, with a very large effect size (d = 1.45), whereas the control group showed a small and non-significant gain (from 60.87 to 65.22, d = 0.17).

This strong improvement can be attributed to the structured phases of PBL, which involve understanding the problem, planning solution strategies, implementing solutions, and evaluating outcomes [17]. Such phases mirror authentic problem-solving processes and provide learners with repeated opportunities to practice analytical and metacognitive skills. The significant t-test results ($p < .001$) further confirm that the gains observed in the experimental group were not due to chance but to the instructional model applied.

Consistent with previous research, learning activities that begin with real-life problems have been shown to increase students' engagement and motivation, thereby deepening conceptual understanding and enhancing problem-solving competence [21], [22]. The present findings reinforce evidence that PBL is particularly effective in elementary education settings, where students benefit from guided inquiry and collaborative exploration of meaningful problems [23].

C. Theoretical Implications: Constructivism and Cognitive Development

From a theoretical perspective, the results of this study strongly align with constructivist learning theory, which posits that knowledge is actively constructed through interaction with meaningful tasks rather than passively received [26]. The significant gains in both critical thinking and problem-solving skills support the notion that learning environments grounded in authentic problems promote deeper cognitive processing. Furthermore, the findings are consistent with Vygotsky's Zone of Proximal Development, as PBL provides scaffolding through peer collaboration and teacher facilitation. During problem investigation, students who had already grasped key concepts supported their peers, while the teacher acted as a facilitator rather than a primary source of information. This social interaction likely contributed to

students' cognitive advancement, as reflected in the substantial posttest gains.

The current results also extend prior empirical work demonstrating that PBL enhances higher-order thinking skills in elementary science and integrated subjects [27], [28]. By situating learning within culturally relevant IPAS content, this study further highlights the adaptability of constructivist-oriented instructional models across diverse curricular contexts.

D. Comparison with Previous Studies and Educational Implications

When compared with previous studies, the findings of this research are consistent with evidence that PBL leads to greater improvements in cognitive skills than more product-oriented instructional approaches, such as PjBL [24]. While Project-Based Learning emphasizes the completion of a final product, PBL prioritizes the reasoning and problem-solving processes that occur throughout learning activities. This distinction may explain the relatively small gains observed in the control group.

Educationally, these findings indicate that integrating PBL into IPAS instruction represents an effective pedagogical strategy for enhancing students' learning independence, analytical reasoning, and creativity. Consistent with Ahmatika [24], students who are systematically trained to solve problems independently tend to demonstrate stronger critical thinking skills, which subsequently support creativity and conceptual depth [25]. Through authentic problem contexts, PBL encourages learners to actively explore, question, and apply knowledge rather than passively receive information. Consequently, PBL can function as a viable alternative or complementary instructional model to conventional approaches, particularly in fostering essential 21st-century competencies such as critical thinking, creativity, collaboration, and problem-solving in elementary education contexts.

E. Limitations and Directions for Future Research

Despite its contributions, this study has several limitations that warrant careful consideration. First, the relatively small sample size (n = 46) restricts the generalizability of the findings beyond the immediate research context. Although the sample reflects the full population of fourth-grade students in the selected school, future studies should involve larger and more heterogeneous samples across different schools and regions to improve statistical power and strengthen external validity. Second, the use of a quasi-experimental design, while appropriate and pragmatic within formal school settings, does not permit full random assignment of participants, potentially introducing selection bias and limiting causal inference [29]. Randomized controlled trials or mixed-method designs may provide stronger evidence of causal relationships in future research.

Third, the relatively short duration of the intervention may not sufficiently capture the long-term retention, transfer, and sustainability of students' critical thinking and problem-

solving skills. Longitudinal studies are therefore recommended to examine whether the observed cognitive gains persist over time and across different learning contexts. Furthermore, the exclusive reliance on multiple-choice assessments may oversimplify complex cognitive outcomes and fail to fully represent the depth, processes, and authenticity of students' higher-order thinking. To address this limitation, future research should incorporate qualitative and performance-based measures, such as open-ended problem-solving tasks, reflective journals, classroom observations, and student interviews. These approaches would enable a more comprehensive understanding of learners' reasoning processes, metacognitive development, and contextual application of knowledge beyond standardized test scores.

F. Overall Contribution

Despite these limitations, the present study provides robust empirical evidence that PBL is more effective than Project-Based Learning in enhancing critical thinking and problem-solving skills among elementary school students. The combination of statistically significant results and very large effect sizes underscores the pedagogical value of PBL, particularly within integrated IPAS instruction. These findings contribute to the growing body of international literature supporting problem-centered instructional approaches and offer practical implications for educators seeking to foster higher-order thinking skills in elementary education contexts.

Conclusion

This study investigated the effectiveness of PBL in enhancing fourth-grade students' critical thinking and problem-solving skills in integrated IPAS instruction. The findings demonstrate that PBL is significantly more effective than Project-Based Learning (PjBL) in promoting higher-order cognitive skills. Students who participated in PBL activities showed substantial improvements in both critical thinking and problem-solving abilities, as evidenced by statistically significant gains and very large effect sizes. In contrast, students taught using PjBL exhibited only modest and non-significant improvements.

The results confirm that learning environments centered on authentic, real-world problems encourage students to actively engage in analysis, reasoning, and reflection. By positioning students as active problem solvers and teachers as facilitators, PBL supports deeper cognitive processing and meaningful knowledge construction. These outcomes align with constructivist learning theory and underscore the role of structured problem-solving processes in fostering critical and analytical thinking at the elementary level.

Despite limitations related to sample size, intervention duration, and assessment format, this study provides empirical evidence supporting the integration of PBL into elementary education curricula. The findings suggest that PBL can serve as an effective instructional approach for developing essential 21st-century skills, particularly within integrated science

and social studies contexts. Future research should explore long-term impacts, involve larger and more diverse samples, and employ mixed-methods designs to further validate and extend these findings.

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