



## The effect of flash card media and problem-based learning to critical thinking skills in elementary school science lessons

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| Article info                                                                                                               | Abstract                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Keywords:<br>flash card media,<br>problem-based<br>learning, critical<br>thinking skills,<br>science, elementary<br>school | The present study examines the effect of flash card media and learning-based problem-solving on the critical thinking skills of students in Science Lessons, Grade V, Elementary School. This is an experimental study with a quantitative approach. The method used is quasi-experimental. Research design is a non-equivalent control group design. The research population involved all the students in Class V of State Elementary School 060970 Medan Belawan. The research sample consisted of 44 students from Classes VA and VB. The research results showed that the independent sample T-Test analysis of the post-test classes, both experimental and control, yielded a significant result. (2-tailed) is 0.000 while the level of significance $\alpha = 0.05$ . The results show a significant value since the value (2-tailed) $< 0.05$ , it is concluded that $H_a$ is accepted and $H_0$ is rejected. This indicates an effect on improvement skills, critical thinking, student class experiments, and controls. It can be concluded that using flash card media and problem-based learning affects these skills, particularly in Class V students of SDN Negeri 060970 Medan Belawan. |

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### 1. Introduction

Science at the school level plays a vital role in equipping students with knowledge, scientific process skills, and values that support methodical thinking and creativity. However, in practice, science learning in schools is still heavily focused on memorizing concepts and has not yet been optimized in pushing students' critical thinking skills. Based on the research results, both national and international skills in critical thinking and participant education in Indonesia are still

classified as low, particularly in solving problems and exploring alternative ideas (Ministry of Education and Culture, 2020; OECD, 2019). Education, as a process of acculturation, knowledge, and technology, empowers and shapes character. It plays a fundamental role in ensuring the improvement, quality, and dignity of the nation. As an essential part of life, human education is an ideal of absolute necessity. Not only should it be oriented towards past and present issues, but it should also be a process that anticipates and discusses the future. Education becomes a necessity, continuing to evolve with patterns and dynamics that are in line with the demands of the times, so that human always seeks to develop existing potential in themselves, well, in a way external and spiritual, based on reflection, values acknowledged truth in society (Muafiah Nur, 2023). In line with objective education explained in Law of the Republic of Indonesia No. 20 of 2003 concerning National Education System Chapter I Article 1 states that "education is business conscious and planned to show atmosphere learning and learning process so that participants educate in a way active develop potential themselves for own religious spiritual power, control self, personality, intelligence, morals noble, and required skills himself, society, nation and state".

Based on the explanation above, someone has the right to receive a proper education to develop their potential and skills. As for the facilitator, education is one of the roles, and one of them is being a teacher. Teachers have a vital role in the development and progress of their students. Teachers are required to perform tasks professionally to meet the competencies and needs of participants. All in all, it worked, regardless of whether the education in one of the countries is attributed to the teacher. To achieve the objective of effective teaching, teachers must be capable of designing active and fun learning experiences for their students. Teachers are faced with a choice of learning methods and media that are capable of covering all the characteristics of their students. Departing from conventional thinking, it has already become a teacher's obligation to enhance their influence as an educator among those willing and able to utilize various learning media. According to Suprihatiningrum (2016: 319), media is defined as an introduction or intermediary, interpreted as an introductory message from the sender to the recipient. In the world of education and learning, media is defined as tools and materials that carry information or purposeful lessons, making it easier to achieve objective learning.

Thinking critically is one of the key elements in 21st-century skills (4C), which includes the ability to generate new, original, flexible, and elaborate ideas to solve problems (Trilling & Fadel, 2015). In science learning, thinking critically is essential to connect scientific concepts with real-life phenomena. According to Runco & Acar (2015), critical thinking not only supports successful academics but also becomes a foundation for innovation and reflective decision-making from an early age. Unfortunately, the approach to learning conventional skills is still natural. One direction is not yet capable of stimulating abilities in a way that maximizes. Therefore, a learning model is needed that encourages active students to collaboratively and reflectively finish problems. One of the relevant models for matter is Problem-Based Learning (PBL). This model puts the student at the center of learning through activity-based problem-solving, demanding contextual skills at a high level (Hmelo-Silver, 2015). Critical thinking skills enable students to analyze information, evaluate arguments, and make informed decisions to solve problems, including those related to eye issues in Science lessons. However, the reality on the ground shows that science learning in schools still tends to be memorization-oriented and teacher-centered, leaving less room for students to develop skills and think at a high level. Various studies have previously shown that the use of innovative learning media can help increase motivation and understanding among students. One of them is a flash card media that is visual, simple, and easy to use to support the learning process. However, some extensive studies about using more flash cards focused

on improving skills in memorizing vocabulary, language, or factual knowledge. Studies on its use for developing critical thinking skills, especially in basic science learning in schools, are still minimal.

In addition, Problem-Based Learning (PBL) has been extensively researched and proven effective in increasing skills and critical thinking at the secondary and tertiary education levels. However, the implementation of PBL in schools still faces various obstacles, such as limitations of supporting media and teacher readiness in designing contextual issues for elementary school children. The literature also shows that there is still limited research combining PBL with simple visual learning media, such as flashcards, to strengthen students' critical thinking processes in science. Based on the gap, research was conducted to study the effect of integrating flash card media with the PBL model. This study aims to contribute to the literature on education by offering innovative, easy-to-implement alternative learning strategies that are applied and relevant to the needs of students facing challenges in the 21st century. Research by Savery (2015) shows that PBL significantly increases student involvement in the critical thinking process. However, PBL does not only focus on cognitive aspects. Learning must also be noted as effective, especially in forming students' character.

The combination of flash card media with the PBL model has the potential to create more learning effective and meaningful learning. Flash cards serve as an interesting, concrete stimulus to focus attention at a given time, providing scaffolding for students to understand problems. At the same time, PBL offers a systematic framework for solving problems. Thus, the relationship between the media and this model is expected to increase students' critical thinking skills in learning science. Media learning is one of the factors affecting student learning. Using learning media, especially in science lessons, can maximize achievement results. Science 3 is an eye-opening lesson that requires media in its learning because science involves studying nature comprehensively, including all its aspects. This can be shown to participants to educate without using an adequate medium. Flash card media is a simple visual aid, but effective in enhancing students' memory and understanding. Flash cards can be used to display images, keywords, or question cards, making it easier for students to link science concepts with visual representation (Arsyad, 2020). According to research by Widodo & Wahyuni (2019), using flash card media in science learning can enhance students' active involvement and strengthen their understanding of science concepts. A merger between the PBL model and flash card media serves as a strategic approach to improve skills, foster critical thinking, and develop a basic strategy for students. This allows students to explore fundamental problems, build solutions critically, and grow their character through collaboration. The research results by Nurhadi et al. (2021) indicate that implementing PBL with visual media support can enhance the quality of both the process and the results. The study of students is comprehensive, including aspects of creativity. However, studies that specifically specialize in integrating flash card media in the Problem-Based Learning Model are still limited, especially in the context of science learning at the elementary level. Therefore, this vital research was conducted to address the gap and empirically test the effect of learning strategies on improving critical thinking skills.

Although numerous studies have previously examined the effect of PBL on critical thinking skills, and other research examines the effectiveness of flash cards in increasing mastery of concepts, studies that combine both in the specific context of science learning in schools are still minimal. This research attempts to bridge the gap in studies, specifically focusing on the effect of flash card media and the Problem-Based Learning model on critical thinking skills in basic science learning.

## **2. Literature Review**

### **2.1 Flash card media in science**

Instructional Media is a tool that aids the learning process by enabling teachers to distribute messages and stimulate the thoughts, feelings, attention, and interests of participants. One of the effective media at the elementary level school-based is flashcards. Flash cards are cards containing pictures, words, or functional sentences as a visual medium for conveying material learning concisely and engagingly (Arsyad, 2015). In the context of science learning, flash cards can help students understand abstract concepts more concretely. Applying this media supports the Dual Coding theory (Paivio, 1986), which states that information presented both visually and verbally is more easily remembered, as it involves two processing paths in the brain. Students' school, the base that is in stage operational concrete (Piaget, 1969), is invaluable with visual stimulus in developing understanding of science concepts. Flash cards not only enhance the ability to absorb information but also serve as tools for exercises that stimulate students' thinking and memory. With interactive use, flash cards can create a fun atmosphere and encourage learning for active students.

### **2.2 Problem-based learning (PBL)**

Problem-Based Learning (PBL) is a learning approach that places the student at the center of the activity learning. In this approach, students are given problems that serve as fundamental points to reject. To learn something, students are given a draft of the principles of learning. This is based on the theory of constructivism, where knowledge is actively built by students through experiences and social interactions (Vygotsky, 1978; Bruner, 1966).

According to Hmelo-Silver (2004), PBL encourages students to think critically, as well as develop problem-solving and work skills. PBL consists of several stages, such as problem identification, information exploration, hypothesis submission, hypothesis testing, and conclusion. Each stage of this practice involves processing information, analyzing, making decisions, and evaluating results, which are characteristic features of critical thinking. PBL is very suitable for implementing in science learning at schools because it can connect scientific concepts with students' daily lives. With this, learning becomes more contextual and meaningful.

### **2.3 Critical thinking skills**

Critical thinking is one of the essential skills of the 21st century. It has developed since the early. According to Ennis (1996), critical thinking is a rational and reflective process oriented towards making decisions about what is believed or done. This involves analysis, interpretation, evaluation, conclusion, and clarification.

At school, basic skills, such as critical thinking, can be developed by challenging and facilitating learning, enabling students to ask questions, test ideas, and make decisions. According to Piaget's developmental theory, children aged 7–11 years are at the operational concrete stage, where they become capable of thinking logically about real objects and events. Therefore, interactive and contextual learning is essential to develop students' critical thinking skills. In the context of science, skills are considered critically needed for observing phenomena, making predictions, identifying variables, analyzing data, and drawing conclusions. Because of that, learning like PBL, which enhances problem-solving skills, becomes very relevant for skill enhancement.

## 2.4 Relationship between components

The merger between flash card media and PBL can strengthen each other in the learning process aimed at developing students' critical thinking skills. Flash cards provide visual stimuli that can help students understand science concepts through fast and engaging cognitive involvement in learning. Problem-based learning creates a research situation that drives issues for students. To think in a way that is analytical, logical, and reflective, according to the characteristic features, think critically.

## 3. Method

The type of research is an experiment with a quantitative approach. The research method used is a quasi-experiment. An experiment is a research method used to evaluate the effect of specific actions on other variables in situations that can be controlled. A cluster sampling technique was used, namely an election sample based on classes that have been there. Two classes were available, namely the VA class, which served as the group of experiments, and the VB class, which served as the control group. Both classes were relatively homogeneous in terms of the number of students, age, and academic ability, making them comparable. The instruments used in the form of critical thinking skill tests through question description and options double-stacked based on basic competence in science for grade V, validated by experts, tested the validity of the questions with correlation product-moment, and tested their reliability using Cronbach's Alpha, which produces a coefficient above 0.7, so that they are declared valid and reliable. The data obtained was analyzed using the independent t-test, with normality and homogeneity tests conducted as prerequisites, followed by hypothesis testing. The t-test results are used to determine whether there is a significant difference in enhancing students' critical thinking skills between the experimental group, which uses PBL-based flash card media, and the control group, which uses conventional learning methods.

## 4. Results

The research results reveal the data collection before and after the implementation. First, the validation test instrument results were considered critical, based on the evaluations by validators 1 and 2. The results showed an average of 4.35, which falls within the valid category, with a reliability of 82%. The second analysis was data flash card media validation. The results from the validator assessment, which showed a score of 3.95, are included in the valid category, with a reliability of 79%. The third analysis of the data validity sheet indicated that the evaluation character result from the validator rating of 3.9 falls within the valid category, with a reliability of 78%. The fourth questionnaire response learning carried out by students showed that, by using flash cards and teaching media-based problems in science lessons, many students achieved scores of 85%, 95%, and 100% in their assessments. Percentage results were categorized as "Good" and "Very High". Normality, homogeneity, hypothesis, and t-test tests were used. To evaluate the results of learning after the pre-test and post-test.

### 4.1 Normality test critical thinking skills

Based on the Tabel 1, the obtained value (Sig) of the Shapiro-Wilk test before treatment is 0.085, while after treatment it is 0.972. If the mark significance is  $> 0.05$ , it can be said that the pre-test and post-test classes are normally distributed. At the significance level, pre-test  $0.085 > 0.05$  and post-test  $0.972 > 0.05$ . Hence, the sample data is normally distributed.

Table 1. Normality test

|                          |            | Tests of Normality              |    |        |              |    |      |
|--------------------------|------------|---------------------------------|----|--------|--------------|----|------|
|                          |            | Kolmogorov-Smirnov <sup>a</sup> |    |        | Shapiro-Wilk |    |      |
|                          | Classes    | Statistics                      | df | Sig.   | Statistics   | df | Sig. |
| Critical Thinking Skills | Experiment | .085                            | 22 | .200 * | .972         | 22 | .763 |
|                          | Control    | .129                            | 22 | .200 * | .905         | 22 | .037 |

\*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

#### 4.2 Hypothesis testing

Based on the normality test results, data were collected, resulting in normal values that allow t-tests to be performed using SPSS Version 20.0, with a significance mark of 0.05. Analysis results can be seen in the Table 2 as follows.

Table 2. Hypothesis testing

##### Paired Samples Statistics

|        |           | Mean    | N  | Standard Deviation | Std. Error Mean |
|--------|-----------|---------|----|--------------------|-----------------|
| Pair 1 | PRE-TEST  | 50.0435 | 23 | 2.77125            | .57785          |
|        | POST-TEST | 74.0870 | 23 | 3.17537            | .66211          |

##### Paired Samples Test

|        |             | Paired Differences |                    |                 |                                           |           | t        | df | Sig. (2-tailed) |
|--------|-------------|--------------------|--------------------|-----------------|-------------------------------------------|-----------|----------|----|-----------------|
|        |             | Mean               | Standard Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |           |          |    |                 |
|        |             |                    |                    |                 | Lower                                     | Upper     |          |    |                 |
| Pair 1 | PRE-TEST    |                    |                    |                 |                                           |           |          |    |                 |
|        | - POST-TEST | -24.04348          | .92826             | .19355          | -24.44489                                 | -23.64207 | -124,220 | 22 | .000            |

Based on the Table 2, there is the effect of flash cards and PBL media on students' critical thinking skills of Class V SD material on Force. According to the data above, the values in groups experiment  $0.000 < 0.05$ .

#### 4.3 The Effect of flash card media and problem-based learning on critical thinking skills

This study was conducted on April 9 at State Elementary School 060970 Medan Belawan, involving a sample size of 22 students in a class experiment. At the beginning of learning, before implementing the treatment with flash cards and PBL media. The results revealed improvement in class V critical thinking skills. The material style was classified as low, with an average value of 50.0. After administering the treatment using flash card media and problem-based learning models, followed by a post-test question for students, the results showed an average improvement in critical thinking skills of 75. Thus, the effect of flash card media and PBL based on character education is significant to students' critical thinking skills.

The normality test calculation was used with SPSS Version 20.0. It can be said that the data produced a normal value since the pre-test group's sig value was 0.76, while the post-test group's sig value was 0.37. Hence, if the significance mark (sig) in the Shapiro-Wilk test is greater than 0.05, the mark from both the pre-test and post-test data is considered a normal value. Based on results from the Paired Samples Test analysis, it shows that  $H_0$  is rejected with a Sig value (2-

tailed) of 0.000 or less than 0.05, which means "there is an effect of flash card media and PBL learning on class V students' critical thinking skills in material style.

#### **4.4 Implementation of flash card media**

The study's implementation of existing flash card media was assessed by researchers and analyzed using a combination of descriptive and quantitative analysis. The workability in the learning module was valued at 83, with criteria rated as good. In applying flash card media, problem-based learning is conducted with a distribution group. Each group focuses on the same work, providing mutual help and support, which motivates them to achieve the research objective together. In addition, by studying in groups, students can get to know each other and transform the originally sleepy class atmosphere into an exciting and happy one. According to Johnson in B. Santoso, students can learn by collaborating, which results in optimal learning and positive experiences for both the individual and the group. This flashcard-assisted PBL involves students in doing an activity. Before doing the activity, the student requested to do a slow pretest. After doing the student pretest sheet, students listen to the teacher's explanation about the material to be studied. Furthermore, the teacher gives students a chance to read and learn the material, as well as to discuss problems that exist in the discourse. The teacher, moreover, prepares flash card media measuring 15x5cm, and each group discusses the questions contained in them.

#### **4.5 Students' response to flash card media and problem-based learning on critical thinking skills**

Based on data analysis of the Respondents' student class, VA indicates that using PBL learning with flash card media and social studies learning with material about Giving Style results in scores of 80% and 93.3%, with some achieving 100%. Percentage results are entered into the "Good" and "Very High" criteria. Students show a positive response to the implementation of PBL learning with flashcard support for enhancing skills in fifth-grade elementary school students, focusing on science learning material about Force. This is due to learning using PBL, which incorporates flashcard media. Flashcard media can capture students' attention and make the learning process pleasant, avoiding boredom. In addition, learning with this flash card model can make students more active and enthusiastic in their studies, as well as increase cooperation among them. Through explanatory materials like flashcards and PowerPoint presentations, participants can educate themselves and conclude that the material has been delivered, thereby increasing their understanding. Furthermore, educators also create a worksheet for Students (LKPD) to develop their cognitive abilities.

### **5. Discussion**

Research results indicate that using science-based flash card media with problem-based learning (PBL) positively influences critical thinking skills in basic-level science lessons. This is evident from the improvement score, which shows a significant post-test in the class experiment compared to the class control. This finding is in line with Ennis's opinion (2011) that critical thinking covers skills to analyze, evaluate, and create rational decisions based on data and facts. Flash card media helps students understand science concepts visually and attractively, making it easy for them to remember information and encouraging active learning. According to Arsyad (2019), visual learning media can strengthen understanding because they can stimulate the senses more effectively. Flash cards make active learning more interactive and fun, especially at this age, as the basis requires a concrete and visual approach. Problem-Based Learning (PBL) plays an essential role in growing critical thinking skills. PBL encourages students to face real

problems and look for solutions through discussion groups, exploration, and reflection. This aligns with Savery's (2015) opinion, which states that PBL is effective in enhancing skills and cognitive levels, including analysis, synthesis, and evaluation. Integration in the learning process also contributes to the formation of positive attitudes in students, such as working hard, responsibility, a desire to know, and honesty in completing tasks through problem-solving. Values character. This functions as a runway to think critically, ethically, and responsibly (Lickona, 2013).

As for the class control that does not use a combination approach, this skill improvement tends to be lower. This shows that the conventional approach to learning is not capable of providing sufficient cognitive and affective stimulus for developing critical thinking in students. Overall, the research results strengthen the view that science teaching in schools is more effective if implemented with an interactive, contextual, visual, and character-based approach. Applying simple flash card media, however effective, when combined with the PBL model—which emphasizes solving problems and values character—can become a learning strategy that encourages the holistic development of critical thinking skills.

The research result is in line with findings previously confirming the effectiveness of visual media and the Problem-Based Learning (PBL) model. Research by Sehartian (2023) and Susanti (2025) implies that using flashcards can enhance students' science learning in a school setting, while meta-analyses by Lu et al. (2025) and Erdem (2024) confirm that PBL significantly contributes to developing critical thinking skills. This research contributes by demonstrating that integrating flash card media with PBL can produce a dual effect. Flash cards reinforce understanding through a draft base, with simple visual presentations remembered, while PBL provides a context for solving real-world problems, requiring skills analysis, evaluation, and synthesis. Interaction between them is seen when flash cards are used as a stimulus or trigger in stage orientation problems, discussions, and presentation solutions, functioning as complementary content and context scaffolding from PBL. Thus, the combination of these approaches has proven more effective than using one approach in isolation.

Despite this research having its own limitations in scope, the sample is limited, so generalization results should be approached with caution. Therefore, research can further use a design experiment with broader coverage, involving schools from diverse socio-economic backgrounds, or compare the effectiveness of other visual media such as digital infographics and augmented reality flashcards. In addition, factors such as motivated students, teacher readiness, and learning support are necessary to consider for their effect on learning outcomes. Findings reveal that this practically provides directions for teachers to use flash cards as a trigger in PBL to encourage critical thinking among students. Theoretically, it enriches the literature on the importance of merging visual media and learning models, an innovative approach in educational contexts.

## **6. Conclusion and Implications**

### **6.1 Conclusion**

This study uses combined flash card media with the Problem-Based Learning (PBL) model to increase critical thinking skills in basic school subjects. For implementation, teachers are advised to design contextual flash cards with thematic or science material to serve as an initial stimulus for problem-solving. Furthermore, flash cards can be used during the orientation phase, in discussion groups, and during presentation results to help students organize information, compare concepts, and draw interesting conclusions. Teachers also need to integrate trigger questions on each card to encourage students to analyze and evaluate, not just remember facts.

To be effective, teachers can blend the use of flash cards with PBL stages in a general, consistent way — starting from formulating a problem, looking for information, up to presenting a solution — so that this media is not just a tool for visual aids, but also means developing skills to think critically in a sustainable way.

## 6.2 Implications

Research results reveal implications that are practically important for teachers, schools, and students' educational policies. For teachers, the findings emphasize the implementation of innovative, fun, and meaningful learning strategies through visual media and problem-based approaches. This underlines the need for PPG and PKB programs that equip teachers with skills for designing contextual visual media and facilitating PBL practically through microteaching, lesson study, and peer coaching, enabling them to develop critical thinking skills in class sustainably. The results provide essential support for schools in developing integrative learning and teacher training for implementing these programs. Meanwhile, for policymakers, integrating critical thinking skills into the curriculum strengthens urgency and encourages the use of PBL strategies and simple visual media like flashcards in science or thematic learning. It also involves adapting standard assessments to emphasize not only memorization but also analysis, evaluation, and research. This becomes a runway for developing curriculum and policies that support learning, strengthen skills, and encourage critical thinking, as the level of education is based on these factors.

## 7. Limitation

The present study has several limitations, including coverage subjects limited to students in a particular area so that the result not yet can generalized in a way area, relative short research duration so that not yet capable catch development critical thinking in a way sustainable, as well as possibility of the existence of variables outside like motivation learning and background behind students who do not fully controlled. In addition, the effectiveness of implementing models and media is highly dependent on teacher competence and the instruments used. Possible, not yet skillful in measuring aspects and thinking critically in a holistic way.

## Authorship Contribution Statement

**First Author:** Conceptualization, implementation edupreneurship, data collection (interviews, observation, documentation), and review final manuscript. **Second Author:** Literature review, framework theory (ethnomathematics), and data interpretation. **Last Author:** Design methodology, supervision research, and manuscript writing.

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