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Implementation of Problem-Based Learning Assisted by Flashcards to Improve Students' Critical Thinking Skills on Landscape Material

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Abstract: This study examines the implementation of Problem-Based Learning (PBL) assisted by flashcard media to improve third-grade elementary students' critical thinking skills in Landscape (Bentang Alam) material. Methods: This study used a quantitative approach with a quasi-experimental, nonequivalent control-group design. The sample consisted of 44 third-grade students from SD Negeri in Semarang, divided into an experimental class (22 students) taught using PBL assisted by flashcards and a control class (22 students) taught using conventional learning. Data were collected using pretest and posttest instruments with 120 multiple-choice items (30 per skill) and analyzed using normality and homogeneity tests, paired-sample t-tests, independent-sample t-tests, Normalized Gain (N-Gain) analysis, and analysis of Covariance (ANCOVA) with the pretest as the covariate. Because of third-grade students' cognitive capacity, the test was administered in four separate sessions on four different days, with each session lasting approximately 45 minutes. Effect size was reported using Partial Eta Squared to measure the magnitude of the intervention's impact. Both groups showed increased critical thinking ability after treatment, but the experimental group's increase was significantly higher than the control group's. After controlling for pretest scores, the ANCOVA results showed a significant difference between groups ($F = 16989.679$; $p < .001$; $ç^2p = .998$), indicating a large effect size. The experimental group's average N-Gain score was 0.7336, categorized as high and fairly effective, while the control group's average was 0.3784, categorized as medium and less effective. The greatest improvement occurred in the analysis and evaluation indicators. Implementing PBL assisted by flashcards effectively improves students' critical thinking skills on Landscape material, as flashcards function not merely as visual media but as contextual problem triggers integrated into each stage of the PBL syntax.

Keywords: problem-based learning, flashcard, critical thinking, landscape, elementary school.

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INTRODUCTION

Education serves as a strategic long-term investment for national advancement in the contemporary era, with the primary goal of producing competent and resilient human resources who can respond to developments in science, technology, and global dynamics. In accordance with this objective, the direction of education is further strengthened through the Regulation of the Minister of Primary and Secondary Education Number 13 of 2025 concerning Amendment to the Regulation of the Minister of Education, Culture, Research, and Technology Number 12 of 2024 concerning the Curriculum, which emphasizes that learning should develop students' potential through deep learning

to shape individuals with critical reasoning, creativity, collaboration, and communication skills, and pancasila character. Therefore, learning implementation needs to be student-centered to optimize students' potential in line with the established curriculum objectives.

Consistent with this regulation, the Merdeka Curriculum grants educators the autonomy to implement student-oriented instructional designs. This framework emphasizes not merely content acquisition but also cultivating 21st-century competencies through experiential and reflective learning. Wahyono et al. (2024) found that the *Merdeka* Curriculum features diverse intracurricular learning, enabling optimal content coverage and giving students sufficient time to understand and deepen concepts while strengthening their competencies. Teachers should create meningful learning experiences, encourage student engagement, and reflect on learning outcomes to foster higher-order thinking skills.

Integrating Natural and Social Sciences (IPAS) is key to achieving this educational objective. It combines scientific inquiry with social understanding to foster holistic student development. Pratiwi & Fathurrahman (2025) explained that the IPAS subject in the *Merdeka* Curriculum presents unique teaching challenges, particularly in developing media that are interactive, thematic, and contextually appropriate. Through IPAS learning, students can understand natural and social phenomena in their surrounding environment, gather information, and solve various problems encountered in daily life. Thus, IPAS learning emphasizes not only concept mastery but also equips students with thinking, problem-solving, and responsible decision-making skills.

One IPAS topic taught in third grade of elementary school is Landscape (*Bentang Alam*). This topic covers various landscape forms and their characteristics, the relationship between landscape conditions and human activities, and environmental problems that occur in these landscapes. This material requires students to connect the concepts they learn with real conditions in their surrounding environment. Therefore, landscape learning should be designed contextually so that students not only memorize landscape types but can also analyze the causes, impacts, and alternative solutions to environmental problems.

Critical thinking is an essential competency to develop in 21st-century learning. According to Facione (2015), critical thinking encompasses cognitive operations such as interpretation, analysis, inference, evaluation, explanation, and self-regulation prior to judgment or decision-making. Riswari et al. (2025) note that students often face questions with only one correct answer, which makes them less accustomed to complex situations; critical thinking skills help individuals evaluate, interpret, and make appropriate decisions. Critical thinking skills are important in IPAS because they help students understand relationships between concepts and real phenomena, analyze problems, and determine solutions based on the evidence they obtain.

The importance of critical thinking skills is also supported by recent educational literature. Johnston (2021) highlighted critical thinking and problem-solving as important twenty-first-century skills that support deeper understanding and the ability to apply knowledge to solve new problems. In the context of IPAS learning, these skills are particularly relevant because students are expected not only to understand scientific and social concepts but also to analyze information and apply their knowledge to solve problems in everyday life. Similarly, Chang et al. (2022) studies have shown that integrating Problem-Based Learning with collaborative learning strategies can improve students' learning outcomes and motivation, highlighting the potential of student-centered approaches to support meaningful learning.

However, evidence shows that Indonesian students' critical thinking skills remain far from adequate. Several studies support this, including the Program for International Student Assessment (PISA) 2023 report. According to the Organization for Economic Cooperation and Development (OECD), Indonesian students' reading ability averaged 359, compared with the OECD average of 476. Mathematics and science scores also showed inadequacy, with Indonesian students scoring far below the OECD average. Indonesia's Education Quality Report also shows insufficient reading literacy and numeracy, as well as a lack of structure in learning-quality development.

Classroom observations in a third-grade setting at a Semarang elementary school revealed that although instruction followed the designated lesson plans, the delivery remained predominantly instructor-led, with students functioning largely as passive recipients of information. Learning activities focused on reading textbooks, listening to the teacher's explanations, and doing practice exercises, resulting in low active engagement; students rarely asked questions, expressed opinions, or gave reasons for their answers, and some appeared easily distracted. This did not align with deep learning, which emphasizes mindful, meaningful, and joyful learning through active student engagement.

These findings were reinforced by interviews with a third-grade teacher at an elementary school in Semarang City, Central Java. The teacher revealed that relying on textbooks as the main learning resource led to one-way learning, so students had insufficient opportunities to explore knowledge or solve problems independently. In addition, learning media remained limited to pictures in textbooks or simple presentation slides, which could not provide concrete, engaging learning experiences, particularly for the Landscape (Bentang Alam) material, which requires visualizing various natural features. As a result, students tended to memorize concepts rather than analyze the relationships between concepts or connect the material with phenomena encountered in daily life. This suggests that learning has not yet given students enough space to build their knowledge through thinking, discussion, and problem-solving activities.

These observations and interview results are in line with the findings of Susilawati & Supriyatno (2023), who stated that teacher-dominated learning tends to result in low learning engagement, making it less effective in developing students' critical thinking skills. Conversely, student-centered learning through investigation and problem-solving activities can more effectively improve learning participation and critical thinking skills.

These problems call for a learning model that shifts the learning process from teacher-centered to student-centered. One relevant learning model is Problem-Based Learning (PBL). The PBL model uses contextual problems as the starting point for learning, encouraging students to identify problems, gather information, discuss and analyze alternative solutions, and draw evidence-based conclusions.

Through these stages, students have the opportunity to build knowledge independently while developing critical thinking, communication, collaboration, and problem-solving skills. In an Indonesian educational context, Marini et al. (2026) found that implementing PBL positively and significantly affects student engagement and critical thinking. The study also showed that student engagement mediates the relationship between PBL and critical thinking, indicating that active involvement in the learning process can support the development of students' higher-order thinking skills. A significant improvement in both critical thinking skills and learning activities was reported by Hawa et al. (2025) following the implementation of the PBL model. Kuniyil and Mancheriputhuserimuhamed (2025) also

reported significant improvements in critical thinking skills following the implementation of Collaborative Problem-Based Learning among students. Similarly, Kaffah, Haryono & Utanto (2023) found that Problem-Based Learning can enhance both learning engagement and higher-order thinking skills because students are actively engaged in the investigation and problem-solving process.

To better suit the characteristics of third-grade elementary school students, who are still in the concrete operational stage, Problem-Based Learning implementation needs learning media that present concepts visually and engagingly. One medium is flashcards. Flashcards are picture-card media that help students understand concepts concretely, increase attention, and facilitate remembering information. In this study, flashcards were not only used to deliver material but were also designed as problem triggers that present real-life scenarios from daily life. Thus, flashcards serve as a stimulus that encourages students to observe, identify problems, discuss, and formulate solutions in line with the Problem-Based Learning stage. Research by Sitorus et al. (2025) showed that integrating flashcard media with an active learning model can improve learning engagement as well as elementary school students' critical thinking skills.

Previous studies have examined the effectiveness of Problem-Based Learning and flashcards in improving learning outcomes. However, research integrating flashcard-assisted Problem-Based Learning on Landscape (Bentang Alam) material in third-grade elementary school remains relatively limited. This study's novelty lies in using flashcards as a stimulus for contextual problems integrated into every stage of the Problem-Based Learning syntax, rather than merely as a visual medium for introducing concepts. Through this design, students not only observe pictures of landscapes but also identify problems, analyze their causes and impacts, and formulate alternative solutions based on group discussion results. This integration of models and media is expected to create more active, contextual, and meaningful IPAS learning, helping students develop their critical thinking skills optimally.

Based on the above description, flashcard-assisted Problem-Based Learning is considered an appropriate alternative to address students' low engagement and critical thinking skills in Landscape material, and this research aims to examine its implementation among third-grade students in Semarang City in line with the demands of the *Merdeka* Curriculum.

Accordingly, this study formulates the following research questions: is there a significant difference in critical thinking skills between students' taught using flashcard assisted Problem Based Learning and those taught using conventional learning; is there a significant improvement in student's critical thinking skills before and after the implementation of flashcard assisted Problem Based Learning; how effective is the implementation of flashcard assisted Problem Based Learning in improving student's critical thinking skills on Landscape (*Bentang Alam*) material based on the Normalized Gain (N-Gain) score; and which indicators of critical thinking skills experience the highest improvement after the implementation of flashcard assisted Problem Based Learning.

METHOD

Research Design

A quantitative methodological framework was adapted, employing a quasi-experimental nonequivalent control group design to evaluate the intervention's effectiveness. This design examined the effectiveness of implementing the Problem-Based Learning (PBL) model, supported by flashcard media, in improving students' critical thinking skills on Landscape (Bentang Alam) Material. In this design, the

experimental class and control class were given a pretest before treatment and a posttest after treatment to measure students' critical thinking skills (Creswell & Creswell, 2018). The experimental class received lessons using the flashcard-assisted PBL model, while the control class received lessons without any special treatment.

Prior to the implementation of the research, the researcher first obtained permission from relevant parties, including the school principal and the classroom teacher. Since the study involved third-grade elementary school students, the researcher also requested permission. Parents or guardians were provided with information about the purpose, stages, and timeline of the research and were informed that their children's participation was voluntary. After obtaining such consent, the research was carried out according to the established procedures. The data obtained during the research were also kept confidential and used solely for research purposes.

Participants

A total of 67 third-grade students across parallel classes at an elementary school in Semarang City formed the study population. The research sample was determined using the cluster random sampling technique, namely sampling by randomly selecting groups in the form of classes as the sampling unit (Fraenkel et al., 2012). Through a lottery process among the three parallel classes, two classes were selected as the research sample. A second lottery then determined the experimental and control classes. The experimental class consisted of 22 students, and the control class consisted of 22 students. Before treatment, both classes took a pretest to measure their initial critical thinking ability. The results of the equivalence test of initial ability using an independent-samples t-test on pretest scores showed that there was no significant difference between the experimental and control classes ($p > 0.05$), so both classes had relatively equivalent initial abilities (Situmorang, 2019).

Research Instruments

The research instrument was a written test to measure students' critical thinking skills on Landscape (Bentang Alam) material, consisting of a pretest and posttest. The instrument consisted of 120 multiple-choice items, including 30 items developed based on critical-thinking indicators. Before use in the study, the instrument was piloted with 23 students not included in the research sample. The instrument trial was conducted to determine the validity, reliability, difficulty level, and discrimination index of each item (Cohen et al., 2017).

The research instrument used in this study was a written multiple-choice test designed to measure students' critical thinking skills in the Landscape material through a pretest and posttest. The instrument was developed by adapting Facione's framework, which identifies six core cognitive skills of critical thinking: interpretation, analysis, evaluation, inference, explanation, and self-regulation (Facione, 2015). This study selected four skills: interpretation, analysis, inference, and evaluation, based on their relevance to the learning objectives, the Landscape material, and the multiple-choice assessment format. The four skills were operationalized as follows: interpretation involved understanding relevant information; analysis involved examining relationships among information; inference involved drawing reasonable conclusions based on available information and evidence; and evaluation involved judging statements, relationships, or proposed actions based on relevant information and evidence (Facione, 2015). For each selected skill, 50 multiple-choice items were initially developed, resulting in 200 items. The items used contextual stimuli related to landscape characteristics, environmental conditions, human activities, and

environmental problems appropriate for third-grade students and were designed to require students to process and use information rather than merely recall factual knowledge.

When constructing the response options, distractors were plausible but incorrect alternatives based on potential processing errors, particularly in items assessing analysis and evaluation. These errors included misinterpreting relevant information, identifying inappropriate relationships, overlooking relevant information, or drawing conclusions that were not supported by the evidence. Thus, the distractors were not obviously incorrect alternatives but choices that could reflect incomplete understanding or inaccurate reasoning.

Based on the item analysis results, 30 items were selected from the 50 items initially developed for each skill, resulting in a final instrument consisting of 120 items, with 30 items assessing each skill: interpretation, analysis, inference, and evaluation. The 120-item instrument had a Cronbach's alpha of 0.87, indicating high internal consistency for the overall critical thinking instrument. The selected items were predominantly medium difficulty and showed good to very good discrimination indices. Therefore, the final instrument met the established item-quality criteria and was used to measure students' critical thinking skills in the Landscape material.

Because of third-grade students' cognitive capacity, the 120-item test was administered in four separate sessions conducted on four different days. Each session consisted of 30 items representing one critical thinking skill and lasted approximately 45 minutes, including a short break. This duration was determined based on the pilot test, in which the average completion time for 30 items was 45 minutes. The items were read aloud by the researcher to accommodate students' varying proficiency, and pictorial stimuli were provided where necessary to reduce cognitive fatigue.

Research Procedure

This study was carried out in three stages: preparation, implementation, and evaluation and analysis. In the preparation stage, the researchers conducted a preliminary study and developed learning tools, including teaching modules, flashcard media, and research instruments in the form of pretest and posttest questions. The learning tools and instruments were then validated by experts, after which the instrument was piloted and validated as described earlier (Cohen et al., 2017). Once the instrument was deemed feasible, the researchers obtained research permits and determined the sample using cluster random sampling to establish the experimental and control classes.

During the implementation stage, both groups took a pretest to measure students' initial critical-thinking ability on the Landscape material. Next, the experimental group learned using the flashcard-assisted Problem-Based Learning (PBL) model, while the control group followed the teacher's usual approach on the same material. The experimental group learned according to the Problem-Based Learning model's syntax. Flashcard media supported learning at every stage, helping students identify, analyze, and understand concepts in the Landscape material. After completing the entire series of lessons, both groups took a posttest using the same instrument to measure students' critical thinking ability after treatment.

To ensure comparable implementation across the two groups, several aspects of the learning process that were not part of the treatment were kept consistent. Both the experimental and control groups participated in three learning sessions, with 2 x 35 minutes per session. Both groups also received the same

Bentang Alam (Landscape) learning material, based on the same learning objectives and curriculum guidelines, and completed the same pretest and posttest instruments.

In the control group, learning followed the teacher's usual daily practices. The lesson began with a teacher explanation, followed by question-and-answer activities to assess students' understanding. Students then read the textbook and completed individual exercises. Throughout the lesson, the teacher provided explanations and guidance when students encountered difficulties. The control group did not receive Problem-Based Learning or use flashcard-based learning media.

To minimize the potential influence of differences in teacher characteristics, the same student teacher conducted the learning process in both the experimental and control groups during the teaching practicum. Thus, both groups received the same learning time, instructional materials, learning objectives, assessment instruments, and teacher instruction. The difference was that the experimental group received Problem-Based Learning assisted by flashcards, whereas the control group followed the teacher's usual instructional practices. This arrangement aimed to ensure that differences in students' critical thinking skills between the two groups more accurately reflected the effect of the treatment.

The pretest and posttest data were then analyzed using statistical analysis techniques in accordance with the research objective, namely to determine the effect of implementing the flashcard-assisted Problem-Based Learning model on students' critical thinking skills.

Data Analysis

Data analysis was carried out using IBM SPSS Statistics version 26. Before hypothesis testing, prerequisite analyses were conducted, including a normality test using Shapiro-Wilk (since each group had fewer than 50 students) and a homogeneity test using Levene's Test. These tests were conducted to assess the assumptions of normality and homogeneity of variance required for parametric statistical analysis (Knief & Forstmeier, 2021). A significance level of 0.05 was used as the criterion for statistical decision-making.

Next, an initial ability equivalence test used an independent-samples t-test on pretest scores to determine whether critical thinking ability differed between the experimental and control groups before treatment. After treatment, a paired-samples t-test was run for each group to assess changes in students' critical thinking ability from pretest to posttest. The effect of implementing the flashcard-assisted Problem-Based Learning (PBL) model on students' critical thinking ability was analyzed using an independent-samples t-test on posttest scores between the experimental and control groups. Hypothesis testing was carried out at a significance level of 0.05 (Situmorang, 2019).

In addition, the improvement in students' critical thinking ability was analyzed using the Normalized Gain (N-Gain) based on each group's pretest and posttest scores. The N-Gain value was used to measure students' learning improvement based on the increase in pretest and posttest scores (Syaiful et al., 2025). An N-Gain value between 0.70 and 1.00 is categorized as high; a value between 0.30 and 0.70 is categorized as medium; and a value greater than 0.00 but less than 0.30 is categorized as low. Furthermore, an N-Gain value of exactly 0.00 indicates no increase, while a value of -1.00 or below 0.00 indicates a decrease. In addition to the N-Gain criteria, effectiveness was also interpreted based on the N-Gain percentage. A percentage of less than 40% is categorized as not effective, a percentage of 40-55% is categorized as less effective, a percentage of 56-75% is categorized as fairly effective, and a

percentage greater than 76% is categorized as effective. Given the nature of the nonequivalent control group design, where groups are formed naturally, there is a possibility that pretest variance acts as a confounding variable. Therefore, to fulfill the assumption of group equivalence and to control for initial ability, the data analysis was escalated using Analysis of Covariance (ANCOVA) with pretest scores as the covariate. This analysis was performed using IBM SPSS Statistics version 26. The ANCOVA test was conducted to examine the effect of the learning model (PBL assisted by flashcards vs. conventional) on posttest scores the magnitude of the intervention's effect size was reported using Partial Eta Squared (ç²p), with interpretation criteria: 0.01 (small), 0.06 (medium), and 0.14 (large).

■ RESULT AND DISCUSSION

This study used a quantitative approach with a quasi-experimental design in the form of a nonequivalent control group design. The research was conducted at an elementary school in Semarang City, Central Java, in the even semester of the 2025/2026 academic year. The sample consisted of two classes: class III-A as the experimental group, which received learning using the flashcard-assisted Problem-Based Learning (PBL) model, and class III-B as the control group, which received conventional learning. Each group consisted of 22 students. The learning media used in this study were flashcards containing contextual problem scenarios related to Landscape (*Bentang Alam*) material. An example of the flashcards used in the learning process is shown in Figure 1 below.

Figure 1. Flashcard media

Before treatment, both groups took a pretest to assess students' initial critical thinking ability on Landscape material. The pretest results showed that the control group's initial average ability was 68.63 (SD = 7.71), while the experimental group's average was 71 (SD = 6.90). Both groups showed relatively low initial ability on the Landscape material. This finding is in line with the Program for International Student Assessment (PISA, 2022) report, which showed that Indonesian students' abilities in reading, mathematics, and science were still below the Organization for Economic Co-operation and Development (OECD) average. This low critical thinking ability reflects a broader problem within the national education system, where learning remains teacher-centered, so students are not yet accustomed to higher-order thinking activities.

To ensure that both groups had equivalent initial conditions, a pretest equivalence test was conducted using an independent-samples t-test. The results showed a 2-tailed significance value of 0.349 (> 0.05), indicating no significant difference in the initial critical thinking ability between the control and experimental groups. Thus, both groups had equivalent initial abilities before treatment was given, consistent with the assumption of the nonequivalent control group design that both groups are equivalent at the initial condition.

After receiving different treatments, both groups took a posttest to measure improvement in critical thinking ability. The posttest results showed that the control group's final average was 82.32, with a standard deviation of 8.37, while the experimental group had an average of 93, with a standard deviation of 5,29. A summary of the descriptive statistics and normality test results is presented in Table 1.

The distribution of students' pretest and posttest scores in the control and experimental groups. The figure shows that scores in both

Table 1. Summary of descriptive statistics and normality test results

Variable	Group	N	Mean	Standard Deviation
Pretest	Control	22	68.63	7.71
Pretest	Experimental	22	71.00	6.90
Posttest	Control	22	82.32	8.37
Posttest	Experimental	22	93.00	5.29

groups increased after the learning process, as indicated by the upward shift from pretest to posttest. The experimental group showed a more pronounced increase, with posttest scores concentrated at a higher level than pretest scores. Meanwhile, the control group also increased its posttest scores, although the distribution remained more spread out. These findings visually represent changes in students' critical thinking ability following the learning process and indicate that the experimental group's increase was more substantial than that observed in the control group. The statistical analysis was subsequently conducted to determine whether these observed differences were statistically significant. The distribution of students' pretest and posttest scores in the control and experimental groups is presented in Figure 2.

Before hypothesis testing, prerequisite analyses, including normality and homogeneity tests, were performed. The Shapiro-Wilk normality test showed that all pretest and posttest data in both groups had significance values > 0.05, indicating that the data were normally distributed. With the normality assumption met, the use of parametric statistics in the data analysis can be justified. Next, the homogeneity test using Levene's Test showed that the assumption of equal

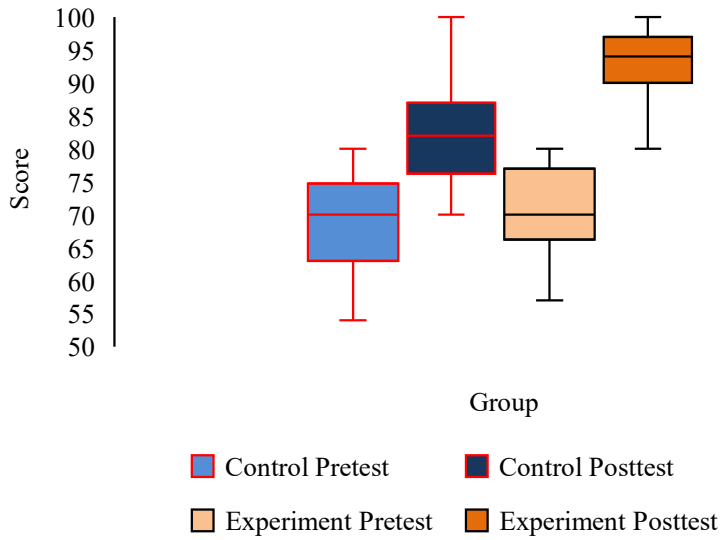

Figure 2. Distribution of pretest and posttest scores by group

variances was met for both the pretest ($F(1,42) = 0.256$, $p = .616$) and posttest ($F(1,42) = 3.446$, $p = .070$), as both significance values were greater than 0.05. This indicates that the homogeneity assumption in the nonequivalent control group design was met.

After meeting the prerequisite tests, we conducted a paired-samples t-test to determine whether a significant difference existed between the pretest and posttest in each group. The test results showed that the significance values (2-tailed) for both groups were < 0.001, indicating a significant difference between the pretest and posttest in each group. This means that both the control group and the experimental group experienced an increase in critical thinking ability after learning. However, the mean difference in the experimental group was greater than in the control group, indicating a larger increase. Next, to determine whether the experimental and control groups' posttest scores differed significantly, an independent-samples t-test was conducted. The results showed a significance value (2-tailed) of 0.004 (< 0.05), indicating a significant difference in critical thinking ability between the experimental and control groups after treatment. This shows that the flashcard-assisted PBL model was more effective than conventional learning. The hypothesis test results are presented in Table 2.

Table 2. Hypothesis test results: paired sample T-Test and independent sample T-Test

Test	Group	Mean Difference	t	df	Sig. (2-tailed)
Paired Sample	Control	-13.682	-4.806	21	0.000
Paired Sample	Experimental	-21.818	-11.976	21	0.000
Independent Sample	Posttest	-	3.042	42	0.004

To determine learning effectiveness and the magnitude of the increase in critical thinking ability, an N-Gain analysis was conducted. Findings indicated that the control group achieved a normalized gain score of 0.3784 (medium category), whereas the experimental group recorded a substantially higher score of 0.7336 (high category). The N-Gain finding in the

experimental group was 0.7336. This finding aligns with the development research conducted by Imama et al. (2021), which demonstrated that the implementation of a PBL model based on traditional game technology (Bakiak) in elementary school learning proved to be effective and could significantly improve student learning outcomes, as evidenced by the significant mean difference in posttest scores ($p < 0.05$) between the experimental and control groups. This indicates that the integration of media into the PBL model consistently produces a higher increase compared with PBL without media or conventional learning. Similarly, Dalimunthe et al. (2025) found that interactive learning media grounded in PBL significantly improve students' learning outcomes, with the experimental group achieving a higher post-test score than the control group ($p < 0.05$) and an N-Gain score of 0,5845, indicating moderate improvement.

The interpretation of N-Gain based on the criteria shows that the increase in critical thinking ability in the experimental group was higher than in the control group. Furthermore, based on the average N-Gain percentage, the control group reached 37.84%, which falls into the less effective category, while the experimental group reached 73.36%, which falls into the fairly effective category. This shows that the implementation of flashcard-assisted PBL is more effective in improving critical thinking ability than conventional learning. The results of the N-Gain analysis are presented in Table 3.

The greater improvement in the experimental group was due to the PBL model's nature, which uses contextual problems as the starting point of learning. This finding aligns with research by Sitorus et al. (2025), which showed that the flashcard-assisted PBL model significantly improves elementary school students' critical thinking ability in science learning (2-tailed $p = 0,000 < 0.05$). That study also showed that PBL provides a real problem-solving context that requires interpretation, analysis, inference, and evaluation. Thus, the interaction between these two components has proven to be more effective than using either approach separately. Through the PBL syntax, students are encouraged to identify problems, gather information, discuss, examine multiple alternative approaches, and then form conclusions grounded in the available evidence. Facione (2015) identifies six core critical-thinking skills. In the present study, four skills, namely interpretation, analysis, inference, and evaluation, were selected and assessed.

Table 3. N-Gain analysis results

Group	N	Mean N-Gain Score	Category	Mean N-Gain Percent	Effectiveness Category
Control	22	0,3784	Sedang	37.84%	Less Effective
Experimental	22	0,7336	Tinggi	73.36%	Fairly Effective

Based on observations throughout the learning period, the experimental group using flashcard-assisted PBL showed more active participation in group discussions, greater ability to identify problems, and more confidence in expressing opinions and giving reasons. Students were involved in the investigation and problem-solving process through flashcard media presented as contextual problem triggers. In contrast, in the control group implementing conventional learning, students tended to be passive and mostly listened to the teacher's explanations. Learning activities were dominated by reading textbooks and doing practice exercises. Students were not yet accustomed to

asking questions or giving reasons for the answers they chose. This condition is consistent with the initial observation results, which showed that learning was still dominated by the teacher-centered learning approach.

The low pretest scores in both groups were consistent with the PISA report, which showed that Indonesian students' abilities in reading, mathematics, and science remain below the OECD average (OECD, 2023). This condition also aligns with the initial classroom observations reported earlier, confirming that teacher-centered instruction limited students' opportunities to develop critical thinking. This is in line with the findings of Susilawati and Supriyatno (2023), who stated that teacher-dominated learning tends to result in low learning engagement, making it less effective in developing students' critical thinking skills. This condition underlies the importance of implementing student-centered learning models, such as PBL, to address these problems.

The research results show that the implementation of flashcard-assisted PBL is effective in improving students' critical thinking ability on Landscape material. This is evidenced by the experimental group's average N-Gain score, which reached 0,7336 (high category) with an effectiveness percentage of 73,36% (fairly effective category), while the control group only reached 0,3784 (medium category) with an effectiveness percentage of 37,84% (less effective category). The posttest independent-samples t-test also showed a significant difference between the two groups (sig. 0.004 < 0.05), confirming the superiority of the flashcard-assisted PBL model over conventional learning. Although the N-Gain Analysis demonstrated the intervention's effectiveness, it did not statistically control for the effect of initial ability (pretest) on posttest outcomes. Given that the research design is a nonequivalent control group design, where groups are formed naturally, there is a possibility that pretest variance acts as a confounding variable. Therefore, to strengthen the validity of the findings, an escalation of analysis was conducted using Analysis of Covariance (ANCOVA) with pretest as the covariate. To further validate the hypothesis and control for the potential confounding effect of initial ability, an Analysis of Covariance (ANCOVA) was conducted. The results of the ANCOVA, as presented in Table 4, show that after controlling for pretest scores, there is a statistically significant difference in posttest critical thinking skills between the experimental and control groups ($F = 16989.679$; $p < .001$). The effect size, measured by Partial Eta Squared ($ç^2p$), is .998, which falls into the large effect category. This indicates that 99,8% of the variance in posttest scores can be explained by the learning model after accounting for pretest scores. Furthermore, the covariate (pretest) also showed a significant effect ($F = 227.968$; $p < .001$; $ç^2p = .848$), confirming that pretest scores significantly influence posttest outcomes. These findings strongly confirm that the PBL model assisted by flashcards has a significantly greater impact on improving critical thinking skills compared to conventional learning.

Table 4. ANCOVA results for posttest scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6273.058	2	3136.529	15298.435	.000	.999
Intercept	254.035	1	254.035	1239.059	.000	.968
Pretest (Covariate)	46.739	1	46.739	227.968	.000	.848
MODEL_PEM (Group)	3483.273	1	3483.273	16989.679	.000	.998
Error	8.406	41	.205			
Total	231662.551	44				
Corrected Total	6281.463	43				

The greater improvement in the experimental group can be attributed to the PBL model's use of contextual problems as the starting point for learning. Through the PBL stages, students are prompted to recognize problems, collect information, engage in discussions, examine a range of possible solutions, and arrive at conclusions supported by the evidence they have gathered. This process is in line with Facione (2015), who defines critical thinking as a thought process that involves the ability to interpret, analyze, draw inferences, and evaluate possible solutions.

These research results support the findings of Maulana et al. (2022), which showed that the application of PBL has a positive effect on improving elementary school students' critical thinking ability. Similarly, research by Kaffah, Haryono & Utanto (2023) found that PBL can improve learning engagement and higher-order thinking ability because students are actively involved in the investigation and problem-solving process. Research by Darmawati and Mustadi (2023) also confirms the effectiveness of PBL in improving elementary school students' critical thinking ability.

Flashcards in PBL functioned as contextual problem stimuli rather than merely as visual media. Each card combined a visual representation, a problem narrative, and guiding questions related to landscape characteristics, environmental conditions, and human activities. Across the PBL stages, students used the cards to interpret information during problem orientation, analyze relationships during group investigation, draw conclusions during problem solving, and evaluate solutions during presentation, corresponding to Facione's four critical thinking skills.

The relationship between the flashcard features and students' reasoning can also be observed from the contextual problems presented on the cards. For example, the flashcard about Rina, who wears a thick jacket in the morning, encouraged students to examine the relationship between environmental conditions and human activities. Similarly, the flashcard about Tono's journey along a winding road across hills and valleys required students to relate the road's characteristics to the landscape's physical features. Another flashcard describing agricultural activities required students to connect environmental conditions with human activities and consider alternative actions when the conditions changed. The flashcard's guiding questions further encouraged students to move beyond identifying information to examining relationships, drawing conclusions, and evaluating possible solutions. In this way, the flashcards served as concrete, contextual representations that supported students' reasoning during collaborative problem solving. This finding is consistent with Sitorus et al. (2025), who reported that flashcards can serve as stimuli or problem triggers during problem orientation, group discussion, and solution presentation. Similarly, Syahrani et al. (2025) found that integrating flashcard media with an active learning model can support students' engagement and critical thinking ability. In the present study, however, the flashcards extended beyond the conventional function of attracting students' attention or introducing concepts by providing contextual problems and guiding questions that supported the cognitive processes involved in critical thinking.

The use of contextual visual representations was particularly relevant to the characteristics of third-grade elementary school students, whose cognitive development should be considered when designing learning materials and instructional activities (Tunalý & Aktürkoðlu, 2025). Recent research on Piaget's cognitive development model indicated that children in the concrete operational stage can reason logically about concrete objects

but may experience greater difficulty with abstract thinking and tend to rely on information that they can see, hear, and experience (Cerovac & Keane, 2025). The combination of visual representations, contextual narratives, and guiding questions therefore provided concrete information that students could examine and discuss collaboratively throughout the PBL process.

Integrating flashcards into PBL learning significantly improves critical thinking abilities. Research conducted by Sitorus et al. (2025) affirms that flashcards, when used as stimuli or problem triggers during problem orientation, group discussion, and solution presentation, scaffold students' organization of information, comparison of concepts, and conclusion-drawing. Additionally, flashcards are effective tools for capturing students' attention and making learning more engaging, reducing boredom and promoting collaboration. These functions are particularly relevant to using visual media in PBL, as flashcards provide accessible visual information that students can examine, compare, and discuss collaboratively as they construct solutions.

Analysis based on critical thinking indicators shows that the experimental group improved across all indicators, with the largest gains in the analysis and evaluation indicators. A detailed comparison of pretest and posttest scores for each critical thinking indicator (interpretation, analysis, inference, and evaluation) between the experimental and control groups is presented in Figure 3, with error bars representing 95% confidence intervals. The results show a greater increase in the experimental group across all four indicators than in the control group. This finding is consistent with Alreshidi & Lally (2024), who found that PBL encouraged students to actively engage in problem-solving by understanding problems and discussing possible solutions. That study further emphasized the role of metacognitive strategies in facilitating students' thinking processes and promoting independent problem solving.

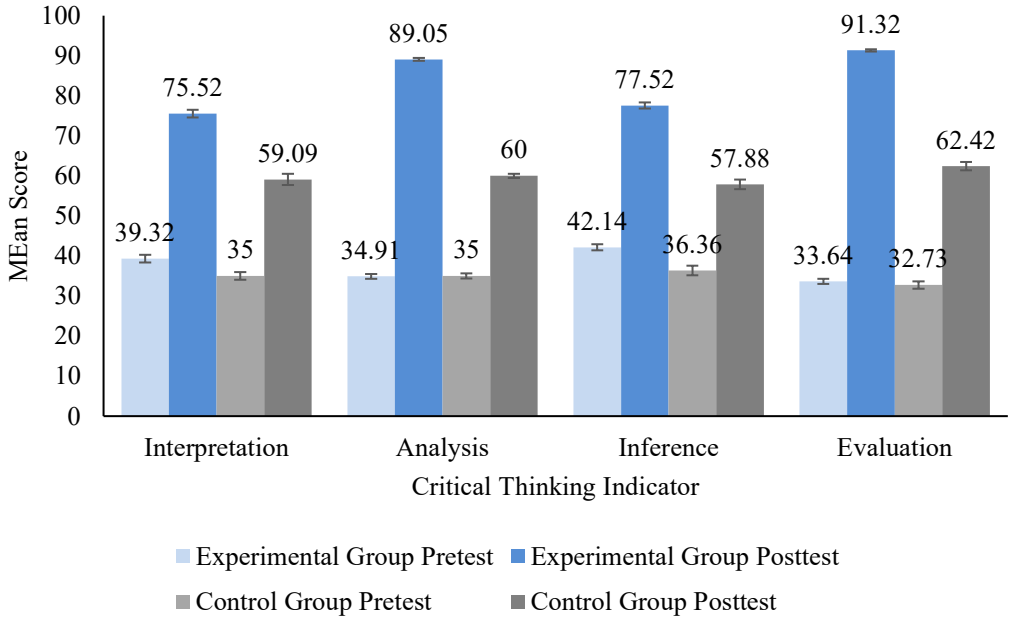

Figure 3. Comparison of pretest and posttest scores for each critical thinking indicator in the experimental and control groups. Error bars represent 95% confidence intervals

This aligns with the stages of the PBL model, which require students to analyze problems (problem orientation and learning organization phase) and evaluate problem solving (analysis and evaluation phase). The analysis indicator improved because flashcards with contextual problems trained students to identify the causes and impacts of phenomena. For example, when students observed a flashcard about differences between plants growing in highland and lowland areas, they were required to analyze the factors that influence the suitability of plants to environmental conditions. This analytical process involves breaking down information into smaller parts, identifying relationships between parts, and finding patterns or principles underlying a phenomenon. The evaluation indicator also improved because, in the final stage of the PBL syntax, students analyzed and evaluated problem-solving. Students learned to assess the accuracy of proposed solutions, consider various alternatives, and make decisions based on the evidence obtained. This process helps students develop higher-order thinking skills, a goal of 21st-century learning. Facione (2015) emphasizes that evaluation is an important component of critical thinking because it involves the ability to assess the credibility of statements, evaluate arguments, and judge the strength of inferential relationships. Significant improvement was also seen in the interpretation and inference indicators in the experimental group. This was due to the initial stage of PBL, which required students to interpret the problems presented through flashcards and make inferences based on the available information. Students learned to identify problems, clarify information, and draw conclusions based on the evidence obtained.

The novelty of this study lies in the use of flashcards as contextual problem stimuli integrated into every stage of PBL. The flashcards present community life scenarios related to landscapes, requiring students to identify problems, analyze causes and impacts, and, through group discussion, formulate alternative solutions. This approach creates more meaningful learning because students can connect the material with real phenomena in daily life. Using flashcards as a problem trigger also supports the deep learning emphasized in the Merdeka Curriculum (Feriyanto & Anjariyah, 2024). Mindful learning is realized when students actively pay attention to and respond to the problems presented. Meaningful learning is achieved when students can connect landscape concepts with real experiences. Joyful learning is created through engaging media and interactive discussion activities.

The research results show that flashcard-assisted PBL learning improves critical thinking ability more than conventional learning. This is due to several factors. First, the PBL model gives students space to build knowledge through thinking, discussion, and problem-solving activities, unlike conventional learning, which places greater emphasis on transferring knowledge from teacher to student. In PBL, students become active subjects in learning, while the teacher acts as a facilitator who guides students' thinking processes. Second, using flashcards as engaging, contextual learning media helps students understand landscape concepts more concretely. Visual media make it easier for students to remember information and connect the material with everyday experience. This is especially important because third-grade students are still in the concrete operational stage. Third, the structured PBL syntax provides a systematic sequence of learning activities that engages students in the four selected critical thinking skills, from interpreting relevant information and analyzing relationships to drawing reasonable inferences and evaluating proposed solutions. Integrating contextual flashcards into these phases provides concrete stimuli and guiding questions that support these cognitive processes throughout problem-solving. Fourth, learning through group discussion in PBL develops collaboration and

communication skills, which are 21st-century competencies. Students learn to respect others' opinions, work together in teams, and express ideas with confidence. This is consistent with the Pancasila student profile dimension that emphasizes cooperation and communication. This finding is in line with research by Sekar Santiwi et al. (2022), which showed that IPAS learning using a visual-media-assisted PBL model effectively improves elementary school students' critical thinking ability. Irayanti et al. (2025) also proved that learning designed to train critical thinking skills can significantly improve student engagement, reasoning ability, and learning outcomes.

These results have important implications for developing IPAS learning in elementary schools, particularly for Landscape material. Practically, these findings guide teachers to design contextual flashcards that function as an initial stimulus in problem-solving and to integrate them consistently into every stage of the PBL syntax, from problem formulation to solution presentation (Sitorus et al., 2025). Thus, flashcards function not only as visual aids but also as a means of continuously developing critical thinking skills. Furthermore, this research highlights the need to incorporate analytical reasoning into educational programs and promotes using Problem-Based Learning techniques with basic imagery, including flashcards, to teach science at the primary level.

PBL supported by flashcards can be an innovative learning model for enhancing students' critical thinking skills. Teachers need to design contextual problems relevant to students' daily lives and present them through engaging media. This aligns with the spirit of the Merdeka Curriculum, which gives teachers the flexibility to design student-centered learning. Teachers can use flashcards as problem triggers for other topics that require visualization and concrete understanding of concepts. Teachers can develop flashcards with various themes based on the material's characteristics and students' needs. Developing contextual, engaging learning media is key to successfully implementing innovative learning models. These research results support the implementation of the Merdeka Curriculum, which emphasizes deep learning through active student engagement. Flashcard-assisted PBL creates mindful, meaningful, and joyful learning. These three aspects form an important foundation for the holistic development of student competencies. This study also contributes to learning theory, particularly by integrating the PBL model with flashcard media to improve critical thinking at the elementary school level. These findings enrich the literature on PBL implementation in elementary schools and provide practical guidance for teachers in designing effective learning.

Several limitations should be considered when interpreting this study's findings. The research was conducted at a single school and involved a relatively small number of participants (22 students per group), so generalize the results with caution. Additional studies with larger, more varied samples are needed to validate these results.

Levene's Test for homogeneity of variance in the ANCOVA yielded a significance value of .001, indicating that the assumption of equal variances was not fully met in this study. This suggests that posttest scores varied across groups. However, this condition is considerably mitigated by the study's balanced design. Both the experimental and control groups consisted of an equal number of participants ($n = 22$ per group). Shields and Lee (1987) found through Monte Carlo simulations that ANCOVA is robust to violations of homoscedasticity and homogeneity of variance when group sizes are equal. Therefore, although the assumption was not fully met, the study's balanced design provides sufficient justification to consider the ANCOVA results reasonably trustworthy. Nevertheless, this condition should be acknowledged as a limitation, and future research with larger, more diverse samples should continue monitoring this assumption.

The research focused only on Landscape material, so it cannot yet be generalized to other IPAS topics. Research on different topics is needed to test the consistency of flashcard-assisted PBL effectiveness. The study was conducted within a limited time frame, so it could not measure long-term retention of critical thinking ability. Longitudinal research is needed to determine whether improvements in critical thinking ability are sustained over time. This study did not strictly control external variables such as learning motivation, family background, and students' learning style, which could affect the research results. Future research needs to consider these variables as control factors.

CONCLUSION

The findings confirm that embedding flashcards as contextual problem stimuli within each phase of the Problem-Based Learning syntax offers a more effective pathway to developing critical thinking than conventional, teacher-centered instruction. The ANCOVA results, with a Partial Eta Squared of .998, demonstrate a very large effect size, proving the intervention's effectiveness. Beyond demonstrating this effectiveness, the study offers a reusable design principle: positioning visual media not as a supplementary illustration but as an integral driver of the inquiry process, informing the development of contextual learning tools across other IPAS topics. Subsequent studies are encouraged to broaden the scope of content and sample size, examine the long-term retention of critical thinking gains, and account for external variables such as learning motivation and prior ability that may influence outcomes.

DECLARATION OF GENERATIVE AI USAGE IN THE WRITING KPROCESS

During the preparation of this manuscript, the authors used Claude AI to refine sentence structure and grammar, translate text into English, and paraphrase and restructure sentences to improve clarity, coherence, and adherence to academic writing conventions in English. After using these tools, the authors reviewed and revised the content as needed and accept full responsibility for the final content of the article.

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