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# Metacognitive Strategies in Problem-Based Learning: What They Are and How to Implement Them?

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**ABSTRACT**

Metacognitive strategies are techniques or approaches used to help students understand and control their own thinking processes, including the abilities to plan, monitor, and evaluate their learning. In the context of Problem Based Learning (PBL), these strategies assist students not only in deeply understanding the material but also in enhancing their ability to organize and reflect on how they solve problems independently. This article employs a Systematic Literature Review (SLR) method to identify and analyze the fundamental concepts of metacognitive strategies, their roles in PBL, and effective implementation steps in the classroom. Key components discussed include task planning techniques, monitoring of understanding, and reflection on outcomes. The findings indicate that the application of metacognitive strategies within PBL can strengthen students' learning independence, improve critical thinking skills, and foster their confidence in tackling complex problems. Furthermore, the implementation of these strategies encourages students to be more active and reflective in their learning processes, contributing to a deeper and more sustainable understanding of the material.

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**KEYWORDS:** Metacognitive Strategies, Problem-Based Learning, and Systematic Literature Review (SLR)

## INTRODUCTION

In the increasingly complex era of globalization, 21st-century education faces the challenge of preparing the younger generation to adapt to rapid changes and real-life challenges. Education should not only focus on knowledge acquisition but also on the development of skills and values relevant to today's world. Therefore, a holistic and sustainable educational approach is required to ensure that learners can cope with the dynamics of modern life.

21st-century education must humanize and socialize students by equipping them with the ability to manage life, contribute to society, and adapt to a constantly changing world. Furthermore, education must raise global awareness, encourage responsible citizenship, and be socio-critical and transformative to create real impact. Core skills needed include collaborative teamwork, problem-solving, communication, connectivity, creativity, and diverse self-expression. These skills are grounded in experience and strong evidence, utilizing technology to maximize relevant and sustainable learning potential (Whitby, 2007).

In the effort to create relevant education in the 21st century, a learning approach that integrates critical thinking, collaboration, and problem-solving skills becomes essential. One prominent approach is Problem-Based Learning (PBL), which allows students to learn through the exploration of real-world problems that are relevant to their lives (Hmelo-Silver, 2004).

Problem-Based Learning (PBL) is a learning approach that focuses on solving real-world problems, where students work in groups to investigate and find solutions to the presented problems (Arends, 2012). Unlike traditional teaching methods, PBL encourages students to be active participants in the learning process, developing critical, collaborative, and creative skills that are essential for addressing real-world challenges.

To maximize the effectiveness of PBL, metacognitive strategies can also be applied to help students manage their own thinking processes. The term "metacognition" was first introduced by Flavel in 1979. According to Flavel, metacognition refers to one's knowledge or awareness of their own thinking processes and self-regulation during thinking (Flavell, 1979). Furthermore, Zhang & Lian (2024) state that metacognitive strategies empower students to recognize their cognitive abilities and actively monitor their ongoing thinking processes. This facilitates the development of plans

and the application of self-regulation, allowing students to adjust their learning behaviors more effectively.

Metacognitive strategies involve three main steps: planning, monitoring, and evaluation (Veenman et al., 2006). By using metacognitik ve strategies, students not only learn how to solve problems but also understand how they think and learn, enabling them to become more reflective and effective learners.

Thus, the application of PBL along with metacognitive strategies provides significant benefits in 21st-century education. This approach not only enhances conceptual understanding but also hones problem-solving, communication, and teamwork skills. Students engaged in this process become better prepared to face global challenges and contribute actively to society.

## METHOD

This study uses a Systematic Literature Review (SLR) approach to identify, evaluate, and analyze literature related to the implementation of metacognitive strategies in Problem-Based Learning (PBL). The aim of this approach is to provide a comprehensive understanding of the concept, application, and effectiveness of metacognitive strategies in improving student learning outcomes.

The research process begins with the identification and selection of literature from various trusted databases such as Google Scholar, Scopus, DOAJ (Directory of Open Access Journals), and ScienceDirect. Keywords used include "metacognitive strategies," "Problem-Based Learning," and "application in education." Inclusion criteria include publications in English or Indonesian, as well as literature providing empirical data or theoretical reviews on Problem-Based Learning and metacognitive strategies. Articles that are irrelevant or do not involve students as the main subjects are excluded from the analysis.

The collected data are analyzed using a thematic approach to identify key patterns. The analysis focuses on several aspects, namely the concept of metacognitive strategies, phases of Problem-Based Learning, examples of practical implementation, and the impact of these strategies on student learning outcomes. Relevant literature is filtered based on abstracts and methods, then analyzed in more depth to ensure data quality.

The results of the analysis are organized in tabular form to facilitate interpretation and presentation of findings. Validation is performed by comparing findings from various references to avoid bias and ensure the accuracy of the research results. The research findings are expected to provide a clear understanding of metacognitive strategies in Problem-Based Learning, examples of their application in various learning phases, and practical recommendations for educators in integrating metacognitive strategies into daily learning.

## RESULTS AND DISCUSSION

Problem-Based Learning (PBL) is a learning method that focuses on solving relevant and realistic practical problems, which are explored in small groups (Bosica et al., 2021). This approach begins with presenting real-world problems that connect the material to students' life experiences. These problems are not limited to a single discipline but are drawn from various contexts relevant to the subject matter being taught. Small groups are formed to ensure effective, integrated, and comprehensive learning, where students are given the freedom to formulate problems and manage solutions independently. PBL also helps students develop skills in arguing, communicating, and collaborating in groups to share ideas and solve problems (Ari & Katranci, 2014; Heong et al., 2020; Lonergan et al., 2022).

PBL emphasizes student-centered learning, where students are involved in problem analysis, goal setting, resource gathering, as well as synthesizing ideas and reflecting on problem-solving. Thus, PBL not only develops problem-solving skills but also fosters students' ability to respond to complex and realistic situations in the real world (Chueh & Kao, 2024; Kang & Lee, 2023).

The characteristics of PBL according to Barrows (1996) include: 1) Student-Centered Learning, 2) Learning Occurs in Small Student Groups, 3) Teachers as Facilitators or Guides, 4) Problems Form the Organizing Focus and Stimulus for Learning, and 5) New Information is Acquired Through Self-Directed Learning.

The PBL model has both strengths and weaknesses that need to be considered. The strengths of PBL include providing challenges for students to discover new knowledge, facilitating the transfer of knowledge in the context of real-life problems, and training problem-solving and critical thinking skills. Furthermore, difficulties faced by students in individual learning can be addressed through group work using a peer-teaching approach. However, PBL also has some drawbacks, such as the significant time required for lesson preparation and difficulties in task distribution in classrooms with diverse student ability levels (Sari & Rahadi, 2014).

The steps of the Problem-Based Learning (PBL) model, according to Arends (2012), are outlined in **Table 1.**

| PBL Phase | Teacher Behavior |
|---|---|
| Phase 1: Introducing Students to the Problem | The teacher explains the lesson objectives and motivates students to engage in problem-solving activities. |
| Phase 2: Organizing Students for Learning. | The teacher assists students in defining and organizing learning tasks related to the problem. |

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| Phase 3: Supporting Independent and Group Investigation. | The teacher encourages students to gather relevant information, conduct experiments, and seek explanations and solutions. |
| Phase 4: Developing and Presenting the Work. | The teacher assists students in planning and preparing appropriate work, such as reports, videos, and models, and supports them in sharing their work with others. |
| Phase 5: Analyzing and Evaluating the Problem-Solving Process. | The teacher helps students reflect on their investigation and the process they used. |

Shoimin (2014, p. 131) also outlines the steps of the Problem-Based Learning model into five stages: 1) The teacher explains the learning objectives, clarifies the required logistics, and motivates students to engage in the problem-solving activity that has been set 2) The teacher helps students define and organize learning tasks related to the problem (setting the topic, tasks, schedule, etc.) 3) The teacher encourages students to gather relevant information, conduct experiments to find explanations and solutions, collect data, formulate hypotheses, and solve problems 4) The teacher supports students in planning and preparing appropriate work, such as reports, and helps them share tasks with their peers 5) The teacher helps students reflect on or evaluate their investigation and the processes they used.

After outlining the implementation of Problem-Based Learning (PBL), it is important to understand how metacognitive strategies can strengthen this learning process. Wilson & Conyers (2016) state that the core of metacognition is the reflective process. Questions that students may ask during the reflective process include: What is the problem that needs to be solved? What should I do? How well am I doing? What could I do differently and better next time? Teachers who apply metacognitive strategies in their teaching need to guide students to become independent learners, which will facilitate the achievement of learning objectives.

Metacognitive strategies help students become aware of their cognitive abilities and actively manage their thinking process during learning. These strategies involve three main stages: planning, monitoring, and evaluation. Planning includes setting goals and selecting the strategies to be used, as well as managing time effectively to complete tasks. Monitoring involves checking comprehension and learning progress, such as through self-testing and asking critical questions. Evaluation focuses on analyzing results and performance after tasks are completed, including reflecting on the learning process. Overall, metacognitive strategies enable students to organize and evaluate their learning processes more effectively, which can enhance their understanding and ability to solve problems independently (Albalhareth & Alasmari, 2023; Muijs & Christian Bokhove, 2020; Veenman et al., 2006; Zhang & Lian, 2024).

In terms of its application, Hartman (2001) identifies four key actions that students engage in when using metacognitive strategies: 1) identifying the given task; 2) determining an initial approach to the task; 3) monitoring available information using knowledge management skills and insight techniques; and 4) evaluating the work, effectiveness, and efficiency employed to complete the task.

This strategy involves students asking themselves or their peers questions about the activities they are engaged in. According to Wilson & Conyers (2016), metacognitive checking can be done by asking questions such as: "How does metacognition help me learn better?", "Are there any study habits I can improve when preparing for this exam?", or "Is there another way to understand this problem and find its solution?".

The selection of strategies in a teaching model needs to consider their advantages. Research by Syahbana (2013) shows that the application of metacognitive strategies in mathematics education enhances mathematical understanding skills, including restating concepts, applying algorithms, providing examples and non-examples, presenting various mathematical representations, and connecting mathematical concepts. Research by Lestari et al. (Lestari et al., 2019) also reveals that metacognitive strategies support students' mathematical communication skills by enhancing thinking awareness, including designing, monitoring, and controlling the learning process. This positively influences students' mathematical communication abilities. In addition, Aleven & Koedinger (2002) suggest that metacognitive strategies improve students' understanding and engagement in learning.

Metacognitive strategies play a crucial role in training students to think at higher levels, as well as in planning, managing, and reflecting on their learning activities (Sunanto & Asyiah, 2018). The implementation of these strategies helps students gain deeper and more lasting learning experiences and understanding. Research by Maulana (2017) shows that students' problem-solving abilities improved after using metacognitive strategies, as these strategies train learning awareness, planning, monitoring, and reflection. Additionally, research by Prasetyoningrum & Mahmudi (2017) also proves that metacognitive strategies are effective in mathematics education, particularly in enhancing students' mathematical problem-solving abilities.

Based on the opinions of several experts and research findings that highlight the benefits of applying metacognitive strategies in learning, this article aims to provide a deeper

understanding of what metacognitive strategies are and how they can be implemented within the Problem-Based Learning (PBL) model. Through practical implementation, this article demonstrates how metacognitive strategies can strengthen the learning process in PBL, enhance student comprehension, and support independent problem-solving skills.

To clarify how metacognitive strategies are applied in Problem-Based Learning (PBL), the following detailed explanation connects theory with practical implementation in the classroom. The following tables will outline the steps for implementing metacognitive strategies in each phase of PBL, from planning to evaluation, as well as how teachers and students can collaborate in this reflective process. These tables provide a clear overview of how metacognitive strategies can strengthen student engagement in the learning process, enhance their understanding, and facilitate them in thinking more critically and independently when solving problems.

**Table 2. Concepts and Their Relationships**

| Concept | Definition | Relationship with the Learning Process |
|---|---|---|
| Problem-Based Learning | Problem-based learning model encourages students to find solutions independently, using group learning as a collaborative tool. | PBL encourages students to think critically and analytically in solving real-world problems. |
| Metacognitive Strategy | A strategy that teaches students to be aware of and regulate their thinking processes during learning. | Metacognition helps students plan, monitor, and evaluate the problem-solving process. |

**Table 3. The Role of Metacognitive Strategies at Each Stage of PBL**

| Stages of PBL | Role of Metacognitive Strategies | Examples of Metacognitive Questions |
|---|---|---|
| Phase 1: Introducing Students to the Problem | Helps students understand the problem and design an approach to solve it. | What do you already know about this problem?<br>In your opinion, what information still needs to be gathered?<br>How do you plan the initial steps to understand this problem? |
| Phase 2: Organizing Students for Learning. | Supports students in selecting the best strategy to solve the problem. | What is the first step your group will take to solve this problem?<br>What strategy do you think will be most effective to begin the research?<br>How will you divide the tasks within the group? |
| Phase 3: Supporting Independent and Group Investigation. | Ensuring that students monitor the effectiveness of their strategies and make adjustments as needed. | Have you understood the information you have gathered?<br>What challenges have you encountered so far?<br>How will you adjust your strategy if you face difficulties? |
| Phase 4: Developing and Presenting the Work. | Helping students evaluate the quality of solutions and consider their validity. | What is the aspect of this work that you are most proud of?<br>How will you present the solution clearly to your peers?<br>If there were more time, what would you like to improve? |
| Phase 5: Analyzing and Evaluating the Problem-Solving Process. | Guiding students to reflect on their learning process and improve strategies for future learning. | What valuable lessons did you learn from this process? |

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| | | Did the time and task distribution go as planned?<br>What would you change in the next task for better results? |

**Table 4. Syntax of Implementing Metacognitive Strategies in the Problem-Based Learning Model**

| PBL Stages | Metacognitive Strategies | Implementation of Metacognitive Strategies | Student Activities | Teacher's Role |
|---|---|---|---|---|
| Phase 1: Introducing Students to the Problem | Planning: Activating prior knowledge and planning problem-solving strategies. | Students are asked to plan how they will solve the problem, considering the knowledge they already have and what they need to learn. | Identifying the problem, determining the initial information available. | Guiding students to understand the problem, asking guiding questions to trigger critical thinking. |
| Phase 2: Organizing Students for Learning | Planning and Monitoring: Designing the steps to be taken to solve the problem. | Students create a learning plan, determine the necessary steps, and choose the appropriate strategies to gather information and solve the problem. | Designing problem-solving strategies; selecting information sources. | Organizing students into groups, providing relevant learning materials and resources. |
| Phase 3: Supporting Independent and Group Investigation. | Monitoring: Ensuring understanding during the investigation process, tracking learning progress. | Students self-monitor their investigation process, ensuring that they follow the plan they created and evaluate the effectiveness of the strategies used. | Collecting data, verifying information, and monitoring the progress of the group work. | Providing guidance without excessive intervention, directing students to reflect on their problem-solving steps. |
| Phase 4: Developing and Presenting the Work. | Evaluation: Analyzing the results of the investigation and evaluating the quality of the solutions found. | Students evaluate their work by reflecting on the process they followed and comparing the results with the initial goals they had set. | Evaluating the solutions found and presenting the results of the problem-solving process. | Providing feedback on the solutions proposed by students; motivating students to consider alternatives. |
| Phase 5: Analyzing and Evaluating the Problem- | Evaluation and Reflection: Assessing the thinking process | Students reflect on the learning process they underwent, evaluate the success of the strategies | Reflect on the learning process, identify effective | Guide students to reflect on the problem-solving process and the |

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| Solving Process. | and deciding on improvements for future learning. | applied, and plan improvements if necessary. | strategies, and address weaknesses for future learning. | outcomes achieved; emphasize the importance of metacognitive strategies. |

Overall, the results obtained indicate that the implementation of metacognitive strategies in problem-based learning has a positive impact on students' ability to plan, monitor, and evaluate the problem-solving process. These findings strengthen the understanding of the importance of implementing metacognitive strategies to improve the quality of learning.

## CONCLUSION

Based on the findings obtained from the analysis of the implementation of metacognitive strategies in problem-based learning, it can be concluded that the application of this strategy is effective in helping students enhance their critical thinking and problem-solving skills. By involving students in the metacognitive reflection process, they can develop the ability to plan, monitor, and evaluate the steps taken in solving problems.

Furthermore, the research results indicate that the implementation of metacognitive strategies positively contributes to group learning, where students not only learn from individuals but also collaborate in finding more comprehensive solutions. This collaborative process enhances communication and problem-solving skills in a more holistic manner.

It is important to note that the success of this strategy's implementation heavily relies on the role of educators in facilitating and guiding students through the metacognitive stages. Therefore, training for educators in implementing metacognitive strategies in problem-based learning is highly recommended to improve learning effectiveness.

As a recommendation, it is crucial to consider the context and characteristics of students when designing and applying this strategy. Future research is expected to further explore variations in the implementation of metacognitive strategies for different subjects or learning contexts, as well as test its long-term effectiveness.

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