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# Enhancing elementary students' learning outcomes in integrated science and social studies through problem-based learning supported by mind mapping: A classroom action research study

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**ABSTRACT**

This study employed a classroom action research design to improve students' learning outcomes in science and social studies through the integration of the Problem-Based Learning (PBL) model supported by a mind-mapping strategy. The research consisted of two cycles, each comprising four stages: planning, action, observation, and reflection. Data were collected through learning outcome tests and observation of student activities. The development of test instruments involved expert validation, empirical validity testing, reliability analysis, difficulty index analysis, and discrimination index analysis. The findings revealed that students' cognitive achievement in the pre-cycle was still below the expected mastery criteria, with an average score of 68.88. After the implementation of PBL assisted by mind mapping in Cycle I, the average score increased to 76.94, followed by further improvement in Cycle II, reaching an average score of 81.38. Observation results also demonstrated progressive enhancement in classroom learning behaviour, including enthusiasm, activeness in questioning, collaboration, confidence during presentations, ability to construct mind maps, and time management. Overall, the results indicate that the integration of PBL and mind-mapping strategies effectively enhances student learning outcomes by strengthening problem-solving engagement and supporting structured cognitive processing throughout the learning activities.



## INTRODUCTION

The rapid development of science and technology has influenced society to enter the era of globalization (B. Beribe 2023). This era of globalization demands strong readiness across all sectors, particularly education, which is expected to equip students with competencies that enable them to compete in the global workforce (Ali 2021) One of the fields that can prepare and create an increase in human resources to face the times is education. Education is an crucial component in the course of human life, especially the next generation of the nation to establish a quality generation (Feszterová 2024). Learning activities are one of the educational processes. Success in learning activities can be evidenced by understanding the concept, mastering the material and when at the conclusion, an assessment is conducted of learning shows very significant learning outcomes (Ramdani et al. 2021). A study by Wardani et al. (2023) confirmed that the problem-

based learning model assisted with mind mapping significantly improves students' critical thinking, as shown by a meaningful pretest–posttest difference and an n-gain average of 0.43. Their findings emphasize that combining PBL with structured mind-mapping activities enables learners to analyze problems more deeply rather than relying on textual learning alone. This aligns with the meta-analysis by Koçoğlu and Kanadlı (2025) which demonstrated that PBL produces higher cognitive and affective learning outcomes than traditional instructional methods across various subject areas.

Lectures, which are usually the focus of the learning model, make students tend to just memorize information without really understanding it or developing thinking skills (Ghaleb 2024). This often results in less than optimal learning outcomes. This condition was also found at state elementary school 2 Jambewangi Banyuwangi. Considering the outcomes of the researcher's observations, it shows that students find it difficult to master science and social studies lessons, this affects the learning outcomes of students that are less than optimal, as evidenced by the findings of the examination of pure Midterm Test scores showing that most students do not meet the school's Minimum Completion Criteria with a minimum score of 73 points. Of the 15 students, 9 were able to reach the Minimum Completion Criteria and 6 students still didn't reach the Minimum Completion Criteria score. This condition is because the learning model where applied in class IV Jambewangi 2 elementary school often uses the lecture method which then causes students to become passive so that they often listen to the teacher and memorize concepts but lack the ability to apply the concept when encountering problems in real situations related through the ownership of the concept. In addition, students are not given many opportunities to explore knowledge independently which results in reducing their interest and motivation in learning. Furthermore, there is no intriguing strategy of learning to provide encouragement to students to comprehend the subject matter to be learned (Dewi et al. 2021).

The innovation of the problem is the application of problem-based learning models and media that are interesting and student-oriented (student centered) (Tang 2023), this innovation can be applied using the PBL model which stands for Problem Based Learning through learning strategy utilization in the form of mind mapping. The explanation of PBL it self is a problem-based learning model that introduces students to a case that has involvement with the material being taught. In the PBL model, students are asked to be able to solve a problem that is being faced in a lesson (Kabilan 2024). In the learning process, there are five main stages of applying the PBL learning model, namely, 1) Orienting students in the problem, (2) Orienting the learning activity, (3) Fostering independent and group observations, (4) Developing and showing the resulting work, (5) Analyzing and evaluating the process of problem solving (Suharno et al. 2024). Researchers in this study used mind mapping media. This media selection is because it is adapted to the PBL educational model in order to later students can present the results of their discussions using mind mapping. Mind mapping is an effective, innovative note method, along with literally later connecting the minds of students (Ardiansyah et al. 2024). Buzan (2024) expressed the opinion that because it unites the work functions of the brain simultaneously and relates to one another, mind mapping is a type of note that is not monotonous. Everything related to the right brain

function can be accessed by the brain, such as music, pictures, symbols, images, and others. Researchers used energy material in this study because it was aligned through research conducted on Dewi et al. (2021) with the resulting research showing that students had difficulty *classifying*. Students face two problems with this indicator, namely they do not understand the material of alternative energy sources and interpret that the material is too much so they are confused by what is being taught. The use of *mind mapping* on energy material helps students connect words, pictures, lines and colors in different ways. With this learning model, students do not need to record too long material, besides that students have the convenience of seeing the material as a whole and certainly make students more creative in learning (Мейрбеков 2022).

The results of several relevant studies demonstrate that the use of the Problem-Based Learning (PBL) model combined with mind mapping can significantly enhance students' academic performance. Wardani et al. (2023) found that the PBL model assisted by mind mapping effectively improved critical thinking skills in fifth-grade social studies, as evidenced by the significant gain score and post-test difference between the experimental and control groups. Similar findings were reported by Jamhari et al. (2025), who confirmed that integrating mind mapping into PBL had a statistically significant positive impact on learning outcomes in the ecosystem lesson, with the experimental class outperforming the control class.

Although the effectiveness of integrating PBL and mind mapping has been supported by previous research, these studies have not yet fully explored its application across different learning contexts. In particular, limited research has examined the use of this combination in elementary-school science and social studies learning, especially on energy-related topics where students commonly experience low concept mastery and passive engagement. The learning challenges identified at State Elementary School 2 Jambewangi such as minimal independent exploration, passive classroom involvement, and difficulty understanding concepts further emphasize the need for an instructional approach that is both engaging and student-centered. Therefore, investigating the combined use of PBL and mind mapping in this context offers novelty by positioning mind mapping not merely as a visual medium but as a cognitive strategy embedded within the stages of PBL to enhance conceptual understanding and learning outcomes.

Aligned with this research gap, the present study aims to improve fourth-grade students' learning outcomes in science and social studies through the implementation of a Problem-Based Learning model assisted by mind-mapping strategies. Specifically, the study examines how this integrated approach influences student engagement, conceptual understanding, and learning performance across two cycles of classroom action research. Through this investigation, the study is expected to provide empirical evidence on the effectiveness of PBL integrated with mind mapping as a learning innovation suited to overcoming classroom difficulties and improving learning quality in elementary school settings.

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## METHODS

Classroom Action Research (CAR) was employed as the methodology in this study. CAR is a systematic process of investigating teaching and learning problems in the classroom through self-reflection, planned actions, and continuous evaluation (Fahmi et al., 2021). This research was conducted at State Elementary School 2 Jambewangi, Sempu District, Banyuwangi Regency, East Java. The study took place during the even semester of the 2024/2025 academic year and involved 18 students as research subjects. Data collection techniques included tests and observations, with direct observations conducted throughout the learning process.

This study collected data through two primary sources, namely learning outcome tests and classroom observations. The learning outcome test was used to measure students' cognitive mastery related to the topic of energy across the pre-cycle, Cycle I, and Cycle II, while the observation sheet served to document students' learning behaviour during classroom activities, including engagement, collaboration, motivation, presentation skills, and time management. The development of the test instrument followed four systematic stages: validity testing, reliability testing, discrimination index analysis, and difficulty level analysis. Item validity was examined through SPSS to identify items that accurately measured the intended construct, and reliability testing using the split-half method was conducted to determine the stability and internal consistency of the instrument.

Data obtained from the learning outcome tests and observation sheets were subsequently analyzed using a descriptive quantitative approach to determine improvements in student performance across cycles after the implementation of the Problem-Based Learning (PBL) model assisted by mind-mapping strategies (Sugiyono 2023). Quantitative learning outcome data were processed by calculating the percentage of individual and class mastery, enabling comparison between the pre-cycle and each action cycle. Meanwhile, observation data were analyzed to identify patterns of behavioural change that occurred during the learning process, and the results of these observations were used as the basis for reflection and planning improvements for the following cycle. According to Masyhud (2021:367) increases in individual student learning outcomes can be determined using the following formula:

$$\text{Pi} = \frac{\sum srt}{\sum si} x\ 100$$

Description:
pi = individual achievement
srt = real score achieved by individual
si = ideal score that can be achieved by the individual

Determining on the completeness of student-generated learning with classical using formulas in form:

$$\text{Pk} = \frac{\sum srtk}{\sum sik} x\ 100$$

Description:
pk = class/group achievement
srtk = the real score achieved by the class (the sum of the scores of all students in the class)
sik = ideal score that can be achieved by all students in the class

The accomplishment of student learning end result is illustrated through table 1 criteria on a student's learning outcomes described by form:

**Table 1.** Student Learning Outcome Assessment Criteria

| Learning Outcome Criteria | Learning Outcome Score |
|---|---|
| Very good | $80 < pk \leq 100$ |
| Good | $60 < pk \leq 80$ |
| Medium/Sufficient | $40 < pk \leq 60$ |
| Less | $20 < pk \leq 40$ |
| Very Less | $0 < pk \leq 20$ |

(Masyhud, 2021)

## RESULTS

### 1. Pre-Cycle Classroom Action Research

Before completed the cycle I at Classroom Action Research, a pre-cycle was first accomplished to determine the prelimary condition the students and the effectiveness of learning methods that had been applied previously. The pre-cycle stage was carried out by learning using the usual method without any improvement, namely applying the lecture, discussion, and question and answer methods. At this stage students were also given evaluation questions to measure students' ability to understand energy material by applying existing learning methods. Furthermore, it was found that the cognitive learning end result of the pre-cycle students stage obtained a median value of 68.88 in which there was one student with very good criteria with a percentage of 5.56% after that 13 students with good criteria with a percentage of 72.22% and 4 students in good enough criteria with a percentage of 22.22%. The following analysis of pre-class learning outcomes can be seen through figure 1.

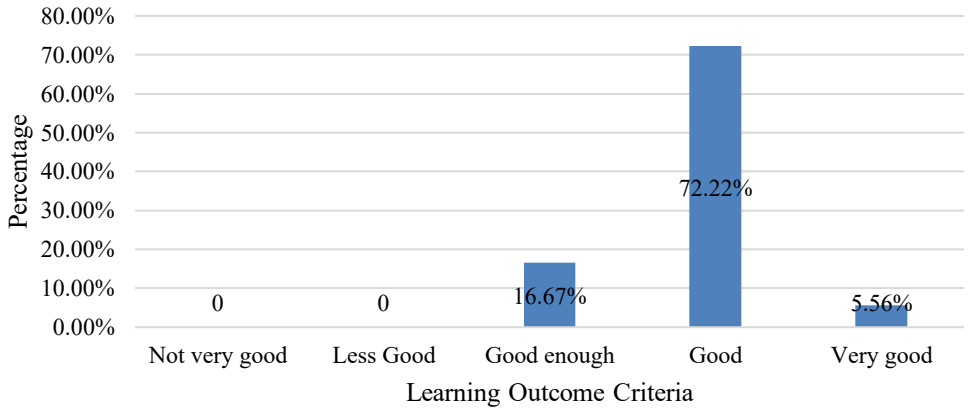


**Figure 1.** Analysis of Pre-Cycle Cognitive Learning Outcomes

With the pre-cyle is outcomes, it is necessary to improve learning by utilizing mind mapping in conjunction with the PBL model to enhance the results of student learning on energy material in class IV SDN 2 Jambewangi Banyuwangi. The enhancement of the educational results of fourth grade students of SDN 2 Jambewangi Banyuwangi on energy material by appealing the two cycles were used to implement the PBL paradigm with mind mapping assistance.

**2. Cycle I Classroom Action Research**

Building on the findings from the pre-cycle, Cycle I was implemented using a problem-based learning approach supported by mind mapping to enhance student learning outcomes. Cycle I was completed as follows:

a. Planning

The following is an implementation of the planning stage activities as follows:

1) Making teaching modules.
2) Prepare materials for *mind mapping.*
3) Prepare a method for determining group members.
4) Prepare student worksheet and cycle I test questions
5) Prepare learning process research observation sheet

b. Implementation

Teaching and learning activities were carried out by covering introductory activities, core activities by implementing a mind mapping-assisted problem-based learning approach, then continued with closing activities.

c. Observation

The observation results obtained are that students together with their groups solve problems but not from various literatures and when carrying out presentations students are less able to respond to groups who are presenting. In cycle I, students tended to be excited when learning, especially when making mind mapping, but were less able to present their work.

d. Reflection

The observation results from the first cycle showed that there were deficiencies in learning activities among students could not solve problems from various literatures due to the lack of books to read, then students also still did not respond to other groups when presenting. In addition, the selection of study groups is also less effective so that in cycle II educators must improve learning activities to the maximum based on cycle I student learning outcomes and the findings of the reflection can be seen in Figure 2.

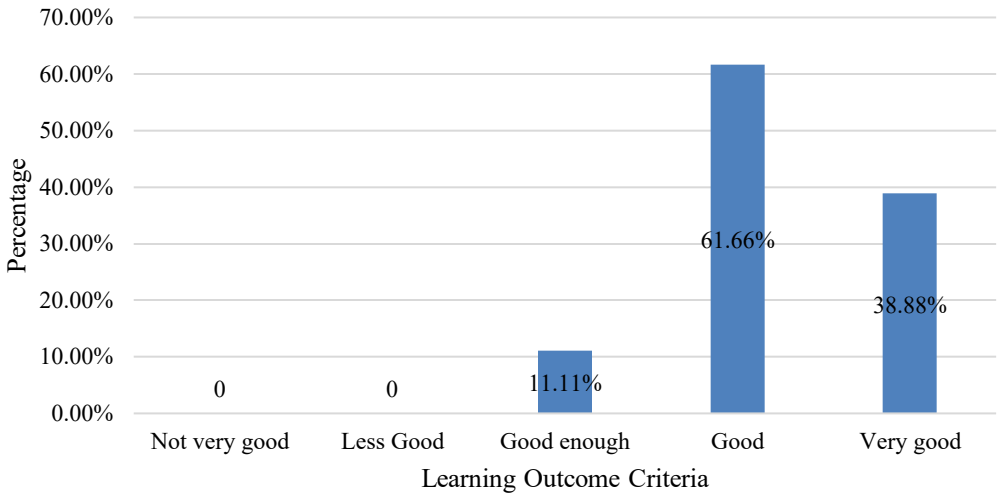


**Figure 2.** Analysis of Cognitive Learning Outcomes Cycle I

Learning outcomes in first cycle obtained an average of 76.94 there were 5 students getting very good criteria with a percentage of 27.78% where students obtained learning outcomes of more than 80 and 11 students got good criteria having a proportion of of 61.66% and 3 the students in moderate / sufficient category having a proportion of 11.11%. The data indicates that there was an increase in learning outcomes in cycle I, as there was an 8.06% rise in student learning outcomes following the implementation of cycle I. In addition, five of the students did not achieve the learning outcomes in first cycle and they were unable to get to learning outcome criteria 73. These learning outcomes indicate that cycle II action is needed to enhance the learning outcomes of students. Improvements in cycle II are adapted to the cycle I reflection's findings. The objective is to correct the shortcomings in cycle I so that in second cyIe there is an optimal improvement in the learning outcomes of students.

### 3. Cycle II Cycle I Classroom Action Research

Following the reflection from Cycle I, Cycle II was carried out with adjustments in group formation and problem presentation to further improve learning performance. The implementation of cycle II was carried out not much different from cycle I. The difference is in the problems given and the way groups are formed. Second cycle action was also completed in two meetings using mind mapping on energy-related topics and the PBL model. The educational objectives in cycle II

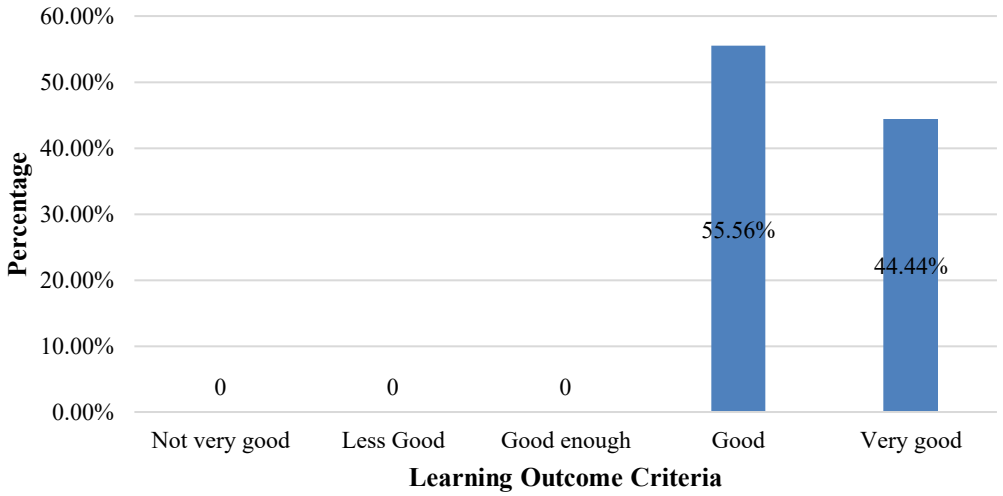


**Figure 3.** Analysis of cognitive learning outcomes cycle II

Learning outcomes in second cycle had a mean of class achievement is 81.38 where there were 8 students in the very good category with an 44.44% percentage meanwhile 10 students in the good category with an 55.56% percentage where almost all students achieved scores that exceeded the learning outcome criteria, and only one student still scored below the learning outcome criteria. Cycle I reflections serve as the foundation for cycle II implementation. The action of cycle II has improved because of cycle I is reflection. Students second cycle have been able to cooperate or discuss with fellow group members because in cycle II study groups are made based on gender, students are no longer confused when making mind mapping of problem-solving results because they already understand the steps of making mind mapping, students also have good time management because they can complete the task within the specified time. Furthermore, at the presentation stage of the work, students seemed to be confident and had a good attitude when presenting in front of the class. The following is an analysis of student learning outcomes from pre-cycle, cycle I, cycle II in table 2.

**Table 2.** Learning Outcomes of Pre-Cycle, Cycle I, Cycle II

| No. | Activities | Classical percentage (%) | Student Learning Outcome Criteria |
|---|---|---|---|
| 1. | Pre-cycle | 68,88 | Simply |
| 2. | Cycle I | 76,94 | Good |
| 3. | Cycle II | 81,38 | Very good |

Based on the findings in Table 2, it can be said that student learning outcomes increased which was 8.06% from the pre-cycle to cycle I, then there was learning growth of 4.44% from first cycle to second cycle. Then, between pre-cycle, first cycle, and second cycle, student learning

outcomes increased. The percentage of classical learning outcomes can be illustrated through Figure 4.

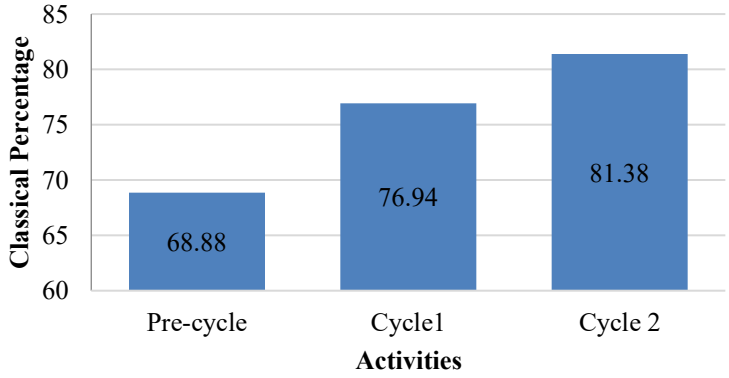


**Figure 4.** Diagram of Learning Outcomes

## 4. Observation

While the improvement in test results strengthens the conclusion that students experienced cognitive growth, it is important to verify whether this improvement was accompanied by changes in their learning behavior during classroom activities. For that reason, observational data were collected to monitor students' enthusiasm, participation, collaboration, and independence throughout the intervention. The recapitulation of observation scores from the pre-cycle, cycle I, and cycle II is shown in the following table.

**Table 3.** Observation Results of Student Learning Activities

| Indicators | Pre-Cycle | Cycle I | Cycle II |
|---|---|---|---|
| Student enthusiasm during learning | 1 (Very Poor) | 3 (Good) | 4 (Very Good) |
| Activeness in class (asking/answering questions) | 1 (Very Poor) | 2 (Fair) | 4 (Very Good) |
| Collaboration in group work | 1 (Very Poor) | 2 (Fair) | 4 (Very Good) |
| Ability to create mind maps | 1 (Very Poor) | 2 (Fair) | 4 (Very Good) |
| Confidence during presentation | 1 (Very Poor) | 2 (Fair) | 4 (Very Good) |
| Time management | 1 (Very Poor) | 3 (Good) | 4 (Very Good) |

The results in Table 3 show that the improvement in cognitive achievement was supported by significant behavioral development during the learning process. Students became more enthusiastic and active in asking or answering questions, and their collaboration within groups improved remarkably from cycle I to cycle II. Their ability to produce mind maps also strengthened in line with increased comprehension of energy concepts. Likewise, confidence during presentations and time management advanced considerably in the final cycle, suggesting that the learning model did not merely enhance knowledge acquisition but also fostered positive learning habits and classroom engagement.

## DISCUSSION

The improvement in students' learning outcomes from the pre-cycle to cycle II demonstrates that the implementation of Problem-Based Learning (PBL) assisted by mind mapping provided a tangible contribution to conceptual understanding of energy among fourth-grade students at SDN 2 Jambewangi. In the pre-cycle, the test results showed an average score of 68.88, with most students only reaching the "sufficient" category and failing to meet the minimum mastery criteria. This finding aligns with the observation results, which revealed low enthusiasm, limited participation, and insufficient independence in solving problems during learning (Wahelo et al. 2025). The ineffectiveness of the conventional lecture, discussion, question and answer method was reflected in the lack of meaningful interaction and the limited opportunities for students to process information independently (Lin et al. 2025).

A gradual shift became visible in cycle I after the PBL approach assisted by mind mapping was implemented, where the average learning outcome increased. The PBL model allowed students to take part in problem solving more actively (Alashwal and Barham 2025), while the mind mapping strategy provided a systematic visualization of key concepts (Fang and Chiu 2025). Theoretically, this outcome aligns with Almardanovna and Shokirovna (2025) view that active participation in problem solving stimulates cognitive elaboration and strengthens long-term memory. In addition, Fank and Chiu's (2025) theory of mind mapping suggests that branching concept maps help the brain cluster information, connect ideas, and retrieve learned concepts more effectively. The alignment between the learning model and learning strategy was also reflected in the observation data in cycle I, where students demonstrated greater enthusiasm, although challenges remained particularly low presentation confidence and less optimal group collaboration.

Reflections from cycle I resulted in several targeted improvements that proved highly effective in cycle II, particularly restructuring group composition based on gender and providing more systematic guidance in the steps of constructing mind maps (Zhang et al. 2025). As a result, the average learning outcome in cycle II increased. Its aligns with Jamhari et al. (2025) findings, which demonstrated that integrating mind mapping into a problem-based learning framework significantly enhances students' academic performancethat. Nearly all students exceeded the minimum mastery criteria, and only one student scored below the target due to persistent reading difficulties. This finding is reinforced by the meta-analysis of (Shi et al. 2023), which demonstrated that mind mapping-based instruction consistently produces higher cognitive learning outcomes compared to traditional learning approaches, particularly among lower-grade students. The alignment between the present study and the meta-analytic evidence strengthens the argument that mind mapping effectively supports elementary learners in organizing information, improving memory retrieval, and achieving higher levels of academic mastery (Wong 2021).

Observation data showed clear improvement in enthusiasm, activeness in questioning, collaboration, ability to create mind maps, presentation confidence, and time management across the learning cycles. This pattern is consistent with Thabethe and Mwambakana-Mutombo, (2025),

who found that project-based learning enhances collaboration, communication, confidence, and time-management skills. In addition, the improvement in students' ability to create mind maps aligns with Shi et al. (2023), who demonstrated that mind-mapping-based instruction strengthens cognitive organization and leads to higher academic performance. Consistently, indicators that were initially categorized as "very poor" during the pre-cycle progressed to "very good" in cycle II, reinforcing that the rise in test scores was not simply due to repeated exposure to the material, but reflected a genuine improvement in the quality of the learning process (Guimaraes et al. 2025).

Together, these patterns indicate that the improvement in learning outcomes was driven by changes in how students learned. These findings are in line with research showing that PBL increases critical thinking and student engagement, while mind mapping strengthens conceptual understanding and memory retention. Previous studies by Wardani et al. (2023) demonstrated that the combination of PBL and mind mapping improves collaboration and learning achievement, and (Ardiansyah et al. 2024) confirmed that mind mapping within PBL supports deeper cognitive processing and creative thinking. Building on these insights, the novelty of the present study lies in positioning mind mapping not merely as a visual aid but as a cognitive strategy embedded throughout the inquiry stages of PBL, enabling learners to organize information, analyze problems, and present solutions more effectively.

Beyond findings related to models and learning strategies, the study also presents a practical contribution regarding group dynamics among elementary students (Gardeli and Vosinakis 2025). Grouping students by attendance number in cycle I resulted in imbalanced participation and the dominance of certain students, whereas grouping by gender in cycle II produced more balanced interaction, smoother communication, and more effective collaboration (Liang et al. 2024). This practical implication can be utilized in planning collaborative learning activities at the elementary level, particularly for lower and middle grades (Babichenko et al. 2024). The increase in presentation confidence in cycle II also emerged as an important point (Saz-Roy et al. 2025). When students understood the correct steps for constructing a mind map, the visual structure guided the flow of explanation, making presentations easier, more organized, and preventing loss of ideas. This indicates that mind mapping is not only effective for encoding information, but also for information retrieval and academic communication dimensions that have not been strongly emphasized in prior research (Ibrahim and Hendy 2025).

Overall, the improvement from the pre-cycle to cycle I and ultimately to cycle II proves that increased learning outcomes were not the result of temporary intervention, but rather consistent improvements in the learning process. The synergy between PBL and mind mapping enables students to construct knowledge not merely through material exposure, but through learning experiences that require critical thinking, collaboration, and emotional involvement. This corresponds with the demands of 21st-century learning, which emphasize student-centered learning processes (Kain et al. 2024). In conclusion, this study provides two major contributions. First, it empirically verifies that integrating PBL and mind mapping can significantly improve student learning outcomes through the transformation of learning processes not merely through raising test scores. Second, it presents a practical and replicable implementation model suited to

elementary school contexts, which can be adapted for different grade levels and subject content requiring structured conceptual understanding and collaborative skills.

## CONCLUSIONS

The results of this classroom action research demonstrate that implementing the Problem-Based Learning (PBL) model supported by mind-mapping strategies effectively improves student learning outcomes in science and social studies. Across two research cycles, learning activities became more conducive, student engagement increased, and learners showed higher levels of enthusiasm, collaboration, creativity, and confidence. Enhancements made in Cycle II following reflections from Cycle I, resulted in more effective group discussions, improved time management, and clearer understanding of the steps for constructing mind maps, which contributed to students' improved ability to analyze problems and communicate their ideas. The increase in academic performance across cycles provides strong empirical evidence for the effectiveness of integrating PBL with mind mapping. Student mastery rose from an average score of 68.88% in the pre-cycle to 76.94% in Cycle I and further increased to 81.38% in Cycle II, with almost all students surpassing the minimum mastery criteria. These findings indicate that the strategic selection of instructional approaches particularly the use of mind mapping as a tool for organizing information and facilitating problem solving, can strongly support the successful implementation of the PBL model. In conclusion, PBL assisted by mind mapping is a relevant and effective instructional approach for enhancing students' conceptual understanding and learning outcomes in elementary science and social studies. This study also provides practical implications for classroom practice, showing that integrating mind mapping as a cognitive strategy within PBL can foster active participation, strengthen collaborative skills, and build students' confidence in presenting academic ideas offering a replicable instructional model for improving learning quality in similar elementary education contexts.

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