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# Metacognitive Strategy and Science Problem-Solving Abilities in Elementary School Students

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**ABSTRACT:** This research aimed to analyze the effect of metacognitive strategies on elementary school students' problem-solving abilities. This research used an experimental method with a quasi-experimental type of research by comparing two groups, namely the groups taught with metacognitive strategies and non-metacognitive strategies. The research subjects consisted of 100 fifth-grade students of elementary school. They were divided into 50 students in the metacognitive strategy group and 50 students in the non-metacognitive strategy group. The analytical technique was used to compare the two groups statistically. The research results showed differences in problem-solving that were taught by using metacognitive strategies and non-metacognitive strategies. Non-metacognitive strategies were better in problem-solving than metacognitive strategies. Problem-solving that had been done in learning was only focused on results. In conclusion, elementary school students needed assistance in the learning process to monitor their knowledge by providing feedback.

**KEYWORDS:** Metacognitive strategy, problem-solving, cognitive, self-question

## I. INTRODUCTION

Metacognition is a person's awareness to monitor thinking processes through awareness about his knowledge and how his knowledge is used (Jokić & Whitebread, 2011). Awareness in metacognitive is awareness of how a person learns; awareness of when one understands and does not understand; knowledge of how to use available information to achieve goals; the ability to assess the cognitive demands of a particular task; knowledge of what strategy will be used for what purpose; and assessment of one's progress during and after the performance (Gourgey, 2002). Metacognitive strategy is a learning strategy that emphasizes the thinking process. Metacognitive strategies are deeper processing strategies, including planning, monitoring, and regulation, that assist students in controlling and regulating cognition (Pintrich, Smith, Garcia, & McKeachie, 1993). Self-knowledge about cognitive processes includes declarative, procedural, and conditional knowledge in answering questions about what is known, how to think, and when/why to apply knowledge and strategies (Paris, Lipson, & Wixson, 1983).

Elementary school students in metacognitive development differ in age levels. Students at the age of 9 already have good self-monitoring skills, and those aged 11-12 years can solve problems compared to those aged nine years (Roebers, Schmid, & Roderer, 2009). In metacognitive knowledge, children do not explicitly focus on tasks (Kurtz & Borkowski, 1984). Children have limitations in knowledge, cognition or metacognition, and little monitoring in memory (Flavell, 1979). In general, children understand their memory. According to Piaget's theory of development, elementary school children (7-11) are at the Concrete Operational stage. At this stage, children begin to use logical reasoning, have classification skills, have difficulty with abstract problems (Santrock, 2010), can form concepts, solve problems and see relationships as long as they are involved in familiar objects and situations (Slavin, 2005). Before learning metacognitive strategies, elementary school students do not use tactics in planning assignments or solving problems. They do not realize they can use strategies and shortcuts to solve problems. They can use strategies to help them think and remember, evidence that even very young children can have goals in their activities (Wellman, Ritter, & Flavell, 1975). King (1991) explains that the metacognitive strategy used by successful students to monitor their understanding during learning and to ask themselves. Because asking students' selves will form their continuous self-examination to check the level of understanding during learning.

Metacognitive strategies are used in the learning process to help students build concepts through the thinking process. The use of metacognitive strategies in children aims to gain understanding in building knowledge. The use of metacognitive strategies for children is to unite them by asking themselves (self questions). Self-questioning is a metacognitive strategy that helps check students' understanding during the learning process that controls the cognitive processes of their understanding (King, 1991). Metacognitive strategies include planning (do), monitoring, and regulatory strategies (Pintrich, Smith, Garcia, & Mceachie, 1993). Students find problems, choose strategies, organize their thoughts, and predict outcomes in solving problems while making plans.;

Students test, revise, and apply the strategies they have used while monitoring the learning process. Moreover, students control other resources outside of their cognitive, managing their time and environment while using the regulatory strategy.

Effective metacognitive strategies, according to Brown (1982) in (Swanson, 1984) are clarifying goals in reading, being able to identify important aspects of reading, focusing on higher-order ideas, integrating ongoing activities, engaging in self-questioning to determine whether objectives have been achieved, and implement new strategies. Self-questioning and self-monitoring are strategies that support success in problem-solving, and self-monitoring encourages students to integrate and produce learning outcomes through appropriate strategies (Hammouri, 2003). Theoretically, this is an expected result because metacognitive strategies include planning, monitoring, regulating, which assist students in controlling and regulating their cognitions (Pintrich *et al*., 1993). Thus, students who carry out planning activities such as setting reasonable goals, making schedules, and managing the work environment, activities such as self-examination and self-checking, and arranging activities such as reading speed according to the level of reading difficulty and checking material that is not more easily accessible tend to succeed.

Self-questioning is considered a metacognitive strategy because it serves as a form of self-examination that helps students continuously check their understanding during learning; that is, the metacognitive process of self-questioning was used to control the cognitive comprehension process. In addition, metacognitive strategies help students understand that concepts are constructed from perceived regularities in objects or events and that we use language or symbolic labels to define these regularities. Thus, metacognitive strategies lead to understanding how humans construct knowledge and offer practice in constructing valuable claims and value claims about some of the observed regularities of objects and/or events.

## II. METHOD

This research design was experimental research by comparing two groups with The Static-Group Comparison Design. Researchers conducted experiments on two groups. One group was treated using a metacognitive method, and another group was treated with a learning method usually carried out by the teacher. The research subjects were 100 fifth-grade students of elementary school, in which 50 students in the experimental class and 50 students in the control class. The subject of this research was selected based on purposive sampling with a homogeneity strategy of research subjects. Data analysis was calculated statistically by comparing two groups, experimental and control

## III. RESULT AND DISCUSSION

The results showed differences in problem-solving abilities between students who learned with metacognitive and non-metacognitive strategies (Table 1). Students who were taught with non-metacognitive strategies had better problem-solving abilities than students with metacognitive strategies. Students who were taught using non-metacognitive strategies get an average of 36.70, while students who were taught using metacognitive strategies got an average of 35.28. Based on the data analysis with independent sample t-test (Table 2) showed sig. 0.011 (< 0.05), it can be concluded that there were differences in students' problem-solving abilities who were taught with metacognitive and non-metacognitive strategies for elementary school.

Metacognitive processes focus on self-awareness of cognitive knowledge deemed necessary for practical problem solving, and they direct and regulate cognitive processes and strategies during problem-solving (Brown, 1978). Thus, it is a successful problem solver, consciously or unconsciously (depending on task demands), which uses self-instruction, self-questioning, and self-monitoring to gain access to strategic knowledge, guide strategy execution, and regulate strategy use and problem-solving performance.

**Table 1. Group Statistics**

| | Problem_Solving | |
|---|---|---|
| | Learning_Strategy | |
| | Metacognitive Strategy | Non Metacognitive Strategy |
| N | 50 | 50 |
| Mean | 35,28 | 36,70 |
| Std. Deviation | 2,886 | 2,581 |
| Std. Error Mean | ,408 | ,365 |

**Table 2. Independent Samples Test**

| | | Problem_Solving | |
|---|---|---|---|
| | | Equal variances assumed | Equal variances not assumed |
| Levene's Test for Equality of Variances | F | ,984 | |
| | Sig. | ,324 | |

| | | | | |
|---|---|---|---|---|
| t-test for Equality of Means | T | | -2,593 | -2,593 |
| | Df | | 98 | 96,806 |
| | Sig. (2-tailed) | | ,011 | ,011 |
| | Mean Difference | | -1,420 | -1,420 |
| | Std. Error Difference | | ,548 | ,548 |
| | 95% Confidence Interval of the Difference | Lower | -2,507 | -2,507 |
| | | Upper | -,333 | -,333 |

Students, in elementary school age, solve a wide variety of problems ranging from textbook problems, mostly well-structured problems characterized by a clear starting state, a known goal, and a set of rules and principles to be solved, to everyday problems that mostly require many trouble solutions, multiple solution paths, or no solutions at all (Jonassen, 2004; Kitchner, 1983 in Lee, Teo, & Bergin, 2009). In the daily problem-solving process, children need metacognitive because problem-solving is very varied, and the criteria for success depend on how students explain and reconcile solutions. Monitoring activities in metacognitive strategies provide students with an understanding of the extent to which they experience the learning process (Baas, Castelijns, Vermeulen, Martens, & Segers, 2015). In this research, students still required help in monitoring their learning process. In the non-metacognitive strategy in this research, the teacher guided the learning process or external monitoring. Rieser *et al.* (2016) explain that intrinsic motivation factors greatly influence the use of metacognitive strategies. Effective learners will try to track their learning process and assess the use of appropriate strategies for them.

Demircioğlu, Argün, & Bulut (2010) explain that high academic achievement does not require high metacognitive behaviour, and someone who has metacognitive solid is not better than someone who has weak metacognitive. The problem-solving process is possible because it focuses on the results of the problem-solving rather than the process. During the learning process, the teacher still has not made full efforts to develop students' metacognitive. The application of metacognitive strategies, according to Montague (1992), has three functions, namely (1) independent learning; to help students identify problem components before solving problems, (2) asking self-directed by dialogue; means analysis of the method of the problem, and (3) self-monitoring; which encourages students to control process performance. Montague also explains that successful problem solving, consciously or unconsciously, uses self-research, self-questioning, and self-monitoring to gain access to strategic knowledge, guide strategy implementation, and manage strategy use and solve performance problems. Self-research assists students in identifying and directing problem-solving strategies before execution.

Metacognitive strategies for elementary students in their implementation require guidance during the learning process. The ability to monitor knowledge and evaluate understanding is essential for guidance. Changes in the learning strategies used by students require a process of guidance and understanding in the implementation of metacognitive strategies. The monitoring process carried out by students and providing feedback can help in understanding learning (Baas, Castelijns, Vermeulen, Martens, & Segers, 2015).

Metacognition in learning related to problem-solving skills is associated with realistic problem solving (Mayer, 1998). The use of everyday problem solving can help students determine appropriate strategies and make decisions (Lee, Teo, & Bergin, 2009). Children aged nine years and over can distinguish right from wrong (Roebers, Schmid, & Roderer, 2009). Children receiving learning strategies by providing feedback are more successful at retaining and transferring knowledge (Cavanaugh & Borkowski, 1979). The use of metacognitive strategies in science learning in elementary schools has improved student learning outcomes. With this strategy, students can plan activities, self-regulate, and self-management (Akyol, Sungur, & Tekkaya, 2010). Metacognitive strategies can improve students' ability in reading conferences (Houtveen & van de Grift, 2007). The learning process with metacognitive strategies (Gunstone & Northfield, 1994) argues that teachers must be metacognitive and change conceptual in learning.

Monitoring activities provide students with information that helps them to understand where they are in their learning (Wiliam, 2011). Feedback is critical in this regard (Hattie & Timperley, 2007; Nicol & Macfarlane-Dick, 2006; Sadler, 1998). Teacher feedback provides students with an understanding of the gap between their current performance and their intended learning goals. Generating student reflection on teacher feedback in student-teacher dialogue helps students gain metacognitive knowledge about the effectiveness of their learning strategies (Clark, 2012). In addition, facilitating self-assessment improves students' ability to use metacognitive strategies.

Comparing current performance with desired performance produces feedback that assists students in optimizing their learning (Butler & Winne, 1995). Furthermore, after monitoring their learning, students should choose and implement strategies to approach their goals (Sadler, 1989). Therefore, an assessment to promote and monitor learning is necessary but not sufficient.

## IV. CONCLUSION

The acquisition of problem-solving skills for elementary school students requires continuous guidance by teachers. This research showed that students who were taught non-metacognitive got better results compared to the metacognitive strategy. Therefore, applying metacognitive strategies to elementary school students was necessary to guide students in their thinking process. In addition, providing feedback for elementary school students was very helpful in monitoring their knowledge. Hopefully, future research will take a longer time to find out more about the impact.

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