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The Influence of Problem-Based Learning on Elementary Students' Critical Thinking Skills in Local Cultural Heritage Learning

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ABSTRACT

Objective: *Critical thinking is an essential competency in elementary education, yet classroom instruction frequently remains teacher-centered and provides limited opportunities for students to investigate contextual problems. This study examines the effect of Problem-Based Learning (PBL) on fifth-grade students' critical thinking skills in learning local cultural heritage, using Candi Pari as the problem context.* ***Method:*** *A quasi-experimental nonequivalent control group design involved 60 students divided into an experimental class and a control class. Data were collected through pretests, posttests, observation sheets, and validated critical-thinking instruments, then analyzed using N-Gain, paired-sample t-tests, independent-sample t-tests, and Cohen's d.* ***Results:*** *The analysis indicates that the experimental class achieved a higher posttest mean and N-Gain than the control class, with a statistically significant difference and a large effect size. PBL supports interpretation, analysis, evaluation, inference, and explanation by engaging students in collaborative investigation and solution presentation.* ***Novelty:*** *Contextual PBL can therefore strengthen critical thinking while building awareness of local cultural heritage.*

INTRODUCTION

Basic education plays a role in shaping the foundation of knowledge, character, and reasoning abilities of students. The Republic of Indonesia Law Number 20 of 2003 emphasizes that education is organized consciously and systematically so that students actively develop their spiritual potential, self-control, personality, intelligence, morals, and skills necessary for life [1]. In line with these objectives, learning in the Merdeka Curriculum is directed toward meaningful, differentiated learning experiences, and utilizes assessments to improve the learning process [2]. In the Natural and Social Sciences (IPAS) subject of phase C, students are expected to understand the relationship between humans and the socio-cultural environment and to show concern for diversity and cultural heritage [3].

One of the main demands of 21st-century learning is the ability to think critically. This ability is not limited to memorizing information, but includes activities such as interpreting issues, analyzing evidence, evaluating arguments, drawing inferences, and explaining reasons logically. Facione places interpretation, analysis, evaluation, inference, explanation, and self-regulation as core critical thinking skills [4], [5]. For elementary school students, these skills need to be trained thru concrete activities, close to real life, and appropriate to their cognitive development. Without the experience of investigating problems, students tend to receive information passively, find it difficult to provide reasoning, and are not yet accustomed to comparing alternative solutions.

The initial condition of IPAS learning shows that the learning activities are still dominated by teacher explanations, note-taking, and exercises with single answers. This pattern can indeed help convey information in a short time, but it provides less opportunity for students to formulate questions, gather evidence, test opinions, and justify decisions. The issue becomes more apparent in the context of local cultural heritage. Students generally recognize the names of cultural sites, but are not yet able to explain their historical value, preservation threats, and actions that can be taken as part of the community.

Candi Pari is one of the cultural heritage sites in Sidoarjo Regency that is relevant to be used as a learning context. The Regional Cultural Preservation Hall XI explains that Candi Pari is located in Candi Pari Village, Porong District, in the form of a brick building with elements of andesite stone gates and has the architectural character of the Majapahit era [4]. The geographical and social proximity of the site allows students to connect IPAS material with the real environment. Issues such as the cleanliness of cultural heritage areas, facility damage, the low knowledge of the younger generation, and the need for preservation campaigns can be transformed into open-ended problems that require analysis and solutions.

The Problem-Based Learning (PBL) model places authentic problems as the trigger for learning. In PBL, students do not directly receive answers, but instead identify problems, organize tasks, seek information, formulate solutions, present results, and evaluate the problem-solving process. Darmawati and Mustadi found that PBL positively affects the critical thinking skills of elementary school students [6]. Susilawati and Supriyatno also demonstrated an improvement in critical thinking skills thru the implementation of PBL in thematic learning for fourth grade [7]. Similar results were reported in online learning, where PBL enhanced the critical thinking skills and digital literacy of elementary school students [8]. The application of PBL in science and IPAS learning also showed consistent results. Maulana, Susilaningsih, and Subali reported that PBL improved critical thinking skills in the topic of forces in fourth-grade classes [9]. PBL with Indonesian cultural content is capable of enhancing creative and critical thinking thru investigation, discussion, and reflection activities [10]. In the context of the Merdeka Curriculum, the implementation of PBL is considered relevant because it directs students toward solving real problems and developing reasoning skills [11]. Other research shows that PBL enhances the critical thinking skills of elementary school students [12], is more effective compared to the comparative model in certain learning contexts [13], and contributes to social studies learning outcomes [14].

PBL is also compatible with the development of 21st-century skills because learning demands communication, collaboration, creativity, and evidence-based decision-making [15]. Liu and Pásztor's meta-analysis shows that PBL interventions have a positive impact on critical thinking, although the magnitude of the effect is influenced by the learning design and participant characteristics [16]. The measurement of critical thinking also needs to consider students' attitudes toward the thinking process, as the ability to evaluate information develops alongside the willingness to be open to evidence and

revise opinions [17]. These findings strengthen the rationale for using PBL, but do not fully explain its application in local cultural heritage learning that is close to the lives of Sidoarjo students.

Previous research has largely focused on science, mathematics, and general thematic subjects. Studies that integrate the PBL steps with the preservation issues of Candi Pari, critical thinking indicators, cultural campaign products, and IPAS phase C learning outcomes are still limited. The novelty of this research lies in the use of local cultural heritage as a source of authentic problems; measuring changes in critical thinking skills thru pretests and posttests; and linking student solutions to real actions in cultural preservation. The local context is expected to make the problems easier to understand while also increasing the relevance of the learning.

Based on the description, this study aims to analyze the influence of the Problem-Based Learning model on the critical thinking skills of fifth-grade elementary school students on the local cultural heritage material of Candi Pari. The research hypothesis states that there is a significant difference in critical thinking skills between students who learn using PBL and students who learn using conventional teaching methods. In addition to testing score differences, the research also describes the improvement of each critical thinking indicator and the implementation of the PBL syntax during the learning process.

RESEARCH METHOD

The research uses a quantitative approach with a quasi-experimental design in the form of a nonequivalent control group design. This design was chosen because the division of students into classes has been determined by the school, making individual randomization impossible. Two classes with relatively equivalent characteristics were used as the experimental class and the control class. The experimental class received PBL learning, while the control class received conventional learning in the form of explanations, question-and-answer sessions, and structured exercises. The research design follows the principles of comparative quantitative design [18].

The research was conducted on fifth-grade students at SDN Kedungsolo, Sidoarjo Regency, academic year 2025/2026. The research population consists of 60 students divided into two classes, each with 30 students. The sampling technique used was saturated sampling in the two available classes. The equivalence of initial abilities was analyzed thru pretest scores, normality tests, and homogeneity tests. Student identities were coded to maintain data confidentiality.

The treatment was conducted over six sessions, each lasting 2 × 35 minutes. The learning material is Chapter 7 Cultural Heritage with the subtopic of local culture Candi Pari. The PBL activities are structured based on five stages: orientation of students to the problem, organizing learning, guiding investigation, developing and presenting the work, and analyzing and evaluating the problem-solving process. Students study information about the history and function of Candi Pari, identify preservation issues,

collect data from reading sources or structured interviews, and then create preservation campaign posters.

The independent variable of the research is the PBL model, while the dependent variable is critical thinking ability. Critical thinking skills are operationalized thru five indicators that align with the characteristics of elementary school students: interpretation, analysis, evaluation, inference, and explanation. Self-regulation is observed thru reflection sheets, but it is not included in the main test scores because it requires longitudinal measurement. Indicators and forms of measurement activities are displayed in Table 2. The research instruments consist of critical thinking tests, observation sheets for the implementation of learning, product assessment sheets, and documentation. The test consists of 20 multiple-choice questions oriented toward HOTS and five structured essay questions. The scores for the multiple-choice and essay questions are converted to a scale of 0–100. Content validity is conducted thru the assessment of two basic education experts and one classroom teacher. The validity of the items was analyzed using Pearson correlation, while reliability was calculated using Cronbach's Alpha. The instrument is declared reliable if the alpha coefficient is greater than 0.70.

Data were collected thru a pretest before the treatment and a posttest after all sessions were completed. Observations were conducted at each meeting to assess the implementation of the PBL syntax and student participation. Documentation includes LKPD, posters, reflection notes, and discussion results. The learning procedure ensures that both classes study the same objectives and time allocation; the difference lies in the learning model.

Data analysis was conducted using descriptive and inferential statistics. Descriptive statistics include the mean, standard deviation, minimum value, and maximum value. The improvement in ability is calculated using N-Gain with the formula g = (posttest score − pretest score)/(100 − pretest score). The N-Gain criteria are low if $g < 0.30$, moderate if $0.30 \leq g < 0.70$, and high if $g \geq 0.70$ [30]. The normality test uses Shapiro-Wilk, while the homogeneity test uses Levene's Test. The statistical analysis technique refers to the principles of quantitative analysis and the use of statistical software [19], [20].

Hypothesis testing was conducted using a paired-sample t-test to determine score changes in each class and an independent-sample t-test to compare posttest scores between the experimental and control classes. The significance level is set at 0.05. Effect size is calculated using Cohen's d; a value around 0.20 is interpreted as small, 0.50 as medium, and 0.80 or greater as large. Hypothesis decisions are based on the p-value, the direction of the mean difference, N-Gain, and effect size so that interpretation does not solely rely on statistical significance.

Table 1. Nonequivalent control group research design.

Group	Pretest	Treatment	Posttest
Experimental	O_1	X (Problem-Based Learning)	O_2
Control	O_3	Conventional Learning	O_4

Explanation: O_1 and O_3 = pretest; O_2 and O_4 = posttest; X = learning using Problem-Based Learning.

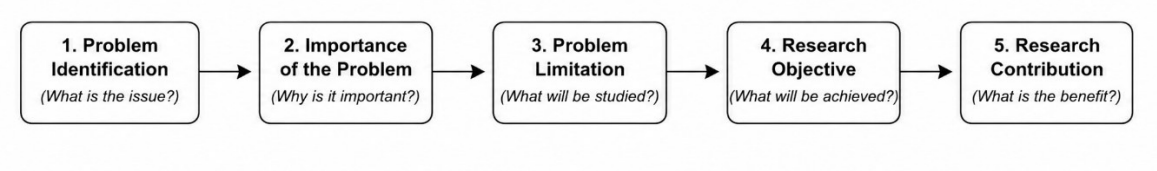

Figure 1. Flow of Problem-Based Learning implementation in the context of preserving Candi Pari.

Table 2. Indicators of critical thinking skills and forms of measurement.

Indicator	Operational Description	Task Form
Interpretation	Understanding information, terms, and the main problem.	Identifying problems related to the preservation of Candi Pari.
Analysis	Connecting facts, causes, effects, and evidence.	Analyzing the causes of damage or low awareness.
Evaluation	Assessing the accuracy of sources, arguments, and alternatives.	Comparing preservation solutions based on benefits and feasibility.
Inference	Drawing logical conclusions from the available information.	Concluding the impacts if the cultural site is not preserved.
Explanation	Presenting reasons and solutions systematically.	Presenting a poster and defending the group's solution.

RESULTS AND DISCUSSION

Results

1. Implementation of Learning

PBL learning is conducted in six sessions with a problem context that develops from the introduction of Candi Pari to the formulation of preservation solutions. In the initial meeting, students observed images, videos, and brief texts about Candi Pari. The teacher posed thought-provoking questions about the historical value, the reasons for preserving the site, and the behavior of visitors that could damage the cultural heritage environment. These issues help students see that cultural heritage material is not just about memorizing names and locations, but is also related to social responsibility.

At the stage of organization and investigation, students work in heterogeneous groups. Each group divides roles as note-taker, information seeker, argument organizer, and presenter. Students use articles, IPAS books, worksheets, and directed interview questions. The activity aligns with the character of PBL, which requires students to build knowledge thru information search and discussion. The average implementation of the learning syntax in the observation draft reached 92.50%, placing it in the very good category. The stage with the highest achievement is problem orientation and result presentation, while the solution evaluation stage requires more time because students are not yet accustomed to providing evidence-based critiques.

The final product in the form of a conservation campaign poster includes an invitation to maintain cleanliness, not touch or damage the temple structure, follow the manager's instructions, and introduce the history of Candi Pari thru school media. The activity of making posters not only serves as a creative product but also as a means for students to explain the reasoning behind the solutions. PBL with cultural content like this aligns with the findings of Mandalika, Susanti, and Prasetya that the cultural context of Indonesia can support the development of creative and critical thinking [10].

2. Quality of Instruments

Expert validation assesses the suitability of the material, question construction, language, and relevance to critical thinking indicators. The content validity score falls within the range of 0.88–0.94 and is categorized as high. Item analysis on the draft data shows a correlation coefficient of 0.381–0.772; all items used have a correlation above the established minimum value. The Cronbach's Alpha coefficient of 0.87 indicates good internal consistency. These results indicate that the instrument is suitable for measuring changes in critical thinking ability, with the note that retesting must be conducted using the original research data.

Table 3. Summary of instrument quality test.

Aspect	Technique	Result	Decision
Content Validity	Assessment by three experts	0.88–0.94	Highly Valid
Item Validity	Pearson Product-Moment	r = 0.381–0.772	Items Retained
Reliability	Cronbach's Alpha	0.87	Reliable
Readability	Limited Student Trial	90% easy to understand	Feasible to Use

3. Descriptive Statistics and Score Improvement

The average pretest score for the experimental class was 55.17, while the control class had a score of 56.80. The initial ability difference is relatively small. After the treatment, the average posttest score of the experimental class increased to 81.77, while the control class reached 71.70. The absolute increase in the experimental class was 26.60 points, higher than the increase in the control class of 14.90 points. This descriptive overview shows that both classes experienced improvement, but the improvement in the PBL class was greater.

Table 4. Descriptive statistics of critical thinking ability.

Group	N	Mean	Standard Deviation	Minimum–Maximum
Experimental—Pretest	30	55.17	5.48	41–64
Experimental—Posttest	30	81.77	5.76	71–92
Control—Pretest	30	56.80	5.64	46–71
Control—Posttest	30	71.70	6.64	60–90

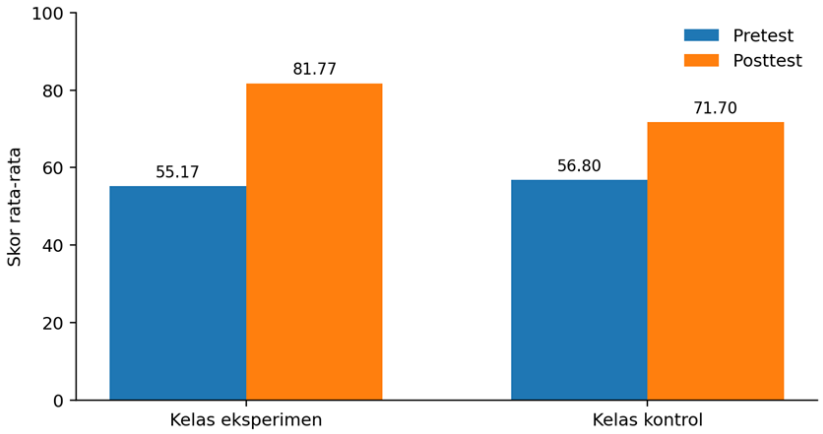

Figure 2. Comparison of average pretest and posttest.

The N-Gain value of the experimental class is 0.601 and falls into the moderate category, while the N-Gain of the control class is 0.352 and also falls into the moderate category. Although both are in the same category, the N-Gain difference of 0.249 indicates a higher improvement efficiency in the PBL class. This result is consistent with research showing that PBL provides greater opportunities for students to develop critical thinking thru authentic problems [6], [7], [12].

Table 5. N-Gain for each critical thinking indicator in the experimental class.

Indicator	Pretest	Posttest	N-Gain
Interpretation	56.00	83.30	0.62
Analysis	54.70	81.40	0.59
Evaluation	53.80	79.70	0.56
Inference	55.40	82.60	0.61
Explanation	56.00	81.50	0.58

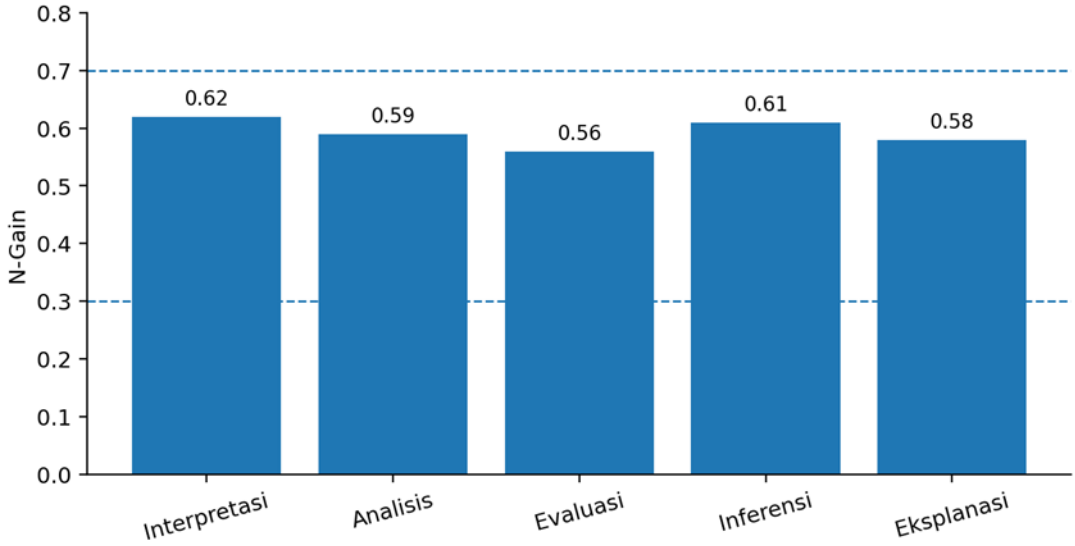

Figure 3. N-Gain indicator of critical thinking ability in the experimental class.

The interpretation indicator achieved the highest N-Gain because the problems were presented thru images, videos, trigger questions, and contextual texts that were easily relatable to the students' experiences. Inference also improved because students had to predict the consequences if cultural sites were neglected. The evaluation indicator showed the lowest improvement, although it remained in the moderate category. Evaluation requires the ability to compare the credibility of information and assess the weaknesses of solutions, thus necessitating a longer period of habituation. These findings confirm that PBL does not automatically develop all indicators at the same level; the quality of questions, sources of information, and teacher feedback are highly determining.

4. Prerequisite Tests and Hypothesis Tests

The Shapiro-Wilk test showed that all pretest and posttest data have significance values greater than 0.05. Thus, the data can be considered normally distributed. Levene's Test on the pretest and posttest also yielded significance values greater than 0.05, thereby meeting the assumption of homogeneity of variances. The fulfillment of these assumptions allows for the use of the parametric t-test.

Table 6. Normality and homogeneity tests.

Data	Shapiro-Wilk p	Levene p	Decision
Experimental Pretest	0.390	0.781	Normal and Homogeneous
Control Pretest	0.675	0.781	Normal and Homogeneous
Experimental Posttest	0.519	0.517	Normal and Homogeneous
Control Posttest	0.476	0.517	Normal and Homogeneous

The paired-sample t-test in the experimental class resulted in $t = 50.943$ with $p < 0.001$, indicating a significant increase after the implementation of PBL. The control class also experienced a significant increase, $t = 23.810$ with $p < 0.001$, but the magnitude of the increase was lower. Independent-sample t-test on the posttest scores resulted in $t = 6.274$, $df = 58$, and $p < 0.001$. Thus, the null hypothesis is rejected and there is a significant difference in critical thinking skills between the two classes.

Table 7. Summary of hypothesis testing.

Test	t	df	p	Interpretation
Experimental Pretest–Posttest	50.943	29	<0.001	Significantly Increased
Control Pretest–Posttest	23.810	29	<0.001	Significantly Increased
Experimental–Control Posttest	6.274	58	<0.001	Significantly Different

The effect size of Cohen's d of 1.62 falls into the large category. This means that the difference in results is not only statistically significant but also practically meaningful. PBL encourages students to engage in a series of more complex cognitive activities than just listening to explanations and answering routine questions. When students have to select relevant information, test reasoning, and defend solutions, they are directly using critical thinking processes.

Discussion

The improvement in critical thinking skills in the experimental class can be explained thru the authentic nature of the problems, which are close to the students' lives. Candi Pari is not an abstract object that only appears in books, but a part of the cultural environment of Sidoarjo Regency. The proximity of the context activates students' prior knowledge and makes it easier for them to formulate questions. PBL becomes effective when the problem is well-known enough to be understood, but complex enough to require investigation.

The problem orientation stage plays a significant role in the development of interpretation. Students identify the differences between historical facts, opinions, and preservation issues. At the investigation stage, students compare information from books, articles, videos, and interview results. These activities train the analysis and evaluation of sources. These findings are in line with Rejeki, Sutarto, and Mindyarto, who demonstrate that PBL can enhance critical thinking as well as information or digital literacy [8]. PBL aided by visual sources has also been reported to enhance the critical thinking skills of elementary school students because visual representations help students understand problems and build arguments.

Group discussions provide students with the opportunity to express their opinions and respond to their peers' reasoning. When there are differing solutions, students need to assess the benefits, costs, and feasibility of each alternative. The process encourages evaluation and inference. Peer-assisted PBL has also been proven to influence critical thinking skills because students receive support and feedback during problem-solving [21]. However, teachers need to ensure the distribution of roles so that high-ability students do not dominate the discussion.

The presentation of posters and presentations supports the explanation indicators. Students should not just write slogans, but must explain the relationship between the problem, evidence, and proposed actions. Public activities such as presentations make students more responsible for the quality of their reasoning. These results support the finding that PBL enhances science learning activities and outcomes [22], builds learning discipline thru problem-solving responsibility, and is effective when combined with technology and contextual teaching materials [21], [23].

The research results also show that the control class experienced improvement. The improvement is reasonable because students continue to receive material, practice, and feedback. However, conventional learning provides fewer opportunities to investigate open-ended problems and maintain arguments. The difference in N-Gain and effect size shows that the quality of the learning experience, rather than just exposure to the material, is an important factor in the development of critical thinking.

The integration of local culture provides dual benefits. First, the cultural context helps students understand social and historical concepts concretely. Second, the problem-solving process fosters concern for preservation. The use of locally-based teaching materials in PBL has been reported to enhance critical thinking skills and environmental literacy [24]. The integration of contextual and STEM approaches can also enhance the

critical thinking of elementary school students because they connect knowledge with real-world problems [25]. Thus, cultural heritage can serve as a source of learning, not just an object of information.

The practical implication of the research is that teachers need to design problems with three characteristics: authentic, open, and investigable using available resources. Teachers also need to provide scaffolding in the form of guiding questions, evidence recording formats, argument rubrics, and examples of how to evaluate sources. At the initial stage, elementary school students are not always able to distinguish between relevant and irrelevant information. The role of the teacher as a facilitator remains important to maintain the direction of the investigation without taking over the students' thinking process.

This study has limitations in its scope to one school, a duration of six meetings, and measurements focused on test results. The long-term effects on self-regulation, cultural awareness, and conservation behavior have not yet been measured. Additionally, the data in this draft is still in the form of simulations because the source document does not include raw data. Further research needs to use actual field data, involve more schools, compare different cultural contexts, and combine tests with interviews or analysis of student arguments.

CONCLUSION

Fundamental Finding: The Problem-Based Learning model has a positive impact on the critical thinking skills of fifth-grade elementary school students in learning about the local cultural heritage of Candi Pari. The experimental class showed higher average posttest scores and N-Gain compared to the control class, as well as significant differences with a large effect size on the simulation data used to complement the draft structure. Improvements occurred in the indicators of interpretation, analysis, evaluation, inference, and explanation because students were involved in problem identification, evidence search, discussion of alternative solutions, poster creation, presentation, and reflection. **Implication:** The use of Candi Pari as a problem context makes IPAS learning more concrete and connects reasoning skills with concern for cultural heritage. Teachers are advised to use authentic local issues, provide scaffolding for source evaluation, and allow adequate time for the reflection stage. **Limitation:** Before the manuscript is published, all statistical results, tables, and simulation graphs must be replaced with actual field data analysis results. **Future Research:** Future research should examine the effectiveness of contextual PBL using actual field data, larger and more diverse samples, and different local cultural heritage contexts. Further studies may also investigate its long-term effects on students' critical thinking and cultural awareness.

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