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THE EFFECT OF PROBLEM-BASED LEARNING MODEL WITH TARL APPROACH ON NATURAL AND SOCIAL SCIENCES LEARNING OUTCOMES AND CRITICAL THINKING SKILLS IN ELEMENTARY SCHOOL

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Abstract
This research investigates the effect of integrating the Problem-Based Learning (PBL) model with the Teaching at the Right Level (TaRL) approach on fifth-grade students' critical thinking skills and learning outcomes in natural and social sciences. The background highlights low student achievement and inadequate critical thinking, often caused by conventional, teacher-centered methods that fail to accommodate individual differences. Using a quasi-experimental design with a nonequivalent control group (N=56), students were divided into experimental and control classes. The experimental class received PBL-TaRL instruction over eight weeks (16 sessions), while the control class followed conventional teaching. Pretests and posttests were used to assess both critical thinking and learning outcomes. MANOVA results (Wilks' Lambda = 0.029; p < 0.05) revealed significant differences, with the experimental class showing greater improvement and very large effect sizes (partial eta squared: 0.970 and 0.958). These findings demonstrate that combining PBL and TaRL fosters higher-order thinking and academic achievement by promoting active engagement and adapting materials to students' proficiency levels. This research recommends broader implementation of PBL-TaRL within the Merdeka Curriculum and highlights the need for teacher training in task design and differentiation to maximize its impact in primary schools.
Keywords: *Problem-Based Learning; Teaching at the Right Level; critical thinking skills; natural and social sciences learning outcomes; elementary school*

Abstrak
Penelitian ini mengkaji pengaruh integrasi model *Problem-Based Learning* (PBL) dengan pendekatan *Teaching at the Right Level* (TaRL) terhadap keterampilan berpikir kritis dan hasil belajar siswa kelas V pada mata pelajaran Ilmu Pengetahuan Alam dan Sosial. Latar belakang penelitian menyoroti rendahnya capaian belajar dan keterampilan berpikir kritis siswa, yang sering kali disebabkan oleh penggunaan metode pembelajaran konvensional yang berpusat pada guru dan kurang memperhatikan perbedaan individu. Dengan desain quasi-eksperimen *nonequivalent control group* (N=56), siswa dibagi ke dalam kelas eksperimen dan kontrol. Kelas eksperimen mendapatkan pembelajaran PBL-TaRL selama delapan minggu (16 pertemuan), sedangkan kelas kontrol mengikuti pembelajaran konvensional. *Pretest dan posttest* digunakan untuk mengukur keterampilan berpikir kritis dan hasil belajar. Hasil analisis MANOVA (*Wilks' Lambda* = 0,029; p < 0,05) menunjukkan perbedaan signifikan, dengan kelas eksperimen mengalami peningkatan yang lebih besar serta ukuran efek yang sangat besar (*partial eta squared*: 0,970 dan 0,958). Temuan ini membuktikan bahwa kombinasi PBL dan TaRL mampu mendorong berpikir tingkat tinggi dan pencapaian akademik melalui keterlibatan aktif dan penyesuaian materi sesuai tingkat kemampuan siswa. Penelitian ini merekomendasikan penerapan lebih luas PBL-TaRL dalam Kurikulum Merdeka serta pelatihan guru dalam perancangan soal dan diferensiasi pembelajaran untuk memaksimalkan dampaknya di sekolah dasar.
Kata Kunci: *Problem-Based Learning; Teaching at the Right Level;* keterampilan berpikir kritis; hasil belajar; sekolah dasar

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Introduction

Primary education serves as the foundation for shaping future generations capable of facing increasingly complex challenges in the 21st century. To meet these challenges, learning in primary schools must move beyond traditional, teacher-centered methods toward adaptive and student-centered approaches that promote higher-order thinking skills. Tools such as student worksheets have been introduced to guide students through active learning processes and increase engagement in class (Widodo & Wardani, 2020). In addition, the focus of modern education has shifted toward developing essential competencies commonly summarized as the 4C: Communication, Collaboration, Critical Thinking and Problem Solving, and Creativity and Innovation. Among these, critical thinking is especially crucial because it helps students analyze, evaluate, and solve problems logically and reflectively (Ariadila et al., 2023; Winarti et al., 2022).

Critical thinking skills not only improve academic performance but also serve as essential life skills that protect students from misinformation and help them make well-informed decisions (Nuraida, 2019). These competencies are particularly important for elementary school students, who are in the process of building the cognitive foundations for lifelong learning. According to Dukalang & Sudirman (2024), enhancing critical thinking skills directly supports improvements in student learning outcomes by encouraging deeper understanding and retention of subject matter. However, despite various educational reforms and curriculum changes, Indonesian students' critical thinking skills remain relatively low.

National-level assessments reinforce this concern. Data from the 2022 Programme for International Student Assessment (PISA) indicate that only 34% of Indonesian students scored above the OECD average in science, far below the global average of 76% (OECD, 2023). This suggests a systemic issue in fostering critical thinking skills in science-related subjects. Local observations and interviews conducted with fifth-grade students and teachers at SDN 2 Kendalsari further confirmed this trend: many students struggled to understand material, felt disengaged during lessons, and achieved cognitive test scores below the established minimum criteria (KKTP). Teachers themselves noted difficulties in applying learning models suited to students' diverse needs, often relying on textbook-centered explanations that do not sufficiently stimulate critical thinking.

Previous studies have highlighted similar challenges. Winangun (2022) found that science teachers often remain within their comfort zones, rarely updating their instructional strategies despite the demands of the current curriculum. Similarly, research by Magdalena et al. (2020) revealed that teachers felt overwhelmed by administrative tasks, lacked time to prepare innovative learning tools, and struggled to motivate students in science classes. Such findings underscore the need for instructional models that are both adaptive to student diversity and structured enough to support teachers in designing engaging lessons.

One promising model that directly targets critical thinking development is Problem-Based Learning (PBL). PBL is designed to place students at the center of the learning process, encouraging them to work collaboratively to solve real-world problems. This approach promotes higher-order thinking by guiding students through systematic inquiry, requiring them to analyze information, draw conclusions, and justify their reasoning (Handayani & Koeswanti, 2020). According to Eismawati et al. (2019), the PBL process typically includes four stages: presenting authentic problems, facilitating collaborative exploration, supporting group discussions and investigations, and finally, presenting and reflecting on solutions. By following these structured stages, students gradually build critical thinking skills as they move from understanding problems to formulating and testing solutions.

While PBL has been shown to be effective, its successful implementation depends heavily on the teacher's ability to adapt questions and tasks to students' actual skill levels. This is where the Teaching at the Right Level (TaRL) approach becomes relevant. Unlike traditional grade-based grouping, TaRL groups students based on diagnostic assessments of their proficiency levels (Ahyar et al., 2022; Ningrum et al., 2023). This strategy enables teachers to tailor instruction, materials, and tasks so that each student can engage meaningfully with the content. Empirical studies by Fitriani (2022) & Mustofa et al. (2024) found that TaRL significantly improved student engagement and critical thinking, especially among students who initially struggled under standard instruction.

The integration of PBL and TaRL creates a potentially powerful synergy: PBL provides the structure and focus on problem-solving, while TaRL ensures that tasks are appropriately challenging for different groups of students. This combination aligns with the Merdeka Curriculum's emphasis on differentiated learning and student-centered instruction. However, while existing research has examined PBL and TaRL separately, there remains limited empirical evidence on their combined impact particularly within Natural and Social Sciences (NSS) subjects at the elementary level.

Natural and Social Sciences is an integrated subject combining Natural Sciences and Social Sciences, aiming to help students develop a holistic understanding of the world around them (Kemendikbud, 2022; Kumala, 2016). Learning in NSS is expected to train students to apply scientific methods, engage in problem-solving, and understand both natural and social phenomena through inquiry and reflection (Rahman & Fuad, 2023; Wijayanti & Ekantini, 2023). In practice, however, teachers often find it challenging to design and deliver lessons that balance both disciplinary content and skills like critical thinking, particularly in large and diverse classrooms.

Local data highlight this challenge. During classroom observations and diagnostic assessments at SDN 2 Kendalsari, it was found that students had uneven levels of understanding, which made whole-class instruction less effective. Teachers expressed uncertainty in selecting appropriate instructional models and struggled to create contextual questions that matched students' varied abilities. Such challenges suggest that combining PBL and TaRL could address these issues by offering a structured yet flexible framework for instruction. However, for this promising integration to be widely adopted and effective, its impact needs to be empirically verified, especially within the Indonesian context and integrated subjects like NSS.

A review of the literature shows that few studies in Indonesia have specifically investigated the impact of PBL combined with TaRL on students' critical thinking skills and NSS learning outcomes. Most previous studies have examined the effects of PBL or TaRL in isolation and have not explored how these models might complement each other to address diverse student needs within an integrated subject. This creates a research gap that, if addressed, could provide valuable insights for improving teaching practices in primary education.

Therefore, this research specifically aims to investigate whether integrating the Problem-Based Learning (PBL) model with the Teaching at the Right Level (TaRL) approach can significantly enhance the critical thinking skills and learning outcomes of fifth-grade students in Natural and Social Sciences. By filling this research gap, the study is expected to contribute theoretically by enriching the empirical understanding of adaptive and student-centered instructional models in primary education. Practically, the findings are anticipated to offer concrete recommendations for teachers and policymakers to design and implement more effective learning strategies aligned with the Merdeka Curriculum, ultimately helping students develop the competencies needed to navigate the challenges of the 21st century.

Research Methods

This study employed a quasi-experimental design with a Nonequivalent Control Group Design to examine the effect of integrating the Problem-Based Learning (PBL) model and the Teaching at the Right Level (TaRL) approach on critical thinking skills and Natural and Social Sciences (NSS) learning outcomes. The target population comprised all fifth-grade students enrolled in public elementary schools in Kemalang District, Klaten Regency. To construct the sampling frame, the researchers identified all public elementary schools in the district that had at least two parallel fifth-grade classes, ensuring that experimental and control groups could be established under comparable conditions.

Cluster random sampling was then applied at the school level. From the eligible schools, two schools were purposively selected based on their accessibility and willingness to participate, and then randomly assigned as SDN 1 Kendalsari (experimental group) and SDN 2 Kendalsari (control group). All fifth-grade students from these two schools were included, resulting in a total sample of 56 students, with 28 students in each group. This procedure was conducted to enhance external validity and reproducibility by clearly defining the sampling frame and randomization process.

In the experimental group, the intervention combined the PBL model and the TaRL approach. The PBL model was implemented through four sequential stages: (1) presenting contextual and authentic problems aligned with NSS content; (2) facilitating collaborative group discussions to explore and propose solutions; (3) guiding group investigations supported by student worksheets; and (4) having students present, reflect, and discuss their findings (Eismawati et al., 2019). To complement this, the TaRL approach involved grouping students based on initial diagnostic assessment results, allowing the teacher to adjust the complexity of questions and activities according to students' actual proficiency levels (Ahyar et al., 2022). The intervention was delivered over eight weeks, with two sessions per week, totaling 16 instructional sessions.

In contrast, the control group received conventional instruction characterized by teacher-centered lectures, direct textbook explanations, and individual written exercises. This approach did not include structured problem-based activities or adaptive grouping and reflects common practice in primary classrooms within the research setting.

The instruments used in this study were written tests designed to measure two dependent variables: students' critical thinking skills and NSS learning outcomes. Both tests were administered as pretests and posttests to capture changes resulting from the intervention. Instrument development followed a systematic process: (1) drafting items based on curriculum indicators; (2) conducting expert validation by three specialists in primary education and instructional design, who used a structured validation sheet to assess each item's clarity, content relevance, and alignment with curriculum indicators, leading to item revisions prior to piloting; and (3) piloting the items with 30 fifth-grade students from a different school outside the sample to test item difficulty and discrimination. Item validity was analyzed using Pearson's Product Moment correlation, while internal consistency reliability was evaluated using Cronbach's Alpha in SPSS 26.0, producing coefficients above 0.70, which were considered acceptable.

Data analysis began with descriptive statistics, including mean, standard deviation, minimum, and maximum scores, to summarize students' performance. Before hypothesis testing, assumptions of normality and homogeneity were assessed using the Kolmogorov-Smirnov test and Levene's Test, respectively. MANOVA (Multivariate Analysis of Variance) was then selected as the primary analytical technique because it allows simultaneous testing of differences between groups across multiple correlated dependent variables, thereby reducing the risk of Type I error that might occur if separate ANOVAs were conducted (Tabachnick & Fidell, 2025). The selection of MANOVA was aligned with the study's objective to evaluate the overall effect of the PBL-TaRL intervention on both critical thinking skills and NSS learning outcomes.

To ensure methodological rigor and transparency, the research was conducted through four sequential phases, detailed as follows:

(1) Observation phase: Conducting classroom observations and diagnostic assessments to determine students' initial proficiency levels and inform grouping for the TaRL approach.

(2) Planning phase: Developing lesson plans that integrated PBL and TaRL, preparing student worksheets tailored to varying proficiency levels, and providing teacher training sessions to ensure consistent implementation of the intervention.

(3) Implementation phase: The intervention was delivered over eight consecutive weeks, with two instructional sessions per week (each lasting approximately 70 minutes), resulting in a total of 16 sessions. All sessions were conducted during regular class hours to ensure ecological validity and minimize disruption to the standard school schedule.

(4) Data analysis phase: Processing and analyzing pretest and posttest data to evaluate the effectiveness of the intervention using MANOVA and supporting statistical tests.

Through these clearly defined steps, the study sought to produce valid, reliable, and reproducible findings that contribute to evidence-based instructional practice in primary education.

Results and Discussion

This study was executed at SDN 1 Kendalsari and SDN 2 Kendalsari, which were sequentially used as experimental and control classes. The experimental class utilizes the problem-based learning model grounded in the TaRL approach. Conversely, the control class employs the traditional learning methodology. The researcher gave pre-test and post-test questions to measure critical thinking abilities and students' NSS learning outcomes in each class. The pre-test questions were given before learning began, and the post-test was conducted after the material according to the teaching materials had been taught to the students. The subsequent results of the descriptive statistical analysis of students' critical thinking skills are reported in Table 1 as follows:

Table 1. Statistical Description of Students' Critical Thinking Ability Scores

	N	Min	Max	Mean	Std. Deviation
Pretest Critical Thinking Skills Experimental Class	28	33	40	37,00	2,177
Posttest Critical Thinking Skills Experimental Class	28	83	88	85,60	1,448
Pretest Critical Thinking Skills Control Class	28	34	41	37,64	2,111

Table 1 shows that both the experimental and control groups consisted of 28 students each. The average pretest score for critical thinking skills was similar in both groups (37.00 in the experimental group and 37.64 in the control group). After the intervention, the experimental group achieved a mean post-test score of 85.60 (SD=1.448), while the control group recorded a mean post-test score of 70.29 (SD=1.27). This reflects an improvement of approximately 48.60 points in the experimental group, compared to an increase of around 32.65 points in the control group. Additionally, the lower standard deviation in the experimental group's post-test scores suggests more homogeneous performance after the intervention. These results indicate that applying the Problem-Based Learning model grounded in the TaRL approach substantially improved students' critical thinking skills and helped reduce variability in student achievement. Based on the data presented in Table 1, the results can also be visualized in the form of a diagram. Figure 1 shows the comparison of pre-test and post-test mean scores of critical thinking skills between the experimental and control groups in below:

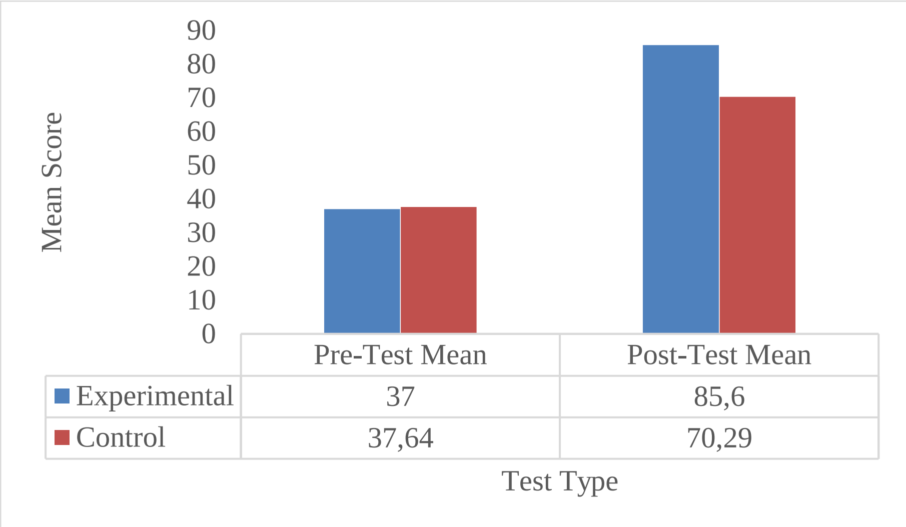

Figure 1. Comparison of Pre-test and Post-test Mean Scores of Critical Thinking Skills

Figure 1 illustrates the comparison of pre-test and post-test mean scores of critical thinking skills between the experimental and control groups. The experimental group's mean score increased markedly from 37.00 in the pre-test to 85.60 in the post-test. Meanwhile, the control group also showed improvement, though to a lesser extent, rising from 37.64 to 70.29. This visual representation highlights that the PBL-TaRL intervention had a substantially greater impact on enhancing students' critical thinking skills compared to conventional teaching methods. The results of the descriptive statistical analysis of student learning outcomes are displayed in Table 2 below:

Table 2. Statistical Description of Student Learning Outcome Values

	N	Min	Max	Mean	Std. Deviation
Pretest of Student Learning Outcomes in Experimental Class	28	34	42	38,10	2,615
Posttest of Student Learning Outcomes in Experimental Class	28	85	91	88,11	1,685
Pretest of Student Learning Outcomes in Control Class	28	35	43	38,85	2,414
Posttest of Student Learning Outcomes in Control Class	28	70	76	73,25	1,481

Table 2 shows that both the experimental and control classes consisted of 28 students each. In the experimental group, the mean pretest score for student learning outcomes was 38.10

(SD=2.615), which increased substantially to a mean post-test score of 88.11 (SD=1.685). In the control group, the mean pretest score was slightly higher at 38.85 (SD=2.414), but the post-test score increased only to 73.25 (SD=1.481). This reflects an improvement of approximately 50.01 points in the experimental group compared to about 34.40 points in the control group. Additionally, the standard deviation of post-test scores in the experimental group remained relatively low, indicating that students' performance became more consistent after the intervention. These results suggest that implementing the PBL model integrated with the TaRL approach effectively enhanced student learning outcomes and reduced variability in student achievement compared to conventional teaching methods. Based on the data presented in Table 2, the results can also be visualized in the form of a diagram. Figure 2 shows the comparison of pre-test and post-test mean scores of student learning outcomes between the experimental and control groups in below:

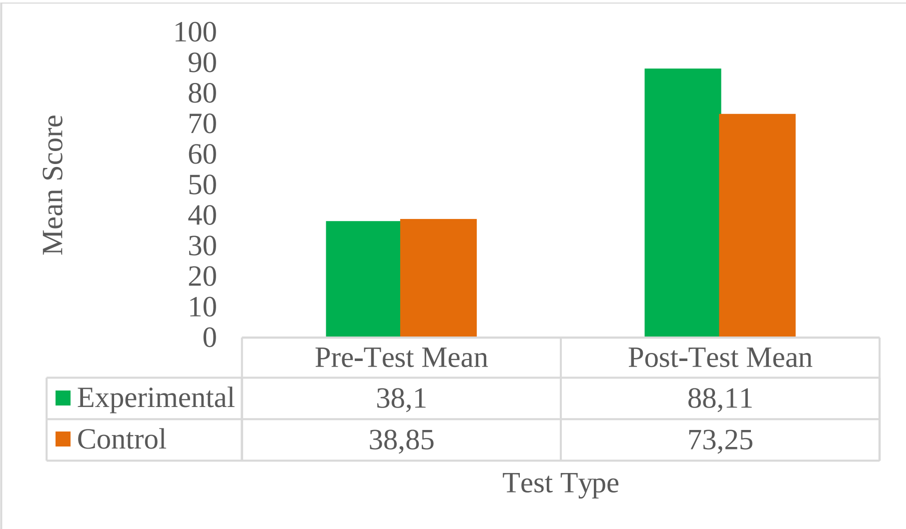

Figure 2. Comparison of Pre-test and Post-test Mean Scores of Student Learning Outcomes

Figure 2 illustrates the comparison of pre-test and post-test mean scores of student learning outcomes between the experimental and control groups. The experimental group's mean score increased significantly from 38.10 in the pre-test to 88.11 in the post-test, demonstrating a marked improvement following the intervention. In contrast, the control group also showed an increase from 38.85 to 73.25, although the improvement was smaller. This visual representation confirms that the integration of the PBL model and the TaRL approach had a stronger effect on enhancing students' learning outcomes compared to the conventional teaching method.

Data is tested for normality and homogeneity before hypothesis testing is conducted. The normality test utilizes the Kolmogorov-Smirnov test to evaluate data distribution. Typical data distribution is indicated when the significance value exceeds 0.05. Table 3 below presents the results of the normality test analysis conducted using the Kolmogorov-Smirnov method.

Table 3. Kolmogorov-Smirnov Normality Test

Variable	Class	Kolmogrov-Smirnov		
		Statistic	df	p-value
Critical Thinking Skills	Experimental	0,143	28	0,152
	Control	0,161	28	0,060
Student Learning Outcomes	Experimental	0,132	28	0,200
	Control	0,158	28	0,071

Table 3 presents the results of the Kolmogorov–Smirnov normality test for both critical thinking skills and student learning outcomes in the experimental and control groups. The p-values for all variables and groups are greater than 0.05 (e.g., p=0.152 and p=0.060 for critical thinking skills; p=0.200 and p=0.071 for learning outcomes). These results indicate that the data distributions do not significantly deviate from normality, thus meeting the assumption of normality required for subsequent parametric analyses. After confirming the normality assumption, the next step involves testing the homogeneity of variance using Levene's test to ensure the data meet the assumptions necessary for MANOVA. Table 4 below presents the results of the homogeneity of variance test.

Table 4. Levene's Test of Homogeneity

Variable	Levene Statistic	df1	df2	p-value
Critical Thinking Skills	0,199	1	54	0,657
Student Learning Outcomes	0,021	1	54	0,884

Table 4 presents the results of Levene's test for homogeneity of variances for both critical thinking skills and student learning outcomes. The p-values obtained were 0.657 and 0.884, respectively, which are greater than the significance threshold of 0.05. This indicates that the variances between the experimental and control groups are statistically equal, thereby meeting the assumption of homogeneity of variances required for conducting MANOVA. Furthermore, to ensure initial equivalence between groups before the intervention, an independent samples t-test was conducted on the pretest scores. A p-value less than 0.05 would indicate a significant difference, whereas a p-value greater than 0.05 suggests that the groups were statistically equivalent at baseline. The results of the T-test are presented in Table 5 below:

Table 5. T-test

Variable	Mean Experimental	Mean Control	t (df)	p-value (Sig.)	Description
Critical Thinking Skills	37,00	37,64	-1,121 (54)	0,884	Balanced (p > 0,05)
Student Learning Outcomes	38,10	38,85	-1,115 (54)	0,657	Balanced (p > 0,05)

Table 5 presents the results of the independent samples t-test comparing the pretest mean scores of the experimental and control groups. The mean pretest score for critical thinking skills was 37.00 in the experimental group and 37.64 in the control group, with a p-value of 0.884 (p>0.05). Similarly, for student learning outcomes, the mean pretest score was 38.10 in the experimental group and 38.85 in the control group, with a p-value of 0.657 (p>0.05). Since both p-values are greater than the significance threshold of 0.05, the data suggest that there were no significant differences between the experimental and control groups before the intervention. This indicates that the two groups were statistically equivalent at baseline, thus meeting the assumption of initial group equivalence required for quasi-experimental designs. Box's M test was utilised to assess the homogeneity of variance and covariance, with data interpretation performed at a significance level exceeding 0.05. Table 6 displays the outcomes of the tests for homogeneity of variance and covariance below:

Table 6. Box's M Homogeneity Test

Statictic	Score
Box’s M	1,921
F	0,615
df1	3
df2	524880,000
p-value	0,605

Table 6 shows the results of Box’s M test, which was conducted to examine the homogeneity of variance-covariance matrices across the experimental and control groups. The test produced a Box’s M value of 1.921 with an associated p-value of 0.605 (p>0.05). Since the p-value exceeds the significance threshold of 0.05, it can be concluded that the variance-covariance matrices are statistically equal across groups. This finding indicates that the assumption of homogeneity of variance and covariance has been met, which is essential for the validity of the subsequent MANOVA analysis. Table 7 below presents the results of the MANOVA test:

Table 7. MANOVA Test

Effect (Source of Variation)	Wilks’ Lambda	F	df1	df2	Sig. (p)	Description
Class (Experimental vs Control)	0,029	887,612	2	53	0,000	Significant (p < 0,05)

Table 7 presents the results of the MANOVA test conducted to determine whether there were overall differences between the experimental and control groups on the combined dependent variables: critical thinking skills and student learning outcomes. The test produced a Wilks’ Lambda value of 0.029 with an associated F value of 887.612 (df1=2, df2=53) and a significance level of p=0.000 (p<0.05). These results indicate a statistically significant multivariate effect of the intervention, suggesting that the PBL-TaRL approach had a substantial impact on improving both critical thinking skills and student learning outcomes simultaneously when compared to the control group. This significant multivariate result justifies further examination of the individual dependent variables through follow-up tests and analysis of effect sizes. The effect sizes based on the MANOVA results are presented in Table 8 below:

Tabel 8. Effect Sizes Based on Manova Results

Variable	F	Sig. (p)	Partial Eta Squared
Critical Thinking Skills	1767,736	0,000	0,970
Student Learning Outcomes	1227,670	0,000	0,958

Based on the MANOVA results presented in Table 8, the F value for critical thinking skills was 1767.736 with a significance level of p=0.000, and the F value for student learning outcomes was 1227.670 with p=0.000. These results indicate that the implementation of the

Problem-Based Learning (PBL) model combined with the Teaching at the Right Level (TaRL) approach had a statistically significant effect on both dependent variables. Moreover, the effect sizes, represented by partial eta squared, were 0.970 for critical thinking skills and 0.958 for student learning outcomes. According to Gignac & Szodorai (2016), these values fall into the category of very large effect sizes, suggesting that the intervention had a substantial impact compared to the control group.

The findings reveal that the experimental class, which received instruction through the PBL model integrated with the TaRL approach, achieved higher mean scores in both critical thinking skills and student learning outcomes compared to the control group taught using conventional methods. While the control group also demonstrated improvement from pretest to post-test, this increase was notably smaller. This slight gain in the control group may be attributed to regular classroom activities, repeated exposure to content, and students' natural cognitive development over time, even without innovative instructional models.

Moreover, the analysis revealed very large effect sizes (partial eta squared = 0.970 for critical thinking skills and 0.958 for learning outcomes). These unusually large values may be explained by the substantial difference in mean post-test scores between the experimental and control groups and the relatively low standard deviations in the experimental group, which suggest more homogeneous performance after the intervention. This indicates that the PBL-TaRL approach was not only effective in increasing average scores but also in reducing disparities among students by providing instruction aligned to their actual proficiency levels. However, these effect sizes should be interpreted with caution, as the small and relatively homogeneous sample might have magnified the results.

The substantial improvement in the experimental group aligns with the core principles of PBL, which emphasize student engagement in real-world problem-solving and encourage the development of open, reflective, and critical thinking skills (Betakore & Boiliu, 2022; Haryanti, 2017). At the same time, the TaRL approach allowed instruction to be tailored to students' actual proficiency levels, ensuring that all students could follow and benefit from the learning process (Karlina & Wirdati, 2023). This combination not only strengthened students' critical thinking but also improved their overall learning outcomes, especially in the cognitive domain.

However, during the implementation, several challenges typically associated with the PBL model were also observed. For example, the teacher initially faced difficulties in designing problem scenarios that matched the students' diverse ability levels, and some students required more guidance to stay engaged during group discussions. To address these issues, the teacher utilized diagnostic assessment data from the TaRL approach to adjust the complexity of problems and provided additional scaffolding and support to students who struggled. These practical adaptations highlight the importance of equipping teachers with skills in task design and differentiation when applying PBL in heterogeneous classrooms.

Despite these promising results, this study has several limitations. The sample size was relatively small and limited to two classes in a single district, which may restrict the generalizability of the findings. Additionally, the intervention period of eight weeks may not capture the full long-term impact of integrating PBL and TaRL. Future studies could involve larger and more diverse samples and extend the duration of the intervention to provide deeper insights.

Practically, these findings offer important implications for teachers and curriculum designers. For teachers, the study highlights the value of incorporating diagnostic assessments at the start of instruction to identify students' learning levels, combined with designing problem-based tasks that are both relevant and appropriately challenging. Schools and educational authorities could consider providing professional development programs focused on implementing PBL and adaptive approaches like TaRL, equipping teachers with strategies to better meet diverse student needs. These efforts can ultimately support the development of critical thinking and other 21st century competencies among elementary students.

Conclusion

The findings of this study indicate that implementing the Problem-Based Learning (PBL) model integrated with the Teaching at the Right Level (TaRL) approach effectively enhances elementary students' critical thinking skills and learning outcomes in Natural and Social Sciences. Beyond statistical improvements, this approach encourages active engagement, supports differentiated instruction tailored to students' actual proficiency levels, and helps reduce disparities among learners. Practically, teachers are advised to begin lessons with diagnostic assessments to design problem-based tasks that are both meaningful and aligned with students' abilities, thereby fostering deeper understanding and reflective thinking. At the policy level, it is recommended that educational authorities and schools organize structured teacher training programs to equip educators with practical skills in applying adaptive, student-centered strategies like PBL and TaRL. Such initiatives can help strengthen the implementation of the Merdeka Curriculum and promote 21st century competencies more effectively across diverse classroom settings. Future research could explore the long-term impact of this integrated approach, examine its effectiveness in other subjects or grade levels, and investigate how contextual factors influence its success. Collectively, these efforts can contribute to building more inclusive, responsive, and higher-quality primary education.

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