



## The Effectiveness of Problem-Based Learning Integrated with Culturally Responsive Teaching on Students' Critical Thinking Abilities

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### ARTICLE INFO

#### Article History

Received : June 06, 2025

1<sup>st</sup> Revision : September 07, 2025

Accepted : September 28, 2025

Available Online: October 30, 2025

#### Keywords:

Critical thinking skills;

Problem-Based Learning (PBL);

Culturally Responsive Teaching (CRT);

Classroom action research;

Learning effectiveness;

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### ABSTRACT

The critical thinking ability of students in one seventh-grade class at a junior high school in Mlati District remains lacking. This is indicated by the low level of students' performance in answering questions and actively participating in the learning process. Therefore, it is necessary to conduct research using the Integrated Problem-Based Learning Culturally Responsive Teaching (CRT) model to improve critical thinking skills. This study aims to evaluate the effectiveness of the Integrated Problem-Based Learning CRT model. The research employs classroom action research, following the Kemmis and Taggart model, which consists of four stages: planning, action, observation, and reflection. The study subjects were 32 students from a seventh-grade class. Data collection techniques included critical thinking ability tests and observations of the learning process. The study was conducted in two cycles. In Cycle I, the percentage of learning implementation reached 83%, with an N-gain value of 0.31 (moderate category), individual completeness of 73.60%, and classical completeness of 53.13%. Cycle II demonstrated improvement, with a learning implementation percentage of 97%, an N-gain value of 0.71 (in the high category), individual completeness of 89.68%, and classical completeness of 81.25%. These results suggest that learning using the PBL model integrated with CRT is effective in enhancing students' critical thinking skills.

**How to cite:** Susilowati, Maryati, & Sadly, D. (2025). The effectiveness of problem-based learning integrated with culturally responsive teaching on students' critical thinking abilities. *International Journal of Pedagogy and Teacher Education*, 9(2), 322–338. <https://doi.org/10.20961/ijpte.v9i2.103388>

## 1. INTRODUCTION

In the current educational context, students are expected to have critical thinking skills. Critical thinking skills are an essential component of the educational process (García-Carmona, 2025). This ability allows students to analyze information, solve problems, and make reasoned decisions. However, research by Safitri et al (2022) shows that the critical thinking skills of junior high school students in science subjects are very low, with a percentage reaching 70% very low, 20% low and 10% low, which includes indicators of concluding 40%, providing simple explanations 41%, providing further exploration 46%, building basic skills 41% and arranging strategies and tactics 43%. Meanwhile, Sugandi & Siswanto (2021) also found that the critical thinking skills of junior high school students were relatively low, with a score of 17.3 (43%) out of a maximum score of 40, with indicators of students' ability to provide simple explanations of 3.3 (81%), building basic skills of 2.1 (53%), ability to conclude of 1.7 (43%), ability to provide further explanations of 1.1 (27%), and ability to organize strategies and techniques of 0.5 (12%). Several factors that influence students' low critical thinking skills include their biased perceptions of questions, a lack of understanding of concepts, and a lack of thoroughness in solving questions (Ayun et al., 2020). Therefore, teachers play a crucial role in enhancing students' critical thinking skills.

The results of observations during Field Experience Practice (PPL) at a junior high school in the Mlati district revealed several instructional challenges. Students' analytical skills were underdeveloped; they tended to respond to factual rather than analytical questions, indicating low levels of critical thinking. Additionally, several students were passive during lessons, preferred off-task activities (e.g., drawing), and frequently disregarded procedural instructions during laboratory work. The existing student worksheets (LKPD) were largely monotonous and lacked variation, which may have reduced engagement and opportunities for higher-order thinking. Collectively, these conditions suggest that students struggled with conceptual items and critical-thinking tasks, underscoring the need for a more responsive, inquiry-oriented learning model. Some students required additional encouragement or support in understanding the material. To enhance critical thinking skills,

teachers can select the most suitable learning model (Pratiwi & Setyaningtyas, 2020). One way to develop these skills is to present students with complex problems (Rizkiani & Septian, 2019; Tsany et al., 2020). Students are then asked to identify them independently and try to solve the problem through brainstorming (Inayah et al., 2021). Through this process, students can identify the knowledge they need and already have to solve the problems they face.

One of the learning models that can be used to train critical thinking skills is Problem-Based Learning (PBL). PBL is designed to help students develop critical thinking skills, problem-solving abilities, and enhance their capacity to learn from new knowledge (Budiman & Esvigi, 2017). This model initiates the learning process by identifying problems, brainstorming ideas, assessing current knowledge, identifying knowledge gaps, and conducting individual research (Aditomo et al., 2013). A study by Masrinah et al. (2019) stated that the PBL model can improve students' thinking skills because it focuses on authentic problems. In line with this, Elfina & Sylvia (2020) developed a PBL-based LKPD. The results of their research indicate that LKPD is highly effective in enhancing students' critical thinking skills, as evidenced by a significant effect observed in the t-test (Elfina & Sylvia, 2020). Research conducted by Mareti and Hadiyanti (2021) shows that the Problem-Based Learning (PBL) model is effective in improving students' critical thinking skills. This is evidenced by the increase in the average score of critical thinking skills, from 64.18 in Cycle I to 80.38 in Cycle II. In addition, the PBL model also succeeded in improving student learning outcomes, with the average score increasing from 69.3 at the beginning to 76.21 in cycle I and 82.19 in cycle II. This fact is confirmed by research conducted by Malinda (2021), which shows that the application of the Problem-Based Learning model can strengthen students' critical thinking skills. A study by Dewi (2021) also found that the Problem-Based Learning model can improve students' critical thinking skills, with a significant increase from 50% in Cycle 1 to 87.5% in Cycle 2. PBL also promotes responsibility and independent learning, involving students in various types of tasks that cater to the diverse learning needs of different learners.

Based on findings from previous research, students experience difficulties in implementing the PBL model, particularly when identifying problems and devising solutions. This is a difficult task for students. Problems can be raised through the presentation of scientific phenomena. The culture in the students' environment can be used as a scientific phenomenon. The use of culture in the science learning process is known as Culturally Responsive Teaching (CRT). This CRT approach is an educational strategy that emphasizes recognition, appreciation, and response to cultural diversity, backgrounds, and students' experiences during the learning process (Wati et al., 2023). The goal of this approach is to create an inclusive learning environment that can adapt to the unique needs and experiences of each student (Wulandari et al., 2023). In this context, teachers realize that each student brings diverse cultural knowledge, values, and experiences into the classroom (Inayah et al., 2023).

The application of the Culturally Responsive Teaching and Problem-Based Learning learning approaches has been proven to improve student learning outcomes (Rahmawati & Agustina, 2025). Furthermore, research by Sari et al. (2023) indicates that integrating the PBL model with CRT yields high student learning motivation (89% agreement). Student activity also increased, with the percentage of class activity rising from 60.96% in Cycle I to 87% in Cycle II. Student learning outcomes also improved, with the percentage of learning completion increasing from 77% in Cycle I to 86% in Cycle II. Previous research findings also demonstrate that integrating CRT with ethno (Ethno CRT) can enhance critical thinking skills (Desandra Putri & Tri Prasetya, 2025). Research on the integration of PBL and CRT in relation to critical thinking has been limited. To address the issue of low critical thinking skills, classroom action research was conducted by implementing the PBL model in conjunction with Culturally Responsive Teaching (CRT). This study aims to investigate the effectiveness of implementing the CRT-integrated Problem-Based Learning model in improving critical thinking skills. The research question in this study is "How effective is the application of the PBL model with CRT to improve critical thinking as measured using a pretest and posttest?"

The novelty of this classroom action research lies in its combination of two effective pedagogical approaches: Problem-Based Learning (PBL) and Culturally Responsive Teaching (CRT). Second, this study focuses on improving students' critical thinking skills. This study offers a fresh perspective on enhancing students' critical thinking skills. In this context, PBL helps students learn actively and independently, while CRT ensures that the teaching and learning process aligns with the students' cultural context. Moreover, this study demonstrates how the integration of PBL with CRT can be applied in everyday educational practice. This offers practical guidance for teachers and other educators on creating an effective and inclusive learning environment.

## 2. MATERIAL AND METHOD

### Research Design

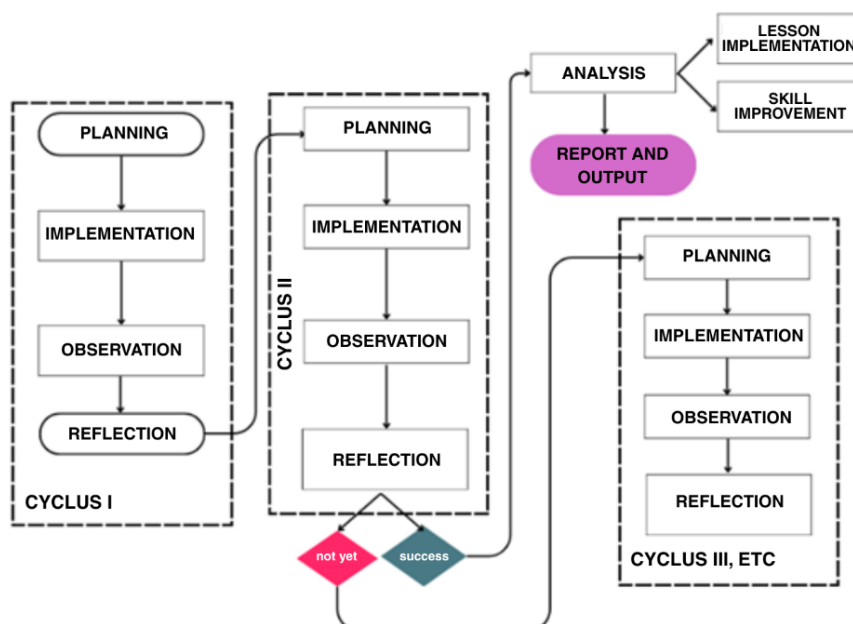
**Table 1.** Research Stages

| No. | Activity    | Stages                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |              |
|-----|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
|     |             | First Cycle                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Second Cycle |
| 1.  | Planning    | 1) Create a teaching module on Indonesian Ecology and Biodiversity by implementing the Problem-Based Learning model integrated with CRT.<br>2) Divide students into several groups based on the differentiation of learning styles and student ability levels.<br>3) Create sources and teaching materials needed during the learning process.<br>4) Create Student Worksheets that each group will work on in the learning process.<br>5) Compile evaluation tools in the form of formative question scripts for all students.<br>6) Prepare Teacher Observation Sheets and Student Observation Sheets, which are useful for seeing the teaching and learning conditions in the classroom.<br>7) Prepare a List of Values that will be needed to collect data on each student's values                                                                                       |              |
| 2.  | Action      | The implementation of the action in the first cycle consisted of two meetings, each with an allocation of 2 lesson hours, totaling 40 minutes. The steps in the first meeting include:<br>1) Students listen and understand the objectives and learning scenarios explained by the teacher.<br>2) Students, in group work at one table, discuss and understand the material on Ecology and Biodiversity of Indonesia explained by the teacher.<br>3) After the teacher distributes the LKPD (Student Worksheet), each group works together to work on the LKPD.<br>4) Students continue learning by following the PBL (Problem-Based Learning) syntax that the teacher has determined. This includes identifying problems, searching for and researching relevant information, developing and implementing solutions, and evaluating the results.                             |              |
| 3.  | Observation | At this stage, observations focused on the implementation of the Problem-Based Learning model integrated with Culturally Responsive Teaching (CRT) and on improvements in students' critical thinking skills in science at a junior high school in the Mlati district. To identify the sequence of activities during instruction, structured observation checklists were used for both students and the teacher. Student behaviors and participation were recorded by the teacher-researcher using a student observation checklist, given their familiarity with the classroom context. In parallel, a colleague served as a peer observer and completed a teacher observation checklist to document instructional practices and classroom management. This dual-observer approach supported triangulation of data on both learner engagement and fidelity of implementation. |              |
| 4.  | Reflection  | In classroom action research, reflection involves examining what has occurred and what has not, as well as what has been produced and what has not been completed, through corrective actions taken. The results of this reflection will be used to determine further steps in an effort to achieve the objectives of the classroom action research that have been set. In other words, reflection is an assessment of success and failure in achieving temporary goals, and it determines follow-up actions to achieve the ultimate goal.                                                                                                                                                                                                                                                                                                                                    |              |

Based on the results of the Reflection Cycle 1, improvements will be made for Cycle 2. The stages used in Cycle Two are the same as those in Cycle One. Cycle two will be implemented if the competencies possessed by students have not been achieved, as indicated by the student success indicators.

This study is a Classroom Action Research (CAR). CAR is a study conducted by teachers in their own classrooms (Palobo et al., 2021) to enhance their teaching performance and, consequently, improve students'

thinking skills (Irwandi et al., 2019). The research design employs the Kemmis and McTaggart model, which involves four stages: planning, implementation, observation, and reflection (Aliyyah et al., 2020). The subjects of this study were 32 students from one of the seventh-grade classes at a junior high school in the Mlati district. The research stages were conducted cyclically, following the classroom action research framework. The study design is illustrated in Figure 1.



**Figure 1.** Classroom Action Research Design Model: Kemmis and McTeggart (Aliyyah et al., 2020)

Classroom Action Research Method consists of two cycles. The first and second cycles were carried out in two meetings. Each cycle consists of four stages that must be carried out: planning, action, observation, and reflection. The research stages are presented in Table 1.

#### Data Collection Technique and Instruments

The techniques used in data collection are presented in Table 2. The instruments used in this study were learning device quality assessment instruments, including learning device validation sheets and observation sheets, to collect data on learning implementation, as well as the results of critical thinking ability tests administered to students. The critical thinking test question grid and observation sheet are presented in Tables 3 and 4.

**Table 2.** Data Collection Techniques

| No. | Data collection technique | Instruments                              | Data obtained                                                                                   |
|-----|---------------------------|------------------------------------------|-------------------------------------------------------------------------------------------------|
| 1.  | Test                      | Critical thinking ability test questions | Student learning outcomes include an increase in students' critical thinking skills.            |
| 2.  | Observation               | Observation sheet                        | Observation sheet of student attitudes in learning<br>Learning Implementation Observation Sheet |
| 3.  | Reflection                | Reflection guidelines                    | Results of reflection on learning activities                                                    |
| 4.  | Documentation             | Photo dan video                          | Documentation in the form of photos and videos of learning                                      |

**Table 3.** Critical Thinking Test Question Grid

| Critical Thinking Indicators | Item Number | Cognitive Level |
|------------------------------|-------------|-----------------|
| Interpret                    | 1, 5        | C4              |
| Analyze                      | 2, 6        | C4              |
| Evaluate                     | 3, 7        | C5              |
| Conclude                     | 4, 8        | C6              |

**Table 4.** Grid for Observation Sheet for Learning Implementation

| Aspects                                            | Item Number    |
|----------------------------------------------------|----------------|
| Introduction                                       | 1,2,3,4,5,6,7  |
| Core of Learning                                   |                |
| - Problem orientation using CRT                    | 8,9,10,11,12   |
| - Organizing students to learn                     | 13,14          |
| - Guiding Investigations                           | 15             |
| - Developing and Presenting Work Results           | 16             |
| - Analyze and Evaluate the Problem-Solving Process | 17             |
| Closing                                            | 18,19,20,21,22 |

**Validity and Reliability of Instruments**

Instrument suitability is achieved through content validity and construct validity. Content validity is used to determine whether the instrument's content represents the entire content to be measured and whether all instrument items conform to the grid. This validity is established through expert judgment, which involves obtaining suggestions from the validator for improving the instrument. Furthermore, quantitative content validity testing is also conducted using the Aiken validity index. Aspects of item review include item conformity to indicators, substantive truth, clarity of statements, and quality of language use. The following formula is used to calculate the Aiken Validity Index.

$$V = \sum S / [n(C-1)]$$

$$S = R - Lo$$

V = Aiken index

S = score given by the assessor minus the lowest score in the category

R = score given by the assessor

Lo = lowest assessment score (1)

C = highest assessment score (4)

n = number of validators (assessors)

The results of the validation of the learning devices are presented in [Tables 5, 6, 7, and 8](#).

**Table 5.** Results of Cycle I Teaching Module Validation

| No. | Assessment Aspects       | Meeting I |            | Meeting II |            |
|-----|--------------------------|-----------|------------|------------|------------|
|     |                          | Aiken V   | Criteria   | Aiken V    | Criteria   |
| 1.  | Teaching Module Identity | 1.00      | Very valid | 1.00       | Very valid |
| 2.  | Learning objectives      | 1.00      | Very valid | 1.00       | Very valid |
| 3.  | Contents                 | 0.89      | Very valid | 0.89       | Very valid |
| 4.  | Evaluation               | 1.00      | Very valid | 0.83       | Very valid |
| 5.  | Language                 | 1.00      | Very valid | 1.00       | Very valid |
| 6.  | Time                     | 1.00      | Very valid | 1.00       | Very valid |

**Table 6.** Results of Cycle I Student Worksheet Validation

| No. | Assessment Aspects                           | Meeting I |            | Meeting II |            |
|-----|----------------------------------------------|-----------|------------|------------|------------|
|     |                                              | Aiken V   | Criteria   | Aiken V    | Criteria   |
| 1.  | Content suitability                          | 0.96      | Very valid | 1.00       | Very valid |
| 2.  | Didactic feasibility                         | 1.00      | Very valid | 0.83       | Very valid |
| 3.  | Suitability of LKPD with learning models     | 0.80      | Valid      | 0.77       | Valid      |
| 4.  | Compliance of LKPD with CRT integration      | 0.83      | Very valid | 0.83       | Very valid |
| 5.  | LKPD content trains critical thinking skills | 0.83      | Very valid | 0.83       | Very valid |
| 6.  | Linguistics                                  | 0.80      | Valid      | 0.80       | Valid      |
| 7.  | Presentation                                 | 0.75      | Valid      | 0.79       | Valid      |

**Table 7.** Results of Cycle II Teaching Module Validation

| No. | Assessment Aspects       | Meeting I |            | Meeting II |            |
|-----|--------------------------|-----------|------------|------------|------------|
|     |                          | Aiken V   | Criteria   | Aiken V    | Criteria   |
| 1.  | Teaching Module Identity | 1.00      | Very valid | 1.00       | Very valid |
| 2.  | Learning objectives      | 1.00      | Very valid | 1.00       | Very valid |
| 3.  | Contents                 | 0.89      | Very valid | 0.92       | Very valid |
| 4.  | Evaluation               | 1.00      | Very valid | 1.00       | Very valid |
| 5.  | Language                 | 1.00      | Very valid | 1.00       | Very valid |
| 6.  | Time                     | 1.00      | Very valid | 1.00       | Very valid |

**Table 8.** Results of Cycle II Student Worksheet Validation

| No. | Assessment Aspects                           | Meeting I |            | Meeting II |            |
|-----|----------------------------------------------|-----------|------------|------------|------------|
|     |                                              | Aiken V   | Criteria   | Aiken V    | Criteria   |
| 1.  | Content suitability                          | 1.00      | Very valid | 1.00       | Very valid |
| 2.  | Didactic feasibility                         | 0.83      | Very valid | 1.00       | Very valid |
| 3.  | Suitability of LKPD with learning models     | 0.90      | Very valid | 0.93       | Very valid |
| 4.  | Compliance of LKPD with CRT integration      | 0.92      | Very valid | 1.00       | Very valid |
| 5.  | LKPD content trains critical thinking skills | 1.00      | Very valid | 0.92       | Very valid |
| 6.  | Linguistics                                  | 1.00      | Very valid | 1.00       | Very valid |
| 7.  | Presentation                                 | 0.75      | Valid      | 0.83       | Very valid |

**Data Analysis Techniques****Learning Implementation**

The implementation of learning from the teaching module can be analyzed using Interjudge Agreement (IJA; see Equation 1; [Nurhasanah et al., 2020](#)).

$$IJA = \frac{AY}{AY + AN} \times 100\%$$

Where AY denotes activities carried out and AN denotes activities that were not carried out

**Table 9.** Percentage of Learning Implementation

| No. | Percentage (%)    | Category   |
|-----|-------------------|------------|
| 1.  | $80 < X \leq 100$ | Very good  |
| 2.  | $60 < X \leq 80$  | Good       |
| 3.  | $40 < X \leq 60$  | Enough     |
| 4.  | $20 < X \leq 40$  | Not enough |
| 5.  | $0 < X \leq 20$   | Very less  |

([Riyanti & Setyawan, 2021](#))

### Analysis of Improving Critical Thinking Skills

N-Gain analysis is used to determine the increase in critical thinking skills from the application of the CRT-integrated PBL model. The magnitude of N-Gain can be determined using a formula as shown in the following equation.

$$N - gain = \frac{\bar{X}_{PostTes} - \bar{X}_{PreTes}}{max. value - \bar{X}_{PreTes}}$$

**Table 10** N-Gain Test Value Categories

| No. | N-Gain Value      | Category |
|-----|-------------------|----------|
| 1.  | $0.00 < g < 0.30$ | Low      |
| 2.  | $0.30 < g < 0.70$ | Medium   |
| 3.  | $0.70 < g < 1.00$ | High     |

(Sebastian et al., 2023)

### Indicators of Success in Implementing the Integrated PBL Model CRT

#### Individual Completion

Each student is declared to have completed their learning (individual completion) if the score obtained by the student reaches the Minimum Mastery Criterion score of 75 ( $\geq 75\%$ ), as the school's minimum mastery criterion score is 75. To determine the student's learning completion (individual), it can be calculated using the following equation.

$$KB = \frac{T}{T_t} \times 100\%. \text{ (Ibnu, 2014)}$$

Notes:

KB = learning completion

T = the number of scores obtained by students

Tt = total score

#### Classical Completion

A class is considered to have achieved *classical mastery* if at least 75% of the students in that class reach the minimum mastery criterion set by the school, which is 75. This indicates that the majority of students have met the required level of learning achievement for the subject.

$$P = \frac{\sum \text{students who have completed their studies}}{\sum \text{students who have completed their studies}} \times 100\% \text{ (Aqib, 2014)}$$

Notes:

P = learning completion percentage

**Table 11.** Completion Categories

| No. | Classical Completion | Qualification |
|-----|----------------------|---------------|
| 1.  | $\geq 75\%$          | Completed     |
| 2.  | $< 75\%$             | Not finished  |

(Kemendikbud, 2014).

## 3. RESULTS

The research procedure conducted in this study follows the Classroom Action Research approach, comprising four stages: planning, implementation, observation, and reflection. At each stage of the activity, the researcher was observed by an assistant who assisted with the classroom activities. This research was conducted in 2 (two) cycles, where each cycle consisted of 2 (two) meetings. The implementation of learning utilized the Problem-Based Learning model, integrating Culturally Responsive Teaching. In each learning cycle, a pretest and a posttest are given to determine the effectiveness of the learning actions.

**Cycle 1****Planning**

At this stage, the activities carried out by the researcher included: creating teaching modules according to the Merdeka curriculum, compiling student activity sheets, and compiling assessment instruments. The teaching modules were integrated with Culturally Responsive Teaching in the Yogyakarta region. This was based on the background of students from the Yogyakarta area. The types of CRT components integrated in Cycle 1 were Parang Tritis beach in Bantul District and onion farmers in Kulon Progo District. In Cycle 2, the integrated CRT components were the Pengger pine forest and the Ruwatan Bumi tradition. Learning using the CRT-integrated PBL model was conducted on the material of the interaction between living things and their environment, as well as biodiversity.

**Implementation**

This stage is the implementation stage of learning activities that were planned, namely, implementing learning activities using the Problem-Based Learning model integrated with Culturally Responsive Teaching. In cycle 1, it was carried out in 2 (two) meetings.

**Observation**

At this stage, observations are made on teacher performance and student activities. Fellow science teachers make observations. The implementation of learning is assessed by observers using observation sheets that follow the syntax of the PBL learning model with the CRT approach during the classroom learning process. The results of the implementation of learning using Problem-Based Learning integrated with CRT are presented in Table 12.

**Table 12.** Learning Implementation Results

| No.     | Implementation | Category  |
|---------|----------------|-----------|
| 1.      | 78%            | Good      |
| 2.      | 88%            | Very good |
| Average | 83%            | Very good |

Based on Table 12, it is known that the results of the implementation of learning using the developed product obtained an average result of 2 (two) meetings of 83% with a very good category. This demonstrates that the implementation of learning has been in accordance with the learning model employed, specifically problem-based learning, which integrates culturally responsive teaching. Student activities are everything that students do during the learning process. The assessment of student attitude activities in this study is based on the Pancasila student profile outlined in the teaching module, specifically collaboration, global diversity, and critical reasoning. The following is a recapitulation of student activity data in cycle 1.

**Table 13.** Percentage of Learning Activities in Cycle I

| No.     | Observed activities | Meeting |        | Average |
|---------|---------------------|---------|--------|---------|
|         |                     | 1       | 2      |         |
| 1.      | Collaborate         | 79.69%  | 82.81% | 81.25%  |
| 2.      | Global Diversity    | 68.75%  | 72.65% | 70.70%  |
| 3.      | Critical Thinking   | 78.13%  | 81.25% | 79.69%  |
| Average |                     | 75.52%  | 78.91% | 77.21%  |

The observation results showed variations in the level of engagement and ability of participants in various aspects during the two meetings. The collaboration aspect reached the highest score with an average of 81.25%, increasing from 79.69% in the first meeting to 82.81% in the second meeting. This indicates that participants exhibited a cooperative attitude in groups, with a 3.12% increase in cooperation. On the other hand, global diversity received the lowest score. However, it experienced a significant increase from 68.75% in the first meeting to 72.65% in the second meeting, with an average of 70.70%. The 3.90% increase in openness and responsiveness to cultural elements indicates progress, but the average value of 3.90% remains below the

minimum target of 75%. The critical reasoning aspect also showed a positive increase, from 78.13% to 81.25%, with an average of 79.69%, reflecting a 3.12% increase in participants' analytical skills. Overall, the average of both meetings was 77.21%, which is above the minimum target of 75%. However, to fully achieve the goal, there needs to be additional focus on increasing global diversity, which is currently below the desired target.

### **Learning Outcomes Cycle I**

The learning outcomes in question are the results of the critical thinking ability test administered to students, as indicated by the values of the pretest and posttest at the end of each cycle. The results of the calculation of the critical thinking ability value were 73.60% in the critical category. This result indicates that students at the end of Cycle I have developed critical thinking skills, despite still being classified as below the minimum mastery criterion. The following is a recap of the data on the results of the critical thinking ability test for students in Cycle I.

**Table 14.** Results of Students' Critical Thinking Ability Test in Cycle I

| No. | Indicator           | Category   |          |        | Criteria |
|-----|---------------------|------------|----------|--------|----------|
|     |                     | Pretest    | Posttest | N-Gain |          |
| 1.  | Average             | 66.10      | 73.60    | 0.31   | Medium   |
| 2.  | Highest score       | 80         | 85       |        |          |
| 3.  | Lowest score        | 45         | 55       |        |          |
| 4.  | Level of completion | Individual | 61.72%   | 73.60% |          |
|     |                     | Classical  | 25.00%   | 53.13% |          |

Based on the results of the pretest and posttest score calculations, as well as N-Gain analysis, it can be concluded that the level of student learning completion shows some progress but has not yet reached the expected target. In the pretest, the average student score was 66.10, with a range of scores from 45 to 80. The individual completion rate reached only 61.72%, while the classical completion rate was 25%. After the posttest, the average student score increased to 73.60, with a range of 55 to 85. The individual completion rate increased to 73.60%, but was still slightly below the completion threshold of 75%. Classical completion increased significantly to 53.13%, but still did not reach the classical completion target of 75%.

The average N-Gain value of 0.31 is in the "Moderate" category ( $0.30 < g < 0.70$ ), indicating that the effectiveness of learning in improving student understanding is at a moderate level. Although there was an increase in terms of average value and level of completion, both individually and classically, the results were still inadequate. This suggests that although the learning carried out was quite effective, there is still room for improvement in teaching methods to achieve even greater improvements. To achieve individual and classical completion according to the minimum mastery criterion of 75 standards, adjustments and improvements in learning strategies, as well as additional support for students who have not yet achieved completion, are necessary.

### **Reflection**

Based on the analysis of the implementation results and observations, several aspects still require improvement to achieve more optimal learning objectives. Although the average implementation of learning during the two meetings reached 83% with a good category, several aspects, such as student collaboration and critical reasoning, showed positive improvements. However, there are still important aspects that do not meet the target. Global diversity, although it increased from 68.75% to 72.62%, is still below the minimum target of 75%. This indicates that, although progress has been made, further attention is needed to openness and responsiveness to cultural elements to achieve the desired standard.

Furthermore, the results of the pretest and posttest score calculations, as well as the N-Gain analysis, also indicate that the level of student learning completion has not yet reached the expected target. The average student score after the posttest increased to 73.60, but was still below the completion threshold of 75%. The classical completion rate reached only 53.13%, far short of the target of 75%. The average N-Gain value of 0.31, which falls within the "Moderate" category, indicates that the effectiveness of learning in improving student understanding remains at a medium level.

From these results, it can be concluded that although there is an increase, there is still room for improvement, particularly in implementing more effective learning strategies and providing additional support for students who have not yet achieved completion. There needs to be an additional focus on aspects of cultural responsiveness and improving teaching methods to achieve individual and classical completion standards in accordance with the minimum mastery criterion of 75%. These efforts are expected further to improve the quality of learning and student learning outcomes overall.

## Cycle II

### Planning

After completing the learning activities in Cycle I, learning planning is carried out by building on previous learning. The creation of teaching modules and learning devices has been improved based on input and suggestions received during the feasibility assessment stage of Cycle I.

### Implementation

The implementation of learning is re-implemented using the Problem-Based Learning model integrated with Culturally Responsive Teaching. Cycle II is carried out in two meetings.

### Observation

At each meeting, observations are made of teacher performance and student activities. Based on Table 15, it can be seen that the results of implementing learning in Cycle II, specifically Meetings 1 and 2, achieved a very good category, with scores of 94% and 100%, respectively. Overall, the results of this observation reflect that the teacher has worked very well and consistently in carrying out learning activities, showing high dedication and competence in managing the class and implementing the learning plan effectively.

**Table 15.** Learning Implementation Results

| No.     | Implementation | Category  |
|---------|----------------|-----------|
| 1.      | 94%            | Very good |
| 2.      | 100%           | Very good |
| Average | 97%            | Very good |

### Student Activity Observation Results

Researchers also observed learning activities in cycle two. The indicators of student activity observation are collaboration, global diversity, and critical reasoning. The following is a recapitulation of student activity data in cycle 2.

**Table 16.** Percentage of Learning Activities in Cycle

| No.     | Observed activities | Meeting |        | Average |
|---------|---------------------|---------|--------|---------|
|         |                     | 1       | 2      |         |
| 1.      | Collaborate         | 86.72%  | 92.19% | 89.45%  |
| 2.      | Kebhinekaan Global  | 78.12%  | 84.28% | 81.25%  |
| 3.      | Critical Thinking   | 85.16%  | 90.63% | 87.90%  |
| Average |                     | 83.33%  | 89.06% | 86.20%  |

Based on the results of observations of students' attitude activities, it can be concluded that all indicators have achieved the expected targets. The collaboration indicator showed the highest results with an average of 89.45%, increasing from 86.72% at the first meeting to 92.19% at the second meeting. Critical reasoning had an average of 87.90%, increasing from 85.16% to 90.63%. Global diversity, although the lowest indicator, also showed an increase from 78.12% to 84.38%, with an average of 81.25%. Overall, the average activity of students' attitudes in the two meetings was 86.20%, indicating a consistent and significant increase, which reflects that students had achieved the expected targets in their learning activities.

### Learning Outcomes Cycle II

The learning outcomes in question are the results of the critical thinking ability test administered to students, as indicated by the pretest and posttest scores at the end of each cycle. The calculation results show that students' critical thinking skills have reached 89.69%. This figure reflects a high level of understanding and skill in applying critical thinking skills. With almost 90% of students able to demonstrate the required analytical, evaluative, and reflective thinking, this indicates that the learning provided has been successful in significantly improving their critical thinking skills. These results also demonstrate that most students can effectively complete tasks that require critical thinking, thereby achieving the set learning targets. The following is a recap of the data from the results of the critical thinking ability test administered to students in Cycle II.

**Table 17.** Results of Students' Critical Thinking Ability Test in Cycle I

| No. | Indicator     | Category   |          |        | Criteria |
|-----|---------------|------------|----------|--------|----------|
|     |               | Pretest    | Posttest | N-Gain |          |
| 1.  | Average       | 65.47      | 89.69    | 0.71   | High     |
| 2.  | Highest Score | 85         | 100      |        |          |
| 3.  | Lower Score   | 50         | 70       |        |          |
| 4.  | Level of      | Individual | 65.49%   | 89.69% |          |
|     | completion    | Classical  | 53.13%   | 81.25% |          |

Based on the obtained data, the students' average pretest score was 65.47, which significantly increased to 89.69 in the posttest, with an N-Gain score of 0.71, categorized as high. The highest score rose from 85 in the pretest to 100 in the posttest, while the lowest score also improved from 50 to 70. The individual mastery level increased from 65.49% in the pretest to 89.69% in the posttest. Similarly, the classical mastery level rose from 53.13% to 81.25%. These data indicate that students experienced a significant improvement in understanding and skills, suggesting that the learning outcomes can be categorized as successful and have met the expected targets.

### Learning Reflection

The reflection on the learning process highlights significant success and achievement based on the results obtained. Teacher performance observations conducted over two meetings in Cycle II achieved an excellent category, with implementation levels of 94% and 100%. This indicates that the teacher demonstrated high dedication and competence in managing the class and effectively executing the lesson plans.

In terms of student activity, all indicators achieved the expected targets. The collaboration indicator achieved the highest result, with an average of 89.45%, followed by critical reasoning at 87.90%. Although global diversity was the lowest indicator, its improvement from 78.12% to 84.38%, with an average of 81.25%, still shows meaningful progress. Overall, the average score for students' attitude-related activities reached 86.20%, reflecting consistent improvement and achievement of learning activity targets.

Learning outcomes also demonstrate success, with students' critical thinking skills reaching 89.69%, reflecting a high level of understanding and competency. The significant increase in the average score from 65.47 in the pretest to 89.69 in the posttest, with an N-Gain of 0.71 (categorized as high), indicates the effectiveness of the learning process. The highest score increased from 85 to 100, while the lowest rose from 50 to 70. Individual and classical mastery levels also improved significantly, from 65.49% to 89.69% and from 53.13% to 81.25%, respectively.

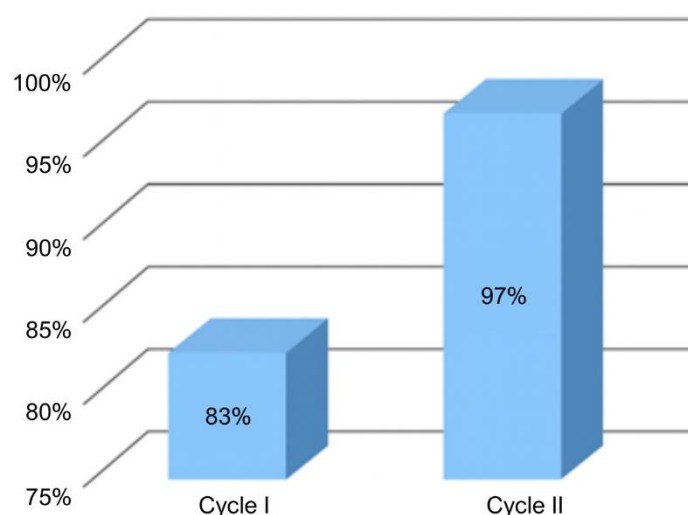
In conclusion, the learning process successfully enhanced students' understanding, particularly their critical thinking skills, significantly meeting and even exceeding the predetermined targets. The efforts to improve teaching strategies have yielded positive outcomes, making this learning experience a model of success in achieving educational goals.

## 4. DISCUSSION

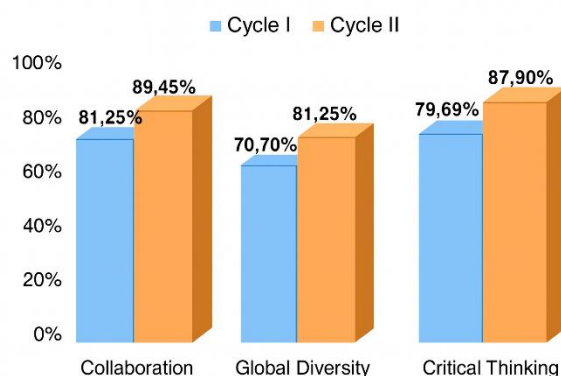
### Trajectory of implementation and student activity

This classroom action research consisted of two cycles, each comprising two sessions. Implementation advanced from 83 percent in Cycle I to 97 percent in Cycle II, a pattern that reflects tighter orchestration of plans,

clearer routines, and more consistent facilitation across meetings, as shown in Figure 2. Student activity aligned with the Pancasila Student Profile also strengthened in Cycle II, with collaboration, global diversity, and critical reasoning all improving, and the previously under-targeted global diversity dimension crossing the mastery threshold of 75, as shown in Figure 3. The joint movement of implementation and activity suggests that process quality and participation were interdependent rather than independent of each other.



**Figure 2.** Learning Implementation in Cycle I and Cycle II



**Figure 3.** Student Activity During Learning in Cycle I and Cycle II

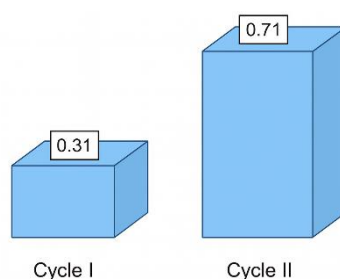
The trajectory aligns with research on contextually and inquiry-oriented science learning, which associates meaningful and situated tasks with improved engagement and readiness to reason (Aditomo et al., 2013; Aliyyah et al., 2020). In the present study, the inquiry structure of problem-based learning was combined with the relevance-enhancing context of culturally responsive teaching, allowing local ecological phenomena to serve as cognitively accessible entry points while still requiring scientific justification. Alignment with the Pancasila Student Profile focused classroom discourse on valued attitudes and reasoning targets, which is consistent with national assessment guidance on mastery reporting (Kemendikbud, 2014).

Qualitative shifts accompanied the numeric gains. Discussions featured more peer-to-peer checking, explicit reference to locally familiar evidence, and clearer movement from description to explanation, all of which function as process precursors to conceptual change in inquiry settings (Nurhasanah et al., 2020). Observations in Cycle II revealed that students were more willing to question claims, request reasons, and compare sources, which are high-leverage moves for constructing warranted explanations in ecology topics. Cycle level refinement is the likely driver of the observed trajectory. Planning notes documented that teacher facilitation became more explicit about justification norms, that examples were chosen to match lived experiences, and that feedback

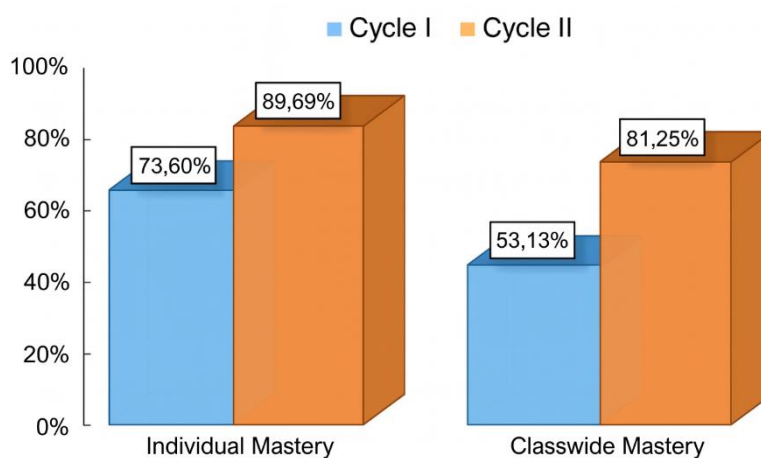
routines were time-bound with roles for presenters and discussants. These adjustments plausibly lowered entry barriers and increased the salience of evidence use, which directly supports the indicators tracked in Figure 3.

### **Evidence of conceptual consolidation**

Learning gains consistently corroborate the picture of the process. N gain increased from 0.31 in Cycle I, which is classified as medium, to 0.71 in Cycle II, which is classified as high, as shown in Figure 4. Mean critical thinking performance rose from 73.60 percent with a critical designation to 89.69 percent with a highly critical designation. The pattern suggests more than just item familiarity and points to the consolidation of core ecological concepts, along with stronger habits of incorporating evidence into reasoning. Convergence with reviews and empirical findings suggests that problem-based learning tends to enhance science outcomes and critical thinking across various topics and grade levels (Nurmahasih & Jumadi, 2023; Dewi, 2021). The conceptual interpretation is compatible with the distinction and mutual support between scientific thinking and critical thinking articulated by García Carmona, where handling evidence and modeling complement evaluation and inference in science education (García Carmona, 2025).



**Figure 4.** N-Gain Scores in Cycle I and Cycle II



**Figure 5.** Individual Mastery and Classical Mastery in Cycle I and Cycle II

Distributional evidence strengthens the inference of classroom-level impact. Individual mastery, defined as a score at or above the seventy-five criterion, increased from 73.60 percent to 89.68 percent, and classical mastery, defined as at least seventy-five percent of students meeting the criterion, rose from 53.13 percent to 81.25 percent, as shown in Figure 5. The shifts indicate benefits across the distribution, rather than concentrating among already proficient students—a feature relevant to equity, given the typical heterogeneity in lower secondary environmental topics (Ayun et al., 2020; Safitri et al., 2022; Sugandi & Siswanto, 2021). Movement of the distribution rather than only the mean is precisely the kind of change that signals instructional power at scale within a class.

Interpretive clarity requires an explicit statement of the N gain computation used. Calculation per student, followed by averaging, which is often referred to as the Hake approach, can yield slightly different values

compared to derivation from class means. Transparency about the method used will help readers align their interpretations with the statistics reported and increase the reproducibility of the study across replications. The transition from medium to high, along with the crossing of mastery thresholds, supports the claim that Cycle II conditions were not only better implemented but also more instructionally powerful, regardless of the exact computational pathway.

Connections between gains and participation patterns deserve emphasis. The emergence of evidence-seeking talk, increased peer checking, and the use of locally familiar examples likely strengthened links between ideas and data, a hallmark of conceptual consolidation. The improvement of the global diversity dimension beyond the mastery threshold can be interpreted as a proxy for the breadth of sources and perspectives considered prior to conclusion, which adds robustness to reasoning in ecology.

### ***Mechanisms linking cultural responsiveness and inquiry to critical reasoning***

The sequence of problem-based learning includes problem identification, brainstorming, surfacing prior knowledge, gap finding, guided inquiry, presentation, and reflection. That sequence is designed to structure learning around justification and revision, which are central to critical reasoning (Aditomo et al., 2013). In the present design, task sheets with Claim, Evidence, and Reasoning prompts, together with teacher questions that requested reasons and comparisons, helped classroom talk shift from reporting to arguing with evidence. Structures of this kind have been shown to foster higher-order thinking and to transcend subject boundaries when adapted with care (Budiman & Esvigi, 2017; Elfina & Sylvia, 2020; Inayah et al., 2021). Evidence from science classrooms further suggests that such structures enhance problem-solving and conceptual outcomes (Mareti & Hadiyanti, 2021; Masrinah et al., 2019).

Culturally responsive teaching complemented the inquiry structure by lowering entry barriers and broadening the evidence base in ways that matter for reasoning. Local places, practices, and traditions served as immediate referents, activated funds of knowledge, and enabled comparisons across perspectives (Wati et al., 2023; Wulandari et al., 2023). The effect was visible in Cycle II activity indicators with collaboration at 89.45 percent, global diversity at 81.25 percent, and critical reasoning at 87.90 percent, as shown in Figure 3. Locally meaningful contexts appear to have facilitated equitable turn-taking and richer elaboration of evidence during group discussions, which is directly linked to the mastery gains shown in Figure 5.

Operational refinements between cycles clarify how the mechanism was activated. Heterogeneous grouping was enforced to maximize perspective diversity and peer checking. Task sheets were revised to make justification nonoptional through explicit Claim, Evidence, and Reasoning sections and sentence starters. Local ecological examples were selected that matched students' lived experiences to increase relevance during entry phases. A local and scientific glossary scaffolded transitions in vocabulary and concepts. Feedback routines were time-boxed with defined roles, allowing process-focused feedforward to occur quickly enough to influence the next meeting.

The analytic use of prior literature situates the mechanism in context. Reviews link problem-based learning to stronger science outcomes and critical thinking, which this study replicated in a lower secondary ecology topic (Nurmahasih & Jumadi, 2023; Mareti & Hadiyanti, 2021). Novelty arises from embedding culturally responsive teaching within the same design, while utilizing the Pancasila Student Profile as process indicators — a less well-documented combination. A plausible theoretical account suggests that culturally responsive supports reduce initial cognitive load during the orientation and information search phases of problem-based learning, thereby freeing resources for evaluating evidence and constructing explanations (Aliyyah et al., 2020). Reports that integrate cultural responsiveness with local or ethno contexts show gains in critical thinking and science literacy in ecology and biodiversity, and studies that combine problem-based learning with a culturally responsive approach report improvements in motivation and outcomes, which is consistent with the present pattern (Desandra Putri & Tri Prasetya, 2025; Rahmawati & Agustina, 2025).

### ***Implications for practice, validity considerations, and future work***

Teachers can frame problems based on authentic, local phenomena that directly map to target concepts, then guide inquiry with task sheets that require the explicit use of evidence through Claim, Evidence, and Reasoning prompts (Elfina & Sylvia, 2020). Observation and scoring of student activity can be aligned with the Pancasila Student Profile so that feedback on collaboration, global diversity, and critical reasoning remains

visible and actionable across meetings, supported by a local and scientific glossary and by macroscopic, sub-microscopic, and symbolic representations to stabilize meaning (Aliyyah et al., 2020). Schools can provide protected planning time for culturally responsive, problem-based lessons, curate a bank of local contexts across science topics, and offer short trainings on talk moves and argumentation assessment. Meanwhile, microteaching and peer coaching sustain fidelity at scale (Rahmawati & Agustina, 2025).

The evidence strength remains qualified by a two-cycle single-class design and potential practice effects from repeated testing (Irwandi et al., 2019; Palobo et al., 2021). Content validity was supported by expert review; however, internal consistency and empirical item validity were not reported. Missing standard deviations prevented the calculation of standardized effect sizes, such as Cohen's *d*. A ceiling effect relative to the 75 mastery criterion may also have influenced the Cycle II results. Future work should contrast problem-based learning alone with problem-based learning integrated with culturally responsive teaching, retain item-level data to report reliability, and conduct Rasch item person mapping, extend to additional cycles and classes with delayed post tests and learning analytics, and run subgroup analyses to test differential benefits for lower baseline students, which is important for equity in contextualized inquiry.

## 5. CONCLUSION

Learning actions using the PBL-CRT model can effectively enhance critical thinking in two research cycles. The implementation of learning through teacher performance and student activities showed a significant increase from Cycle I to Cycle II, with the percentage of learning implementation increasing from 83% in Cycle I to 97% in Cycle II. Learning in cycle II was more effective in improving critical thinking skills compared to cycle I, as evidenced by the increase in the average N-gain from 0.31 to 0.71. In addition, individual and classical completeness were also achieved in Cycle II, with the percentage of students who met the minimum mastery criterion increasing from 73.60% in Cycle I to 89.68% in Cycle II, and classical completeness increasing from 53.13% to 81.25%. Learning in cycle II proved effective in improving students' critical thinking skills. This study has limitations in terms of the empirical validity of the critical thinking questions. Further research can be conducted with more cycles to achieve higher improvements in critical thinking and completeness.

## 6. REFERENCES

- Aditomo, A., Goodyear, P., Bliuc, A. M., & Ellis, R. A. (2013). Inquiry-based learning in higher education: Principal forms, educational objectives, and disciplinary variations. *Studies in Higher Education*, 38(9), 1239–1258. <https://doi.org/10.1080/03075079.2011.616584>
- Aliyyah, R. R., Ayuntina, D. R., Herawati, E. S. B., Suhardi, M., & Ismail. (2020). Using contextual teaching and learning models to improve students' natural science learning outcomes. *Indonesian Journal of Applied Research*, 1(2), 65–79. <https://doi.org/10.30997/ijar.v1i2.50>
- Aqib, Z. (2014). *Model-model, media, dan strategi pembelajaran kontekstual (inovatif)*. Yrama Widya.
- Ayun, Q., Hasasiyah, S. H., Subali, B., & Marwoto, P. (2020). Profil keterampilan berpikir kritis siswa SMP dalam pembelajaran IPA pada materi tekanan zat. *JPPS (Jurnal Penelitian Pendidikan Sains)*, 9(2), 1804–1811. <https://doi.org/10.26740/jpps.v9n2.p1804-1811>
- Budiman, H., & Esvigi, I. (2017). Implementasi strategi Mathematical Habits of Mind berbantuan multimedia untuk meningkatkan kemampuan berpikir kritis siswa. *Jurnal Prisma*, 6(1), 32–42. <https://doi.org/10.35194/jp.v6i1.26>
- Desandra Putri, E., & Tri Prasetya, A. (2025). Development of an Ethno-CRT learning model to improve critical thinking skills and science literacy in ecology and biodiversity materials. *International Journal of Active Learning*, 10(2), 35–44. <http://journal.unnes.ac.id/nju/index.php/ijal>
- Dewi, D. T. (2021). Penerapan pembelajaran Problem Based Learning untuk meningkatkan kemampuan berpikir kritis siswa. *ACTION: Jurnal Inovasi Penelitian Tindakan Kelas dan Sekolah*, 1(2), 149–157. <https://doi.org/10.51878/action.v1i2.637>
- Elfina, S., & Sylvia, I. (2020). Pengembangan lembar kerja peserta didik berbasis Problem Based Learning dalam meningkatkan kemampuan berpikir kritis siswa pada mata pelajaran sosiologi di SMA Negeri 1

- Payakumbuh. *Jurnal Sikola: Jurnal Kajian Pendidikan dan Pembelajaran*, 2(1), 27–34. <https://doi.org/10.24036/sikola.v2i1.56>
- García-Carmona, A. (2025). Scientific thinking and critical thinking in science education: Two distinct but symbiotically related intellectual processes. *Science & Education*, 34(1), 227–245. <https://doi.org/10.1007/s11191-023-00460-5>
- Ibnu, T. B. A. (2014). *Mendesain model pembelajaran inovatif, progresif, dan kontekstual: Konsep, landasan, dan implementasinya pada Kurikulum 2013*. Prenadamedia Group.
- Inayah, N., Triana, L., & Retnoningrum, D. (2023). Pendekatan culturally responsive teaching menggunakan media game Kahoot pada pembelajaran bahasa Indonesia. *Prosiding Seminar Nasional Literasi Pedagogi (SRADA) III*, 24–31.
- Inayah, S., Septian, A., & Komala, E. (2021). Efektivitas model flipped classroom berbasis Problem Based Learning dalam meningkatkan kemampuan berpikir kritis. *Wacana Akademika: Majalah Ilmiah Kependidikan*, 5, 138–144. <https://jurnal.ustjogja.ac.id/index.php/wacanaakademika/article/view/11323>
- Irwandi, Khairuddin, Alwi, N. A., & Helsa, Y. (2019). Classroom action research for improving teacher's professionalism. *Journal of Physics: Conference Series*, 1321(2), 022093. <https://doi.org/10.1088/1742-6596/1321/2/022093>
- Kementerian Pendidikan dan Kebudayaan. (2014). *Peraturan Menteri Pendidikan dan Kebudayaan Nomor 104: Pedoman penilaian hasil belajar oleh pendidik*.
- Malinda, G. (2021). Penerapan Problem Based Learning dalam meningkatkan kemampuan berpikir kritis siswa MA Negeri 1 Kota Bengkulu. *Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS)*, 5(1), 139–146. <https://doi.org/10.33369/jp2ms.5.1.139-146>
- Mareti, J. W., & Hadiyanti, A. H. D. (2021). Model Problem Based Learning untuk meningkatkan kemampuan berpikir kritis dan hasil belajar IPA siswa. *Jurnal Elementaria Edukasia*, 4(1), 31–41. <https://doi.org/10.31949/jee.v4i1.3047>
- Masrinah, E. N., Aripin, I., & Gaffar, A. A. (2019). Problem Based Learning untuk meningkatkan keterampilan berpikir kritis. *Prosiding Seminar Nasional Pendidikan*, 924–932. <https://prosiding.unma.ac.id/index.php/semnasfkip/article/view/129>
- Nurhasanah, N., Denny, Y. R., & Utami, I. S. (2020). Penerapan media pembelajaran majalah fisika "Physicsmagz" berbasis contextual learning untuk meningkatkan kemampuan literasi sains. *SPEKTRA: Jurnal Kajian Pendidikan Sains*, 6(1), 53–62. <https://doi.org/10.32699/spektra.v6i1.129>
- Nurmahasih, U., & Jumadi, J. (2023). Effect of utilizing the PBL model in physics learning on student learning outcomes: A systematic literature review. *Jurnal Penelitian Pendidikan IPA*, 9(6), 81–88. <https://doi.org/10.29303/jppipa.v9i6.2741>
- Palobo, M., Tembang, Y., Pagiling, S. L., & Nur'Aini, K. D. (2021). Identification of math teacher's capabilities in classroom action research. *Journal of Physics: Conference Series*, 1806(1), 012077. <https://doi.org/10.1088/1742-6596/1806/1/012077>
- Pratiwi, E. T., & Setyaningtyas, E. W. (2020). Kemampuan berpikir kritis siswa melalui model pembelajaran Problem Based Learning dan model pembelajaran Project Based Learning. *Jurnal Basicedu*, 4(2), 379–388. <https://doi.org/10.31004/basicedu.v4i2.362>
- Rahmawati, L., & Agustina, L. (2025). Application of problem based learning learning model based on culturally responsive teaching to the science learning outcomes of grade VII students. *ASSIMILATION: Indonesian Journal of Biology Education*, 8(1), 109–120. <https://doi.org/10.17509/aijbe.v8i1.81384>
- Riyanti, R., & Setyawan, D. (2021). Application of the flipped classroom learning model with interactive video learning media to improve student understanding of biology concepts. *Jurnal Inovasi Pendidikan Sains*, 12(2), 316–326. <https://doi.org/10.20527/quantum.v12i2.11224>

- Rizkiani, A., & Septian, A. (2019). The metacognitive ability of junior high school students in learning mathematics using the Realistic Mathematics Education approach. *UNION: Jurnal Ilmiah Pendidikan Matematika*, 7(2), 275–284. <https://doi.org/10.30738/union.v7i2.4557>
- Safitri, D., Munawaroh, F., Qomaria, N., & Fikriyah, A. (2022). Profil kemampuan berpikir kritis siswa kelas VII materi pencemaran lingkungan. *Jurnal Natural Science Educational Research*, 4(3), 209–213. <https://doi.org/10.21107/nser.v4i3.8392>
- Sari, A., Sari, Y. A., & Namira, D. (2023). Penerapan model pembelajaran Problem Based Learning terintegrasi culturally responsive teaching untuk meningkatkan motivasi dan hasil belajar siswa kelas X IPA 1 SMA Negeri 7 Mataram pada mata pelajaran kimia tahun ajaran 2022/2023. *Jurnal Asimilasi Pendidikan*, 1(2), 110–118. <https://doi.org/10.61924/jasmin.v1i2.18>
- Sebastian, R., Kuswanto, H., Jumadi, J., & Putri-Haspari, N. P. (2023). Effectiveness of flip-book optic devices based on Problem-Based Learning, assisted with virtual laboratory simulation, to improve high school students' visual representation. *Revista Cubana de Física*, 40(2), 90–97. <https://revistacubanadefisica.org/index.php/rcf/article/view/2023v40p090>
- Sugandi, K., & Siswanto, J. (2021). Profil kemampuan berpikir kritis mata pelajaran IPA pada siswa kelas VIII SMP Negeri 3 Taman tahun pelajaran 2019/2020. *Jurnal Penelitian Pembelajaran Fisika*, 12(1), 78–82. <https://doi.org/10.26877/jp2f.v12i1.5511>
- Tsany, U. N., Septian, A., & Komala, E. (2020). The ability of understanding mathematical concept and self-regulated learning using Macromedia Flash Professional 8. *Journal of Physics: Conference Series*, 1657(1), 012074. <https://doi.org/10.1088/1742-6596/1657/1/012074>
- Wati, S., Mutiara, T. M., & Guru, P. P. (2023). Peningkatan minat belajar peserta didik melalui metode pendekatan culturally responsive teaching di kelas XI 10 SMA Negeri 3 Palembang. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 8, 6260–6268. <https://journal.unpas.ac.id/index.php/pendas/article/view/10224>
- Wulandari, A., Ningsih, K., & Rahmawati. (2023). Meningkatkan minat belajar IPA melalui penerapan pendekatan *Culturally Responsive Teaching (CRT)* pada siswa kelas VIII SMP Negeri 19 Pontianak. *Jurnal Pendidikan dan Pembelajaran Sains Indonesia (JPPSI)*, 6(2), 130–142. <https://ejournal.undiksha.ac.id/index.php/JPPSI/article/view/68218>