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# Metacognitive in Learning: Conceptual, Instructional Strategies, and Assessment

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**Abstrak**
Metacognition development plays an important role in improving the quality of 21st century learning. This article aims to comprehensively review three main aspects of metacognition in education, namely: conceptual clarification, instructional strategies, and assessment approaches. This study uses a literature review method with thematic analysis of ten articles from reputable journals. The results of the study indicate that metacognition consists of two main dimensions: metacognitive knowledge (declarative, procedural, and conditional) and metacognitive regulation (planning, monitoring, controlling, evaluating). Effective metacognitive learning strategies include explicit (self-testing, reflection prompts) and implicit (collaborative discussion, epistemic tools) approaches. On the other hand, metacognitive assessment needs to be developed from self-report to performance-based assessment and real-time monitoring for more contextual results. This study concludes that the integration of conceptual understanding, teaching strategies, and metacognitive assessment is essential in designing reflective and adaptive learning. These findings provide a theoretical and practical basis for teachers, researchers, and curriculum developers in implementing metacognition-based learning in a comprehensive.

Keywords: metacognition; metacognitive strategies; metacognitive assessment; reflective learning

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## INTRODUCTION

The development of metacognition has become a major focus in education because of its significant role in supporting independent, reflective, and adaptive learning. In the context of 21st century learning, metacognitive skills not only support improved academic performance, but also contribute to students' readiness to face complex and dynamic challenges outside the classroom (Stanton et al., 2021). The ability to be aware of, monitor, and regulate one's own thinking processes is an essential foundation of effective learning.

Conceptually, metacognition refers to knowledge and regulation of one's own cognitive processes. Flavell (1979), as a major pioneer, categorizes metacognition into two dimensions: metacognitive knowledge and metacognitive regulation or experience. Metacognitive knowledge includes understanding of self, tasks, and strategies, while metacognitive regulation involves planning, monitoring, and evaluating skills in the learning process. These dimensions are also further developed in a framework that includes declarative, procedural, and conditional awareness (Livingston, 1997). On the other hand, Stanton et al., (2021) emphasized that metacognition includes the conscious process of choosing learning strategies, evaluating their effectiveness, and making adjustments based on learning outcomes.

However, in its implementation, there are a number of fundamental problems. First, there is still conceptual confusion among educators and researchers regarding the definition and scope of metacognition, especially in distinguishing it from other terms such as self-regulated learning or epistemic cognition (Tang, 2020). Second, learning strategies designed to foster metacognition are often unsystematic, fragmented, and not integrated into the learning design (Li & Yuan, 2022). Third, the metacognitive assessment approach used is generally limited to self-report instruments and is not fully capable of capturing students' metacognitive dynamics in complex and authentic learning situations (Zeng et al., 2023).

In response to these problems, various solutions have been offered. Stanton et al. (2021) proposed a reflection-based teaching approach and explicit strategies in guiding students to develop learning awareness. Meanwhile, a structured collaborative activity-based approach has been shown to be effective in increasing students' metacognitive engagement (Li & Yuan, 2022). In addition, real-life activity-based assessment approaches such as the use of exam wrappers, learning journals, and observation protocols have also been applied to measure metacognitive development more authentically (Ratnayake et al., 2023). Although there are various studies discussing metacognition development strategies and assessment methods, there is still a research gap in the integration between conceptual clarification, instructional strategies, and assessment approaches in a single framework. Many studies only focus on one aspect without explaining its relationship to other aspects. In addition, the relationship between metacognition and motivational factors such as task value and self-efficacy is also not fully understood, especially in the context of technology-based learning or open environments (Zhang et al., 2022).

Therefore, this article aims to comprehensively examine the development of metacognition in learning with three main focuses: (1) conceptual clarification of metacognition and its components, (2) exploration of effective teaching strategies to foster metacognitive skills, and (3) review of accurate and contextual assessment approaches to measure students' metacognitive development. By uniting these three aspects in one integrated framework, this article is expected to provide theoretical and practical contributions in the development of metacognition-based learning designs.

The urgency of this research lies in the need to strengthen students' abilities in learning independently, reflectively, and sustainably, which not only impacts academic achievement but also the development of lifelong learner character. In an increasingly digitalized world, metacognition is a crucial skill in managing information, making decisions, and facing complex challenges adaptively and responsibly (Urban et al., 2021).

## RESEARCH METHOD

This study uses a descriptive qualitative approach with a literature review method to examine the development of metacognition in learning from three main perspectives: (1) conceptual clarification, (2) instructional strategies, and (3) assessment approaches. This study does not aim to test hypotheses, but rather to critically synthesize findings and thoughts from previous studies in order to build a comprehensive integrated theoretical framework.

The articles analyzed in this study are scientific works published in reputable international journals. All articles are primary publications and have gone through a peer-review process. The main focus of source selection is on articles that explicitly discuss metacognition, both from theoretical, practical, and assessment aspects, in the context of formal education, especially science education and higher education.

The analysis process was carried out using the content analysis approach (Mayring, 2022) and thematic analysis (Braun & Clarke, 2006), which allows the identification of conceptual patterns and thematic synthesis from various sources of academic documents (Bowen, 2009). The analysis process was carried out in 4 stages. The first stage is document inventory. At this stage, the researcher collected 10 main articles from reputable journals that are relevant to the topic. Articles were obtained from manual selection based on their relevance and academic authority. The second stage is thematic coding, namely all articles were read in depth, then coded thematically using a content analysis approach. The main themes developed include: definitions and dimensions of metacognition, forms of metacognitive teaching strategies, and assessment techniques and instruments used.

The third stage is critical analysis and conceptual synthesis. Researchers analyze similarities and differences between articles, evaluate the strengths and limitations of each approach, and identify gaps and potential integration between dimensions of metacognition. The results of the analysis are used to formulate an integrated conceptual framework that describes the relationship between conceptual dimensions, learning strategies, and metacognition assessments. The final stage is interpretative validation. To maintain the validity of conceptual arguments, the interpretation results are cross-checked with classical theoretical foundations such as the model (Flavell, 1979), and the frameworks of (Schraw & Dennison, 1994) and (Livingston, 1997).

## RESULT AND DISCUSSION

### Conceptual

Understanding the internal structure and function of metacognition needs to be emphasized and distinguished from other overlapping concepts in order to develop metacognition effectively in educational practice. Many experts have defined metacognition. Flavell is one of the early experts who discussed metacognition. In 1979 Flavell published a model called cognitive effort monitoring which was later considered metacognition. According to this model, cognitive effort monitoring takes place through actions and interactions between metacognitive knowledge, metacognitive experience, goals/tasks, and actions/strategies. It can be said that Flavell provides a definition of metacognition oriented towards the dimensions that build it. After analyzing the opinions of experts afterward, it was found that the goal/task dimension and the action/strategy dimension were no longer emphasized as a dimension, but the 2 dimensions were included in the knowledge and regulation dimensions. An in-depth analysis of the dimensions of metacognition will be discussed after discussing the definition.

According to Hacker (1998), metacognition is knowledge about knowledge and cognitive processes, and one's mental state, and the ability to monitor and regulate them. Meanwhile, Livingston (1997) argues that metacognition is a high-level thinking ability that involves active control over the cognitive processes involved in one's learning. In line with the previous 2 experts, According to Schraw & Dennison (1994) metacognition refers to the ability to reflect, understand, and control one's learning. Metacognition consists of 2 dimensions, namely the dimensions of knowledge and regulation (Flavell, 1979; Livingston, 1997; Schraw & Dennison, 1994; Urban et al., 2021). Metacognitive knowledge means the knowledge that a person has about people as cognitive processors, and with their various cognitive tasks, goals, actions, and experiences. Metacognitive knowledge according to Flavell (1979), has 3 aspects, namely people, tasks, and strategies.

People, namely general knowledge about how humans learn and process information, as well as individual knowledge about their learning processes (Livingston, 1997). In this case, people are divided into 3, namely: 1) intraindividual (that you can learn most things better by listening than reading), 2) interindividual (that one of your friends is more socially sensitive than others), and 3) universality of cognition, they can learn that there are different levels and types of understanding (paying attention, remembering, communicating, solving problems, and so on. Tasks, namely knowledge about the nature of the task and the types of processing demands that will be imposed on the individual. Children will learn that some cognitive efforts are more demanding and difficult than others, even with the same available information. For example: someone might realize that (1) it is easier to remember the gist of a story than the actual words (Flavell, 1979), (2) reading and understanding science texts takes longer than novels (Livingston, 1997).

Strategy is knowledge about cognitive and metacognitive strategies, and conditional knowledge about when and where to use them (Livingston, 1997). For example, a child will begin to believe that a good way to remember or learn is to pay close attention to important/main points and try to repeat them in their own words (Flavell, 1979).

Metacognitive knowledge involves two or three of the above types of variables. For example, you may believe that you (unlike your sibling) should use Strategy A (rather than Strategy B) in Task X (as opposed to Task Y) (Flavell, 1979).

Knowledge is considered metacognitive if it is actively used strategically to ensure that a goal is achieved. For example, a student may use knowledge in planning how to approach a math test: "I know that I (person variable) have difficulty with word problems (task variable), so I will do the computation problems first and save the word problems for last (strategy variable)." Simply having knowledge of one's cognitive strengths or weaknesses and the nature of the task without actively using this information to monitor learning is not metacognitive (Livingston, 1997).

According to Schraw & Dennison (1994) and Urban et al. (2021), metacognitive knowledge consists of 3 aspects, namely: declarative knowledge (knowledge about oneself and about strategies), procedural knowledge (knowledge about how to use strategies), and conditional knowledge (knowledge about when and why to use strategies).

Metacognitive regulation (Livingston, 1997; Schraw & Dennison, 1994; Urban et al., 2021) is also called metacognitive strategy (Li & Yuan, 2022) or metacognitive experience (Flavell, 1979). Metacognitive regulation is a sequential process (planning, monitoring, and checking results) that a person uses to control cognitive activities, and to ensure that cognitive goals have been achieved (Livingston, 1997). Meanwhile, according to (Flavell, 1979), metacognitive experience is a cognitive or affective experience that accompanies intellectual activity. Example: the feeling when we suddenly cannot understand what someone else is saying. Metacognitive experiences are most likely to occur in situations that stimulate a lot of careful and highly conscious thinking. The impact of metacognitive experiences is that they can lead you to set new goals and revise or abandon old goals and affect your metacognitive knowledge base by adding, deleting, or revising them.

Next, we discuss cognitive strategies and metacognitive strategies. Cognitive strategies are used to help individuals achieve specific goals (e.g., understanding a text) while metacognitive strategies are used to ensure that goals have been achieved (e.g., testing oneself to evaluate one's understanding of the text) (Livingston, 1997).

Metacognitive strategies can activate strategies aimed at one of two types of goals, cognitive or metacognitive (Flavell, 1979). As an example of the former, you feel (a metacognitive experience) that you don't understand a particular chapter in your text well enough to pass your exam tomorrow, so you read it again (a cognitive strategy, which is aimed at the straightforward cognitive goal of simply improving your knowledge). As an example of the latter, you wonder (a metacognitive experience) whether you understand the chapter well enough to pass the exam tomorrow, so you try to find out by asking yourself questions about it and noting how well you can answer them (a metacognitive strategy, which is aimed at the metacognitive goal of assessing your knowledge, and thus, generating other metacognitive experiences). Cognitive strategies are used to make cognitive progress, metacognitive strategies are used to monitor it.

Questioning strategies can be considered cognitive or metacognitive strategies, depending on the purpose of using the strategy. For example, you can use the strategy of asking yourself questions while reading as a means of gaining knowledge (cognitive), or as a way to monitor what you have read (metacognitive). Attempting to test one without acknowledging the other will not provide an adequate picture (Livingston, 1997).

Metacognitive experiences will drive metacognitive strategies. Metacognitive experiences usually precede or follow cognitive activities. An example of metacognitive following cognitive is when someone does not understand what they have just read. Such an impasse is believed to activate metacognitive processes as the learner tries to improve the situation (Livingston, 1997).

According to Livingston (1997)., metacognitive regulation consists of 5 aspects, namely: 1) planning, 2) information management strategies, 3) monitoring understanding, 4) debugging strategies, 5) evaluation. Meanwhile, according to Urban et al. (2021) metacognitive regulation consists of 4 aspects, namely 1) planning (selection of the right strategy, allocation of study time, and prediction of results), 2) monitoring: assessment of a person's cognitive processes, and 3) control (adaptation or change in related behavior), 4) evaluation (assessment of performance and effectiveness of a person's strategy).

Sternberg (1984) argues that the ability to allocate cognitive resources appropriately, such as deciding how and when a particular task should be completed, is the core of intelligence. Metacognition includes self-regulated learning (SRL) because SRL is the ability of students to actively regulate their own learning process through a series of strategies that include: motivation, learning behavior, and cognitive and metacognitive strategies (Ratnayake et al., 2023).

Stanton et al. (2021) proposed that social metacognition in group work is very important because it allows students to assess each other, provide feedback, and share strategies actively during the complex problem-solving process. By using metacognitive scaffolding designed within the Project Based Learning framework, students engage in structured discussions to explore solutions, compare methods, and evaluate processes collectively. This collaborative process helps them build semantic networks of relevant information, organize ideas systematically, and construct more optimal solutions. This directed social interaction not only increases the tendency for collaboration and problem solving, but also strengthens individual metacognitive regulation in the group context.

**Instructional Strategies**

Individuals can learn how to better regulate their cognitive activities through Cognitive Strategy Instruction. Cognitive Strategy Instruction (CSI) is an instructional approach that emphasizes the development of skills and thinking processes as a means to enhance learning. The most effective approach to metacognitive instruction involves providing knowledge about cognitive processes and strategies (which will be used as metacognitive knowledge) and experience or practice in using cognitive and metacognitive strategies and evaluating the results of their efforts (developing metacognitive regulation). The implication of metacognition is to teach students how to become more aware of the processes and products of their learning and how to regulate those processes for more effective learning (Livingston, 1997).

Li & Yuan (2022) conducted various metacognitive teaching (peer learning, group discussion, self-assessment, and self-reflection) in collaborative classroom conference learning (A classroom-based inquiry) which was designed and organized systematically and progressively (Figure 1).

Research by Zhang et al. (2022) used a computer-based learning application called Betty's Brain (Figure 2). Students learned about scientific phenomena (climate change and thermoregulation), with Betty's teaching strategy (a virtual student). Students created causal maps by accessing hypermedia resource pages about relevant scientific concepts. Students could monitor their causal modeling progress by asking Betty to take graded quizzes or by asking cause-and-effect

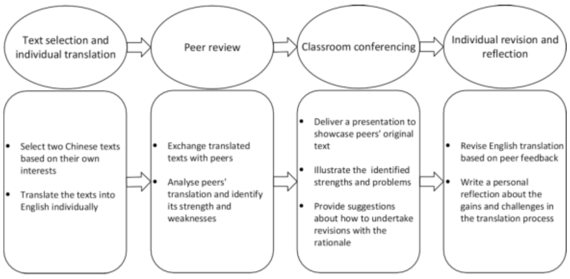


**Figure 1.** Metacognitive classroom-based inquiry teaching (Li & Yuan, 2022)

questions. Students could also ask Mr. Davis as a virtual pedagogical agent who could be asked for help if students did not know how to use the system. In some situations, Mr. Davis could intervene if students had difficulty or were not making progress in the mapping task.

This study operationalized the use of metacognitive strategies as coherent actions because it required students to monitor information generated by previous actions (e.g., viewing quiz results) and adjust current actions (e.g., reading pages) based on the information obtained at 5-minute intervals.

Stanton et al. (2021) proposed several teaching strategies that encourage students' metacognition (Figure 3). The strategies formulated are fully published on the website [https://lse.ascb.org/evidence-based-teaching-guides/student-metacognition/supporting-student-learning-strategies/](https://lse.ascb.org/evidence-based-teaching-guides/student-metacognition/supporting-student-learning-strategies/)

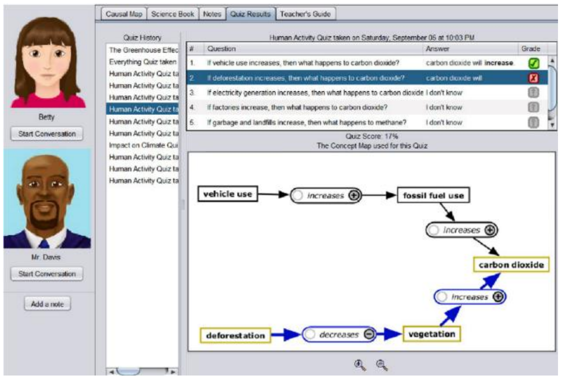


**Figure 2.** Betty's Brain application as a metacognitive strategy (Zhang et al., 2022)

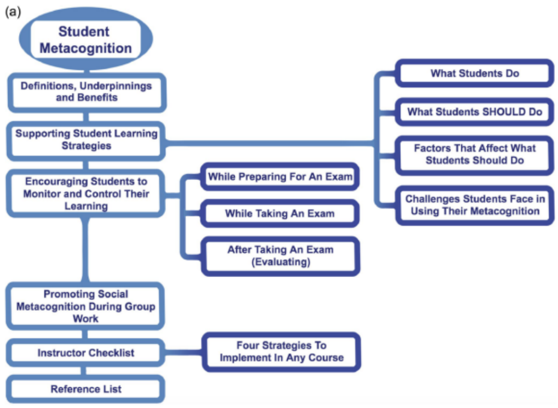


**Figure 3.** Metacognition teaching strategies by (Stanton et al., 2021)

Self-testing is a metacognitive strategy in which students actively test themselves on the material they have learned, without first looking at a book or notes. Examples of this include using flashcards to remember definitions or concepts, answering practice questions without opening the source, or re-explaining material out loud without the help of a text. Self-testing is not just practicing questions, but rather the process of recalling information to form a strong memory network (Stanton et al., 2021).

Spacing is a metacognitive strategy by spreading study sessions for the same topic over several times (days/weeks), rather than all at once (cramming). Examples of this include studying a chapter today, repeating it again two days later, creating a daily study schedule with topic rotation, reviewing the first week's material when it enters the third week. The greater the distance between study sessions, the more effective it is if the material is not yet familiar. Spacing can be combined with self-testing for optimal results (Stanton et al., 2021).

Interleaving is a metacognitive strategy in which students study several topics or types of problems alternately, rather than one type of topic in sequence (blocked practice). Examples of this practice are learning mathematical concept A, then B, then back to A, working on problems from several chapters in one Practice session, in biology, interspersing learning about metabolism, cell structure, and genetics at one time. Although it feels more difficult, interleaving produces more lasting understanding than learning one topic in isolation (Stanton et al., 2021)..

Tang (2020) proposed the use of epistemic tools that support not only epistemic cognition, but also epistemic metacognition, an aspect that has been underexplored in the literature. Premise-Reasoning-Outcome (PRO) as an epistemic tool can be used not only to guide students in constructing scientific explanations cognitively, but also to develop epistemic metacognitive awareness. Metacognition is developed through strategies such as emphasizing the interrelationships between elements in scientific explanations (P-R-O), questions that encourage reflection on one's own thinking process, visualization of key ideas to organize and control the flow of scientific thinking. The teacher's instructional transformation changes from only cognitive modeling to explicit metacognitive instruction. PRO is used as a non-linear structure to guide the flow of scientific explanations reflectively and strategically.

**Assessment**

Metacognitive assessment is a very important but often overlooked aspect of learning. The literature shows that the most commonly used approaches are self-report questionnaires such as the MAI (Metacognitive Awareness Inventory), think-aloud protocols, and written reflections (Schraw & Dennison, 1994; Zeng et al., 2023).

However, the main weakness of self-report-based assessments is the tendency for respondents to be inaccurate in assessing themselves. For this reason, several recent studies have proposed performance-based assessments and online metacognition as more contextual and valid alternatives (Zhang et al., 2022).

Zeng et al. (2023) developed a two-tier instrument to measure students' metacognitive skills in solving chemistry problems. The results showed that although many students were able to monitor their thinking processes, only a small number were able to regulate or correct themselves. This indicates a gap between metacognitive awareness and the ability to apply it in real contexts.

In addition to the diagnostic function, metacognitive assessments also need to be directed to support formative learning. The use of tools such as exam wrappers or post-task reflections has the potential to help students not only become aware of their mistakes but also develop strategies to improve them in the future (Ratnayake et al., 2023; Stanton et al., 2021)

## CONCLUSION

This study confirms that the development of metacognition in the context of learning plays a strategic role in improving the quality of student learning, both in terms of learning awareness, strategic decision-making, and adaptation to complex academic challenges. Based on the literature analysis, metacognition consists of two main dimensions, metacognitive knowledge and metacognitive regulation, each of which plays a role in shaping reflective and independent learners. Metacognitive knowledge includes declarative, procedural, and conditional understanding of the thinking process, while metacognitive regulation includes the skills of planning, monitoring, controlling, and evaluating cognitive processes.

Instructionally, approaches based on explicit strategies (such as self-testing, exam wrappers, and reflection prompts), as well as implicit strategies (such as student collaboration and the use of epistemic tools), have been shown to be effective in stimulating metacognitive processes. Technological innovations such as virtual agent-based learning (e.g. Betty's Brain) also provide new opportunities to embed metacognitive strategies in a coherent and interactive manner. However, the effectiveness of these strategies is highly dependent on structured instructional design and active teacher participation in facilitating learning reflection.

Meanwhile, assessment approaches to metacognition still face conceptual and methodological challenges. Assessments that rely too much on self-report are often inaccurate, so that the development of performance-based assessments and more contextual real-time monitoring is needed. Good metacognitive assessments should be not only summative, but also formative, in order to provide feedback that can guide continuous improvement of students' learning strategies.

Overall, this study contributes to building an integrated conceptual understanding between metacognition dimensions, instructional strategies, and assessment approaches. These findings emphasize the importance of integrating these three aspects in learning design to support students' metacognitive development authentically, sustainably, and adaptively to the challenges of the 21st century. Active involvement of educators, curriculum developers, and researchers is needed in developing metacognition-based learning models that are contextual, applicable, and rooted in strong theoretical understanding.

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