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The Implementation of Problem-Based Learning to Enhance Critical Thinking Skills among Elementary School Students

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Abstracts

Integrated Natural and Social Sciences learning in elementary schools still faces problems related to students' low critical thinking skills due to the dominance of teacher-centered instruction. This condition was also found among fifth-grade students at SD Negeri 05 Tual, as indicated by low learning participation, engagement, and achievement. This study aimed to improve students' critical thinking skills through the implementation of the Problem Based Learning (PBL) model in IPAS learning. The study employed a classroom action research approach conducted in two cycles, consisting of planning, action, observation, and reflection stages. The research subjects were 18 fifth-grade students. Data were collected through critical thinking ability tests and observation sheets of students' learning activities. The results showed an increase in students' learning mastery from 55.56% in the first cycle to 83.33% in the second cycle. In addition, students' participation, engagement, and quality of thinking processes also improved significantly. The implementation of the PBL model proved effective in creating active, contextual, and student-centered learning. Therefore, Problem Based Learning is recommended as an innovative instructional strategy to enhance students' critical thinking skills in IPAS learning at the elementary school level.

Keywords: *Problem Based Learning; Critical Thinking; Classroom Action Research; Elementary School*

1. Introduction

Education plays a fundamental role in shaping the quality of human resources who are competent, well-characterized, and capable of adapting to the dynamic changes of the times. In the current era of globalization and digital transformation, the education sector faces increasingly complex challenges, particularly in preparing students to possess 21st-century competencies such as critical thinking, creativity, collaboration, communication, as well as technological and information literacy. Education is no longer solely oriented toward the mastery of knowledge; rather, it is directed toward the development of higher-order thinking skills, character formation, and the ability to solve problems independently and responsibly (Triana et al., 2025). Therefore, the learning process in schools is required to create an active, innovative, meaningful, and contextual learning environment, enabling students to optimally construct their knowledge through authentic learning experiences (Afandi et al., 2024).

Learning plays a strategic role as a fundamental foundation in shaping students' mindsets, attitudes, and character from an early age (Puspitaningrum et al., 2025).

Elementary school represents a crucial stage for cultivating habits of critical thinking, curiosity, scientific attitudes, as well as communication and collaboration skills (Rambe et al., 2024). In line with this perspective, the Merdeka Curriculum emphasizes that the learning process should be oriented toward strengthening 21st-century competencies, including critical thinking, creativity, collaboration, and communication, as well as character development through the Pancasila Student Profile. Accordingly, learning at the elementary school level is required not only to emphasize cognitive aspects but also to integrate the development of higher-order thinking skills (HOTS) and character formation in a balanced manner (Fitria et al., 2023).

Field evidence indicates that the learning process of Integrated Natural and Social Sciences (IPAS) in elementary schools is still predominantly dominated by lecture-based instruction and conventional assignments (Marlina Susanti & Hadiyanto, 2024). Teacher-centered instructional patterns tend to position students as passive learners, resulting in limited participation in discussions and a lack of habituation in expressing opinions and posing critical questions. This condition has a direct impact on the low level of students' critical thinking skills. Research by (Suparya et al., 2025) reveals that conventional learning approaches are less effective in developing critical thinking skills due to the minimal active involvement of students in the learning process. In line with this, (Liu, 2024)emphasizes that problem-based learning significantly enhances students' learning engagement and critical thinking abilities. Similar findings were also reported by (Banua & Wiji, 2025), who state that innovative, problem-oriented learning models are capable of improving higher-order thinking skills among elementary school students.

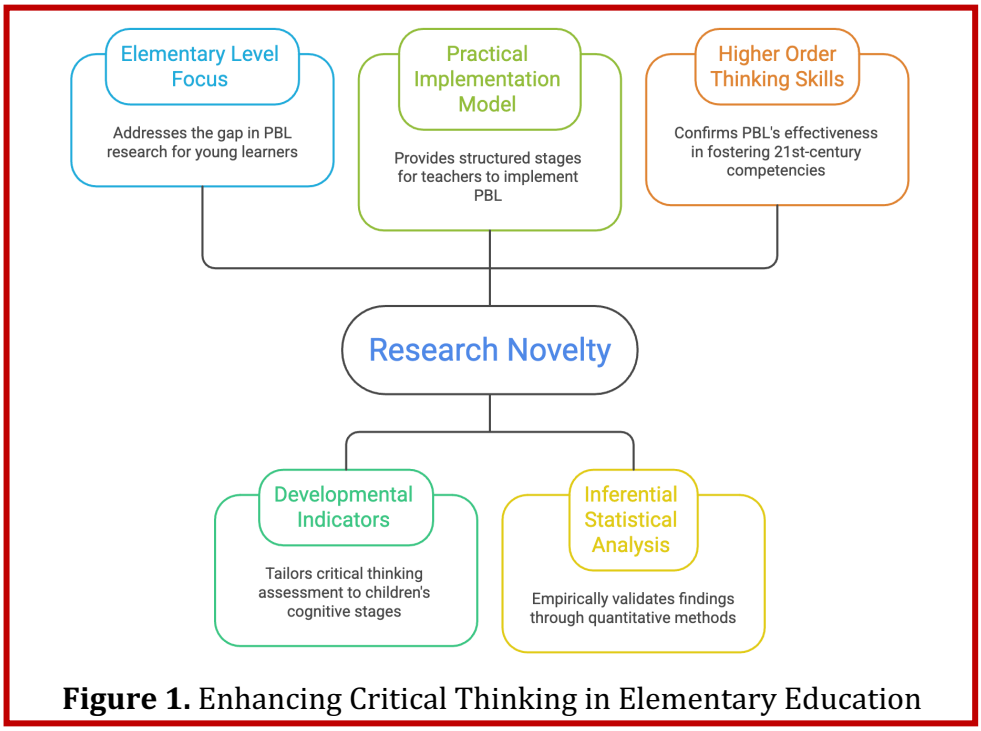

Figure 1. Enhancing Critical Thinking in Elementary Education

The figure illustrates the structured process of implementing Problem-Based Learning (PBL) to enhance students' critical thinking skills in the elementary classroom (Yunulius, 2025). It demonstrates a sequential learning cycle that begins with the presentation of an authentic problem, followed by student inquiry, collaborative discussion, information gathering, and problem analysis (Sappaile et al., 2025).

Throughout this process, students actively construct knowledge by identifying key issues, formulating hypotheses, evaluating possible solutions, and drawing logical conclusions (Sappaile et al., 2025). The teacher functions as a facilitator who guides reflection and supports cognitive development rather than directly delivering information (Surya et al., 2025). This systematic flow highlights how PBL promotes analytical reasoning, decision-making skills, and higher-order thinking through meaningful engagement with real-world problems.

These conditions indicate a gap between curriculum demands that emphasize the development of critical thinking skills and classroom learning practices that remain predominantly teacher-centered (Damayanti et al., 2025). If this issue is not addressed promptly, students' critical thinking abilities will be difficult to develop optimally (Puspitaningrum et al., 2025). Therefore, an instructional innovation is required to create an active learning environment, foster students' curiosity, and train them to solve problems in a systematic and contextual manner (Wahdaniyah et al., 2025). One relevant alternative solution to address these issues is the implementation of the Problem Based Learning (PBL) model (Jauziati et al., 2025). The PBL model emphasizes student-centered learning by presenting contextual problems as the starting point of instruction, thereby encouraging students to think critically, analyze problems, seek relevant information, and collaboratively formulate solutions. (Nabihah et al., 2025) state that the implementation of Problem Based Learning has been proven effective in improving critical thinking skills, learning motivation, and learning outcomes of elementary school students (Rezkilia et al., 2025). Through PBL, students not only acquire knowledge but also develop reflective thinking skills and problem-solving abilities that are relevant to real-life contexts (Mahir & Martawijaya, 2025).

Based on the results of preliminary observations conducted in Grade V of SD Negeri 05 Tual, it was found that out of 18 students, 11 students (61.11%) had not yet achieved the Learning Objective Achievement Criteria (Kriteria Ketercapaian Tujuan Pembelajaran/KKTP), while only 7 students (38.89%) had reached learning mastery in the topic of changes in the states of matter and their applications in daily life. This low level of learning mastery indicates that most students still experience difficulties in understanding concepts, analyzing problems, and relating learning materials to real-life contexts. In addition, students' learning activities remain low, as indicated by minimal participation in discussions, a lack of critical questioning, and a tendency to memorize content without deep conceptual understanding. These conditions further reinforce the urgency of implementing instructional improvement through the application of innovative, student-centered learning models. The Problem Based Learning model is considered capable of addressing these issues, as it provides ample opportunities for students to actively think, engage in discussions, and solve problems independently as well as collaboratively. By presenting contextual problems that are closely related to students' daily lives, IPAS learning is expected to become more meaningful and to significantly enhance students' critical thinking skills.

Based on the foregoing discussion, the researcher considers it necessary to conduct a study entitled *"The Implementation of Problem-Based Learning to Enhance Critical Thinking Skills among Students at Public Elementary School 05 Tual."*This study aims to improve students' critical thinking skills through the implementation of the Problem-Based Learning model in IPAS instruction. The findings of this study are expected to benefit students by enhancing their conceptual understanding and critical

thinking abilities, provide teachers with an alternative innovative instructional strategy, and support schools in continuously improving the quality of instructional processes and learning outcomes.

2. Research methods

This study employed a quantitative approach aimed at examining the effect of implementing the Problem Based Learning (PBL) model on students' critical thinking skills in IPAS learning (Widiarta et al., 2023). The quantitative approach was selected because it allows for the objective measurement of research variables through numerical data that are analyzed using statistical techniques (Isnani, 2023). In this study, the implementation of the Problem Based Learning model served as the independent variable, while students' critical thinking skills constituted the dependent variable and the primary focus of measurement (Dwijayanti & Wiarta, 2024). Furthermore, this study applied a quantitative experimental design to determine the effectiveness of the Problem Based Learning model in enhancing students' critical thinking skills (Syahfitri & Sulaiman, 2023). This experimental design enabled systematic comparisons of students' abilities before and after the implementation of the learning model, allowing observable changes to be analyzed in a measurable manner (Endaryati et al., 2023). Through this design, the study sought to obtain a clear depiction of the effectiveness of Problem Based Learning in improving students' critical thinking skills in IPAS instruction.

The population of this study comprised all fifth-grade students of SD Negeri 05 Tual. The research sample, which also functioned as the research subjects, consisted of 18 students, including both male and female learners with heterogeneous academic backgrounds. The study was conducted at SD Negeri 05 Tual during the second semester of the 2025/2026 academic year.

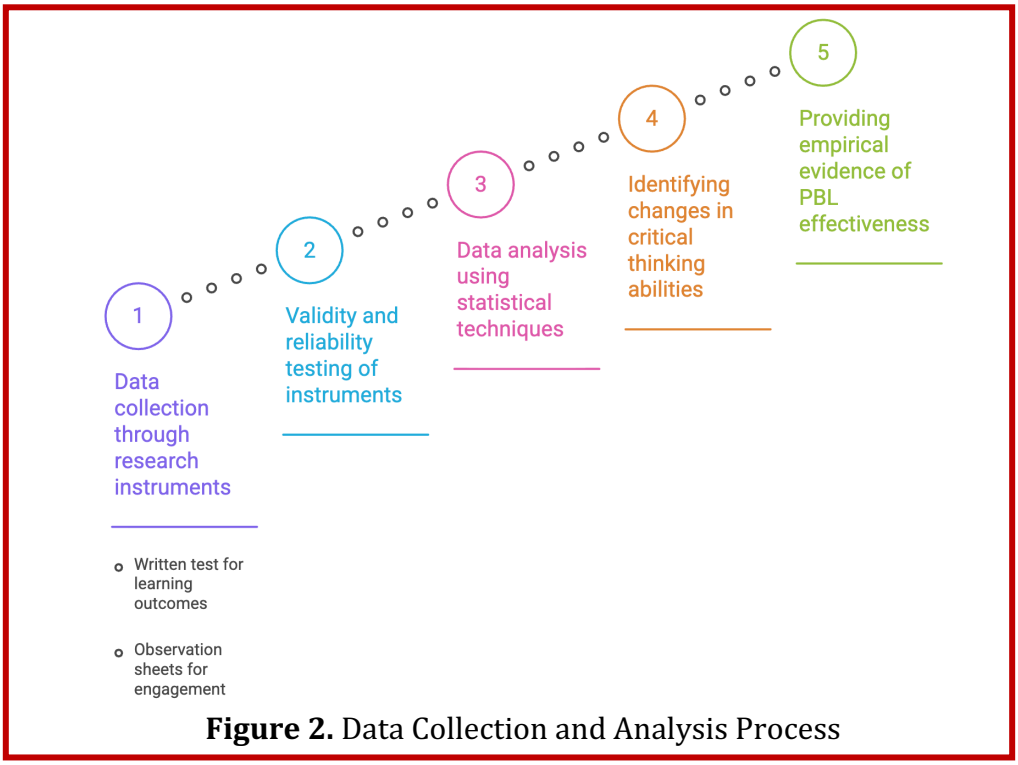

Figure 2. Data Collection and Analysis Process

Figure 2 illustrates the sequential process of data collection and analysis implemented in this study. The first stage involved data collection through research

instruments designed to measure students' learning outcomes and engagement during the learning process. Written tests were administered to assess students' critical thinking skills, while observation sheets were used to capture students' active participation and involvement throughout the implementation of the Problem-Based Learning model. This combination of instruments ensured that both cognitive and behavioral aspects of learning were systematically documented. The second stage focused on the validity and reliability testing of the research instruments. Prior to data analysis, all instruments were examined to ensure that they accurately measured the intended constructs and produced consistent results. Validity testing was conducted to confirm the appropriateness of each test item and observation indicator, while reliability testing was applied to determine the consistency of the measurements. This step was essential to guarantee the credibility and scientific rigor of the collected data.

The third stage involved data analysis using appropriate statistical techniques. The quantitative data obtained from the pretest and posttest were analyzed to identify patterns and differences in students' critical thinking performance before and after the implementation of the Problem-Based Learning model. Statistical analysis was employed to test the research hypotheses and to determine the magnitude of change resulting from the instructional intervention. The final stage aimed to identify changes in students' critical thinking abilities and to provide empirical evidence of the effectiveness of the Problem-Based Learning model. The results of the statistical analysis were interpreted to determine whether the observed improvements were significant and meaningful. Through this systematic process, the study provides empirical support for the effectiveness of Problem-Based Learning in enhancing critical thinking skills among elementary school students.

3. Results and Discussion

3.1 Results

Students' critical thinking skills in this study were comprehensively analyzed by comparing the results of the pretest and posttest administered before and after the implementation of the Problem Based Learning model in IPAS instruction. The pretest was conducted at the beginning of the research process to obtain baseline data regarding students' initial levels of learning mastery and critical thinking ability. This initial assessment provided an overview of students' capacity to analyze problems, interpret information, evaluate arguments, and formulate logical conclusions prior to receiving the instructional intervention. After a series of learning activities designed according to the principles of Problem Based Learning, including problem orientation, collaborative investigation, information analysis, and presentation of solutions, the posttest was administered to measure the extent of improvement in students' critical thinking skills. This comparative design enabled the researcher to systematically identify measurable changes in students' performance that occurred as a result of the instructional model applied in the classroom.

The comparison of pretest and posttest results was presented through graphical visualizations to support clearer interpretation and ensure a more objective analysis of the findings. These visual representations illustrate the percentage distribution of students who achieved mastery and those who did not achieve mastery at both stages of measurement. By examining the graphical data, shifts in learning mastery levels can be observed more clearly, particularly the increase in the proportion of students who

met the established criteria for success after the implementation of the learning model. The use of percentage based graphs simplifies complex quantitative information and allows readers to identify patterns of improvement, performance trends, and the overall instructional impact. Therefore, the combination of statistical comparison and visual presentation strengthens the empirical evidence that the implementation of Problem Based Learning contributed significantly to the enhancement of students' critical thinking skills in IPAS instruction.

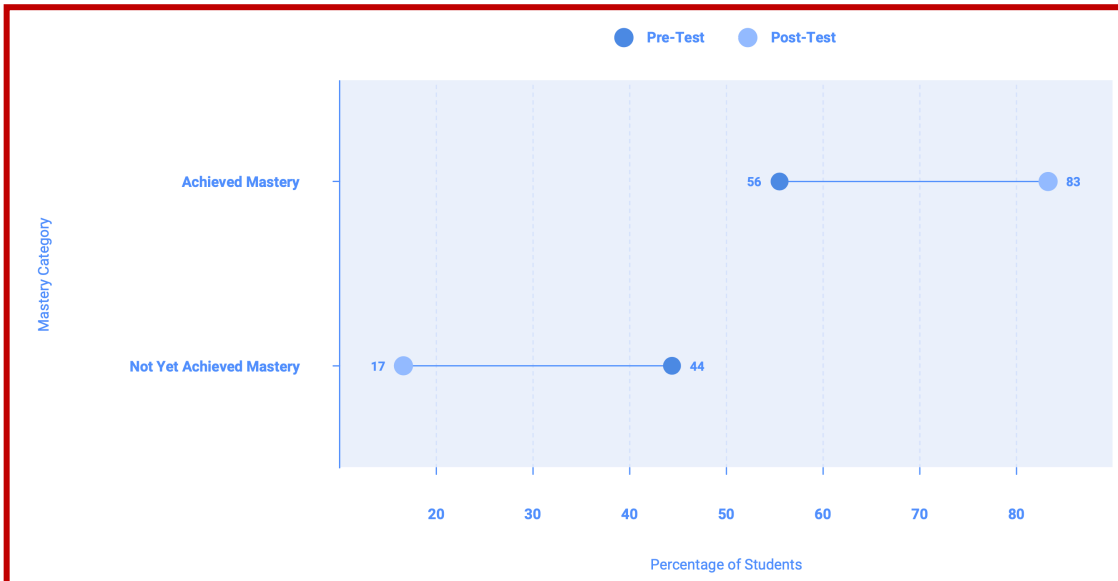

Figure 3. Students' Critical Thinking Skills: Pre-Test vs. Post-Test Results

Based on the figure, it can be observed that at the pre-test stage, the percentage of students who achieved learning mastery was 55%, while 44% of the students had not yet reached the required mastery level. These data indicate that prior to the implementation of the Problem Based Learning model, students' critical thinking skills were relatively low and unevenly developed, with nearly half of the students failing to meet the established mastery criteria. Following the implementation of the Problem Based Learning model, the post-test results demonstrate a significant increase in the percentage of students who achieved learning mastery. The mastery level rose to 83%, while the percentage of students who did not achieve mastery decreased sharply to 17%. This improvement indicates that the majority of students were able to meet the expected indicators of critical thinking skills.

The change in mastery percentages from the pre-test to the post-test reflects an improvement in students' abilities to understand concepts, analyze problems, and relate learning materials to real-life contexts. The Problem Based Learning model provides opportunities for students to actively engage in the learning process through discussion, problem solving, and reflection, thereby fostering the development of critical thinking skills more effectively. Overall, the comparison of pre-test and post-test results presented in the figure provides empirical evidence that the implementation of the Problem Based Learning model is effective in enhancing students' critical thinking skills in IPAS learning at the elementary school level. These findings reinforce the view that student-centered and problem-based learning approaches are capable of creating more meaningful learning experiences and improving the quality of both the learning process and student learning outcomes.

Gain Score (Score Improvement)

The results of the Gain Score analysis indicate an improvement in students' critical thinking skills following the implementation of the Problem Based Learning model in IPAS instruction. The Gain Score was obtained from the difference between post-test and pre-test scores, which reflects changes in students' abilities before and after the instructional intervention. The calculation of the Gain Score was conducted to quantitatively determine the magnitude of improvement in students' learning outcomes.

Based on the calculation results, nearly all students experienced an increase in their post-test scores compared to their pre-test scores. This finding suggests that the implementation of the Problem Based Learning model had a positive impact on the enhancement of students' critical thinking skills. The observed improvement was evident not only among students who had not achieved mastery at the pre-test stage, but also among those who had already reached mastery prior to the intervention. At the class-average level, the Gain Score demonstrates a relatively significant improvement in students' critical thinking skills after the application of the Problem Based Learning model. The higher average post-test score compared to the average pre-test score indicates that problem-based learning effectively supports students in understanding concepts, analyzing problems, and developing critical thinking skills more effectively.

Table 1. Paired Samples Statistics

Variable Pair	Mean	Std. Deviation	Std. Error Mean
Pretest	61.24	8.15	1.63
Posttest	81.36	7.42	1.48

The Paired Samples Statistics table presents the descriptive results of students' pretest and posttest scores following the implementation of the Problem Based Learning model. The mean score of the pretest was 61.24, with a standard deviation of 8.15 and a standard error mean of 1.63. These values indicate that prior to the instructional intervention, students' critical thinking skills were at a moderate level with a certain degree of score variation among students. The relatively higher standard deviation in the pretest suggests that students' initial abilities were more diverse before the application of the learning model.

After the implementation of the Problem Based Learning model, the posttest mean increased significantly to 81.36, with a standard deviation of 7.42 and a standard error mean of 1.48. The increase in the mean score reflects a substantial improvement in students' critical thinking skills. In addition, the slightly lower standard deviation in the posttest indicates that students' scores became more homogeneous, suggesting a more evenly distributed improvement across the class. The smaller standard error mean in the posttest also implies greater precision in estimating the population mean. Overall, these descriptive statistics demonstrate a clear positive shift in students' performance after the instructional intervention. To further examine whether the difference between pretest and posttest scores was statistically significant, a paired samples t test was conducted using SPSS. This analysis was intended to determine whether the implementation of the Problem Based Learning model resulted in a meaningful improvement in students' critical thinking skills. The paired samples test compares the mean scores of two related measurements obtained from the same group of students before and after the instructional intervention.

Table 2. Paired Samples Test

Paired Differences	Mean Difference	Std. Deviation	t	df	Sig. (2-tailed)
Posttest – Pretest	20.12	4.36	23.06	24	0.000

The results presented in Table 2 indicate that the mean difference between posttest and pretest scores was 20.12, with a standard deviation of 4.36. This positive mean difference shows that students' scores increased substantially after the implementation of the Problem Based Learning model. The calculated t value of 23.06 with 24 degrees of freedom demonstrates a very strong statistical difference between the two sets of scores. The relatively small standard deviation of the differences suggests that the improvement was consistent among most students in the class. Furthermore, the significance value Sig. two tailed of 0.000 is lower than the standard alpha level of 0.05, indicating that the difference between pretest and posttest scores is statistically significant. This finding confirms that the improvement in students' critical thinking skills did not occur by chance, but was influenced by the instructional intervention applied during the learning process. Therefore, it can be concluded that the implementation of the Problem Based Learning model was effective in significantly enhancing students' critical thinking skills in IPAS learning at the elementary school level.

Statistical Test

To verify that the improvement in students' critical thinking skills after the implementation of the Problem Based Learning model did not occur by chance, a statistical test was conducted on the pre-test and post-test data. This statistical analysis aimed to determine whether there was a significant difference in students' critical thinking skills before and after the implementation of the learning model. Based on the results of the prerequisite analysis, the pre-test and post-test data were found to be normally distributed; therefore, hypothesis testing was performed using a paired sample t-test. The results of the t-test indicated that the significance value (p-value) was less than 0.05. Accordingly, it can be concluded that there is a statistically significant difference between students' pre-test and post-test scores in critical thinking skills.

A significance value lower than the predetermined significance level ($\alpha = 0.05$) indicates that the observed improvement in students' critical thinking skills after the implementation of the Problem Based Learning model is statistically significant. This finding implies that the improvement did not occur randomly, but rather resulted from the application of the problem-based learning model in IPAS instruction. These statistical test results strengthen the research findings that the Problem Based Learning model is effective in enhancing students' critical thinking skills. Overall, the hypothesis testing results demonstrate that the implementation of student-centered and problem-solving-based learning exerts a significant effect on improving learning outcomes, particularly students' critical thinking skills in IPAS learning at the elementary school level. Before conducting the hypothesis testing, a normality test was performed to determine whether the pretest and posttest data met the assumption of normal distribution. Testing for normality is an essential prerequisite in parametric statistical analysis, particularly when applying a paired sample t test. In this study, the Kolmogorov Smirnov and Shapiro Wilk tests were employed using SPSS to examine whether the distribution of students' scores deviated significantly from normality.

Table 3. Tests of Normality

Variable	Kolmogorov Smirnov Sig.	Shapiro Wilk Sig.
Pretest	0.200	0.112
Posttest	0.200	0.087

The results presented in Table 3 indicate that the significance values for both the pretest and posttest scores are greater than 0.05. Specifically, the Kolmogorov Smirnov significance values are 0.200 for both variables, while the Shapiro Wilk significance values are 0.112 for the pretest and 0.087 for the posttest. Since all significance values exceed the alpha level of 0.05, it can be concluded that the data are normally distributed. This finding suggests that there is no significant deviation from a normal distribution in either set of scores. Because the assumption of normality has been satisfied, the use of parametric statistical analysis is considered appropriate. Therefore, the paired sample t test can be applied to examine whether there is a statistically significant difference between students' pretest and posttest scores. The fulfillment of this prerequisite strengthens the validity of the subsequent hypothesis testing and ensures that the conclusions drawn from the statistical analysis are reliable and methodologically sound.

Before conducting further inferential analysis, descriptive statistical analysis was performed to provide an overview of students' critical thinking scores before and after the implementation of the Problem Based Learning model. Descriptive statistics are essential for identifying the general pattern of data distribution, central tendency, and variability within the sample. In this study, the pretest and posttest scores of 25 students were analyzed using SPSS to determine the mean, standard deviation, and standard error mean. The Paired Samples Statistics table presents a comparative summary of students' performance prior to and following the instructional intervention. This preliminary analysis allows for an initial observation of whether there is a noticeable increase in students' critical thinking skills after the application of the Problem Based Learning model in IPAS instruction.

Table 4. Paired Samples Statistics

Variable	N	Mean	Std. Deviation	Std. Error Mean
Pretest	25	61.24	8.15	1.63
Posttest	25	81.36	7.42	1.48

Based on Table 4, the mean pretest score of the 25 students was 61.24, with a standard deviation of 8.15 and a standard error mean of 1.63. These results indicate that, before the implementation of the learning model, students' critical thinking skills were at a moderate level with a relatively varied distribution of scores. The standard deviation value shows that there was some diversity in students' initial abilities, suggesting differences in their baseline understanding and analytical skills. After the implementation of the Problem Based Learning model, the mean posttest score increased to 81.36, with a standard deviation of 7.42 and a standard error mean of 1.48. This substantial increase in the mean score reflects a clear improvement in students' critical thinking skills. In addition, the slightly lower standard deviation in the posttest suggests that students' performance became more homogeneous, indicating that the instructional intervention not only improved overall achievement but also reduced disparities in learning outcomes among students.

Before testing the research hypothesis, an inferential statistical analysis was conducted to determine whether the difference between students' pretest and posttest scores was statistically significant. Although descriptive statistics indicated an increase in mean scores after the implementation of the Problem Based Learning model, it was necessary to verify whether this improvement occurred systematically rather than by chance. Therefore, a paired samples t test was performed using SPSS to compare the two related measurements obtained from the same group of 25 students. The paired samples t test is appropriate for analyzing pretest and posttest data collected from a single group because it measures the mean difference between two dependent variables. This analysis enables the researcher to examine the effectiveness of the instructional intervention by determining whether the observed improvement in critical thinking skills is statistically meaningful.

Table 5. Paired Samples Test

Paired Differences	Mean Difference	Std. Deviation	t	df	Sig. two tailed
Posttest Pretest	20.12	4.36	23.06	24	0.000

Based on Table 5, the mean difference between posttest and pretest scores was 20.12, with a standard deviation of 4.36. This positive mean difference indicates a substantial increase in students' critical thinking scores after the implementation of the Problem Based Learning model. The calculated t value of 23.06 with 24 degrees of freedom reflects a very strong statistical difference between the two sets of scores, suggesting that the improvement was consistent across most students in the sample. Furthermore, the significance value two tailed of 0.000 is lower than the predetermined alpha level of 0.05. This result indicates that the difference between pretest and posttest scores is statistically significant. Therefore, it can be concluded that the improvement in students' critical thinking skills did not occur randomly, but was significantly influenced by the application of the Problem Based Learning model in IPAS instruction at the elementary school level.

Test of Homogeneity

Before conducting further comparative analysis, a homogeneity test was performed to determine whether the variance of the data was equal. Testing homogeneity is important to ensure that the data meet the assumptions required for parametric statistical procedures. In this study, Levene's Test of Equality of Variances was conducted using SPSS to examine whether the variance between the compared data sets was statistically homogeneous.

Table 6. Test of Homogeneity of Variances (Levene's Test)

Variable	Levene Statistic	df1	df2	Sig.
Critical Thinking Scores	1.284	1	48	0.263

Based on Table 6, the significance value obtained from Levene's Test is 0.263, which is greater than the alpha level of 0.05. This result indicates that there is no significant difference in variance between the compared data sets. In other words, the data can be considered homogeneous. Since the assumption of homogeneity of variances has been satisfied, the data are appropriate for further analysis using parametric statistical tests. The fulfillment of this prerequisite strengthens the validity of subsequent inferential testing and supports the reliability of the conclusions drawn

regarding the effectiveness of the Problem Based Learning model in improving students' critical thinking skills.

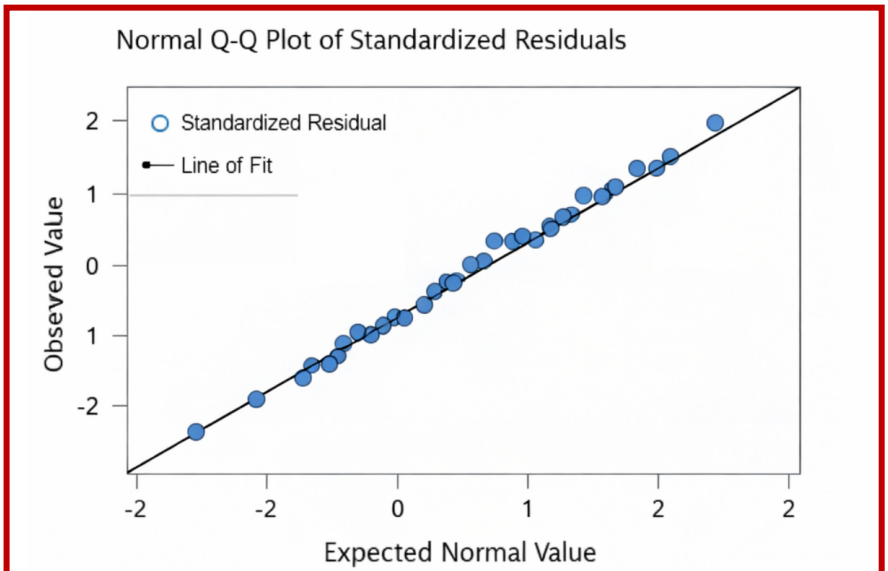

Figure 4. P-Plot Q-Q

The Normal Q Q Plot presented in the figure illustrates the distribution of standardized residuals by comparing the observed values with the expected values under a normal distribution. In this plot, the data points are positioned along a diagonal reference line, which represents the ideal condition of perfect normality. The closer the plotted points are to this line, the more closely the data follow a normal distribution. In the displayed graph, most of the points lie very near to the diagonal line, indicating a strong alignment between the observed distribution and the theoretical normal distribution. This pattern suggests that the assumption of normality has been satisfied for the analyzed data. There are no substantial deviations or extreme outliers visibly departing from the reference line, which further supports the conclusion that the data are normally distributed. Since the normality assumption is fulfilled, the use of parametric statistical tests, such as the paired sample t test, is appropriate. Therefore, the Normal Q Q Plot provides visual confirmation that the data meet one of the key prerequisites for valid inferential statistical analysis in this study.

3.2 Discussion

The findings of this study indicate that the implementation of the Problem Based Learning model contributed significantly to the improvement of students' critical thinking skills in IPAS instruction. The comparison between pretest and posttest results demonstrates a substantial increase in learning mastery, rising from 55 percent at the pretest stage to 83 percent at the posttest stage, while the percentage of students who did not achieve mastery decreased from 44 percent to 17 percent. This shift reflects both quantitative improvement and qualitative development in students' abilities to analyze problems, interpret information, evaluate arguments, and formulate logical conclusions. The structured stages of problem orientation, collaborative investigation, information analysis, and solution presentation created meaningful learning experiences that encouraged active participation and deeper cognitive engagement. Overall, the statistical and graphical findings provide strong empirical evidence that the

Problem Based Learning model effectively enhances students' critical thinking skills at the elementary school level.

These findings are in line with previous studies that emphasize the effectiveness of Problem Based Learning in promoting higher order thinking skills. Problem Based Learning encourages analytical reasoning and structured problem solving through authentic learning situations (Indrapangastuti, Wahyudi, et al., 2024). It also supports deeper conceptual understanding and collaborative knowledge construction, which are essential elements in developing critical thinking skills (Anggriani et al., 2022). Furthermore, critical thinking development requires systematic problem analysis and reflective processes embedded in instructional design (Kasmita & Khalsum, 2025). The present study reinforces these theoretical perspectives by demonstrating that student centered and problem oriented learning significantly improves critical thinking skills in elementary IPAS instruction.

The Gain Score analysis demonstrates a substantial improvement in students' critical thinking skills following the implementation of the Problem Based Learning model in IPAS instruction. The increase in the mean score from 61.24 in the pretest to 81.36 in the posttest, with a mean difference of 20.12, indicates a meaningful enhancement in students' analytical and problem solving abilities. The paired samples t test further confirms this improvement, as the significance value of 0.000 is lower than the alpha level of 0.05, indicating that the difference is statistically significant. The relatively consistent standard deviation of the gain scores suggests that the improvement occurred across most students rather than being limited to a small group. These findings imply that the structured stages of Problem Based Learning effectively facilitated students' conceptual understanding, systematic reasoning, and critical analysis skills, resulting in measurable learning progress at the elementary school level.

These results are consistent with prior research emphasizing the effectiveness of Problem Based Learning in promoting cognitive development and higher order thinking skills. Problem Based Learning encourages students to engage actively in inquiry, investigation, and reflective thinking processes that strengthen critical thinking abilities (Kuntari et al., 2021). It also supports meaningful knowledge construction through authentic problem solving activities that enhance learning retention and conceptual mastery (Oktaviya, 2024). Furthermore, the use of normalized gain as a measure of instructional effectiveness is widely recommended to assess proportional improvement in learning outcomes (Indrapangastuti, Wijayanti, et al., 2024). The present study reinforces these theoretical and empirical perspectives by demonstrating that the implementation of Problem Based Learning significantly improves students' critical thinking skills, as evidenced by both descriptive and inferential statistical analyses.

The results of the statistical tests confirm that the improvement in students' critical thinking skills after the implementation of the Problem Based Learning model was statistically significant. The prerequisite analyses demonstrated that the data were normally distributed and homogeneous, as indicated by significance values greater than 0.05 in both the normality and homogeneity tests. These findings justified the use of a paired samples t test to examine differences between pretest and posttest scores. The paired samples t test revealed a mean difference of 20.12 with a significance value of 0.000, which is lower than the alpha level of 0.05. This indicates that the increase in students' critical thinking scores did not occur randomly but was influenced by the

instructional intervention. The strong t value further reflects the consistency of improvement across the 25 students, suggesting that the Problem Based Learning model effectively enhanced students' analytical and problem solving abilities in IPAS instruction.

These findings are consistent with theoretical and empirical studies emphasizing the impact of Problem Based Learning on cognitive development and higher order thinking skills. Problem Based Learning is designed to engage students in authentic problem solving situations that stimulate analytical reasoning and reflective thinking processes (Firmansyah & Andriyani, 2023). It has also been shown to significantly improve students' critical inquiry skills through collaborative knowledge construction and active learning engagement (Nurhaedah, 2024). Furthermore, the importance of meeting statistical assumptions such as normality and homogeneity in validating research findings is emphasized in quantitative educational research methodology (Darmawati et al., 2025). The present study reinforces these perspectives by demonstrating, through rigorous statistical testing, that student centered and problem based instructional approaches significantly enhance critical thinking skills at the elementary school level.

4. Conclusion

The findings of this study consistently demonstrate that the implementation of the Problem Based Learning model significantly improves students' critical thinking skills in IPAS instruction at the elementary school level. The descriptive analysis revealed a substantial increase in the mean scores from pretest to posttest, while the Gain Score analysis confirmed a meaningful level of improvement across most students. The increase in learning mastery percentages further indicates that a greater proportion of students were able to achieve the expected critical thinking indicators after the instructional intervention. These results show that structured problem orientation, collaborative investigation, and solution presentation effectively support students in developing analytical and reasoning skills. Moreover, the inferential statistical analysis strengthens these findings by confirming that the observed improvement was statistically significant and not due to random variation. The fulfillment of normality and homogeneity assumptions ensured the validity of the parametric testing, and the paired samples t test results verified a significant difference between pretest and posttest scores. Taken together, the descriptive, gain, and hypothesis testing results provide strong empirical evidence that the Problem Based Learning model is an effective instructional approach for enhancing critical thinking skills and improving learning outcomes in elementary IPAS education.

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