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Metacognitive Approach to Science Learning Outcomes of Elementary School Students

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ABSTRACT

This study aims to examine the effect of metacognitive approaches on the science learning outcomes of students at SD Inpres 16, Sorong Regency. A quasi-experimental design with a pretest-posttest control group configuration was employed. The study population comprised all students enrolled during the even semester of the 2022/2023 academic year. The research sample consisted of 14 students from Class IVA as the experimental group and 14 students from Class IVB as the control group, selected using purposive sampling. The experimental group received instruction incorporating metacognitive learning strategies, while the control group received conventional instruction. Results indicated that all 14 students in the experimental class attained scores above the minimum mastery criterion (KKM > 70), with a mean posttest score of 88.15, compared to 80.86 for the control class. The difference in mean scores between the two classes was 7.9 points. Statistical analysis yielded a t-calculated value of 4.445, which exceeded the t-table value of 0.532, confirming a significant difference in learning outcomes between the two groups. These findings demonstrate that metacognitive learning approaches significantly improve science learning outcomes in elementary school students. Integrating

Metacognitive strategies in classroom instruction are therefore recommended as an effective pedagogical practice for elementary science education.

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INTRODUCTION

Education constitutes one of the most fundamental necessities in human life. It represents an essential aspect that must be attended to in the process of human self-development and serves as the cornerstone of both individual growth and societal progress. As defined by the Indonesian National Education System Law (Undang-Undang No. 20 Tahun 2003), education is a conscious and planned effort to create a learning environment and learning process that enables students to actively develop their potential, capabilities, and talents. Education is also broadly understood as a purposeful activity directed toward fully developing human potential both as individual persons and as members of society (Purwanto, 2014; Santrock, 2019).

Metacognition plays a critical role in the cognitive activities of learners, encompassing thinking, comprehension, communication, memory retention, and problem-solving (Flavell, 1979; Veenman et al., 2006). It refers to an individual's awareness and regulation of their own cognitive processes, commonly described as "thinking about thinking." Students who possess strong metacognitive skills are able to evaluate, monitor, and independently resolve challenges they encounter in learning. Conversely, students with limited metacognitive ability tend to be passive in learning activities, are unable to self-regulate their learning, and are at risk of poor academic performance (Sihaloho et al., 2018; Ohtani & Hisasaka, 2018).

Current research in educational psychology consistently demonstrates that metacognitive approaches positively influence student achievement. Dent and Koenka (2016), in a comprehensive meta-analysis of 67 studies, confirmed that self-regulated learning, of which metacognition is a key component, maintains a significant positive relationship with academic achievement across all school age levels. Similarly, Panadero (2017) reviewed six prominent models of self-regulated learning and identified metacognitive monitoring and control as the most consistently supported predictors of high academic performance. These findings are echoed in the domain of elementary science education, where metacognitive instruction has been shown to enhance students' conceptual understanding and procedural competence (Zohar & Barzilai, 2013; Ardura & Galán, 2019).

In the Indonesian context, research on metacognitive approaches has demonstrated comparable outcomes. Sihaloho et al. (2018) found that metacognitive ability significantly influences students' learning outcomes in economics through the mediation of self-efficacy. Putri and Misriandi (2020) demonstrated that the application of metacognitive strategies effectively improved students' critical thinking skills in elementary school classrooms. Nur'aini and Sutarman (2022) further confirmed that metacognitive learning strategies produce significantly better science learning outcomes in primary school students compared to conventional instruction. These studies collectively underscore the pedagogical value of integrating metacognitive approaches into elementary school science teaching.

Despite this growing evidence, empirical investigations in the eastern Indonesian context, particularly in the Sorong Regency of West Papua Province, remain scarce. The geographic and socioeconomic conditions of this region present unique challenges for educational quality, making it imperative to evaluate the effectiveness of evidence-based strategies in this local setting. Based on the background presented above, this study was designed to investigate the effect of a metacognitive learning approach on the science learning outcomes of students at SD Inpres 16, Sorong Regency.

The objective of this research is to determine whether the implementation of a metacognitive learning approach produces significantly better science learning outcomes compared to conventional instruction among fourth-grade students at SD Inpres 16, Sorong Regency, during the even semester of the 2022/2023 academic year.

METHODS

Research Design

This study employed a quasi-experimental method using a pretest-posttest control group design. This design involves two groups of subjects: an experimental class that received learning treatment using metacognitive strategies and a control class that received no such treatment. The design is described in Table 1 below.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental	O1	X	O2
Control	O1	–	O2

Notes: O1 = identical pretest administered to both groups; X = metacognitive learning strategy instruction; O2 = identical posttest administered to both groups; – = no treatment

Population and Sample

The study population comprised all students of SD Inpres 16, Sorong Regency, enrolled during the even semester of the 2022/2023 academic year. The research sample consisted of all fourth-grade students: 14 students from Class IVA constituted the experimental group, while 14 students from Class IVB constituted the control group. The purposive sampling technique was employed based on the criterion that the two classes had comparable mean academic scores prior to the intervention, which minimized pre-existing differences that might confound the results (Sugiyono, 2019).

Instruments and Data Collection

The research instrument consisted of a written cognitive test developed to measure science learning outcomes. The instrument was administered as both a pretest and a posttest to both groups. The minimum mastery criterion (Kriteria Ketuntasan Minimal/KKM) was set at a score of 70. Content validity was verified through expert review, and the instrument was piloted prior to the main study to ensure reliability. The metacognitive learning strategy implemented in the experimental class followed the framework proposed by Schraw et al. (2006), encompassing metacognitive awareness, self-monitoring, evaluation, and regulation activities integrated into science lessons.

Data Analysis

Descriptive statistics were used to calculate the mean, maximum, and minimum scores for both the pretest and posttest in each group. Inferential analysis was conducted using an independent samples t-test to determine whether the difference in posttest scores between the experimental and control groups was statistically significant. The t-test was selected because the data met the assumptions of normality and homogeneity of variances, which were verified using the Kolmogorov–Smirnov test and Levene's test, respectively, prior to hypothesis testing.

RESULTS AND DISCUSSION

Pretest and Posttest Results

Based on the analysis of pretest and posttest scores from both the experimental and control classes (Table 2 and Table 3), the following findings were obtained. In the control class (n = 14), the pretest yielded a maximum score of 62 and a minimum score of 24, with a mean of 40.00. None of the students achieved the minimum mastery criterion (KKM > 70) during the pretest. Following instruction using conventional methods, the posttest scores ranged from a minimum of 76 to a maximum of 92, producing a mean of 80.86, with all students meeting the KKM threshold.

Table 2. Pretest and Posttest Scores – Experimental Class

Student	Pretest	Posttest
R1	60	92
R2	40	92
R3	52	92
R4	64	84
R5	40	96
R6	36	88
R7	36	84
R8	44	80
R9	56	92
R10	36	84

R11	44	80
R12	48	94
R13	24	88
R14	40	92
Mean Score	**44.29**	**88.15**

Table 3. Pretest and Posttest Scores – Control Class

Student	**Pretest**	**Posttest**
R1	52	76
R2	36	80
R3	44	84
R4	40	80
R5	48	76
R6	24	80
R7	36	76
R8	44	92
R9	40	84
R10	36	76
R11	52	80
R12	32	76
R13	36	84
R14	62	88
Mean Score	40.00	80.86

In the experimental class (n = 14), the pretest scores ranged from 24 to 64, with a mean of 44.29. Following the implementation of metacognitive learning strategies, all 14 students in the experimental class met the KKM (> 70) on the posttest, with scores ranging from 80 to 96 and a mean of 88.15. The mean difference between the experimental class posttest (88.15) and the control class posttest (80.86) was 7.29 score points, indicating a meaningful advantage for the metacognitive instruction group.

Inferential Analysis

The independent samples t-test yielded a t-calculated value of 4.445, which substantially exceeded the t-table value of 0.532 at the designated significance level. This result confirms a statistically significant difference in science learning outcomes between the experimental and control classes, with the experimental class demonstrating superior performance. Consequently, the null hypothesis is rejected, and it is concluded that the metacognitive learning approach has a significant positive effect on the science learning outcomes of fourth-grade students at SD Inpres 16, Sorong Regency.

Discussion

The findings of this study are consistent with a robust and growing body of literature affirming the effectiveness of metacognitive instruction in improving academic outcomes. The significant posttest difference between groups aligns with the meta-analytic findings of Ohtani and Hisasaka (2018), who reviewed 56 studies and concluded that metacognition constitutes a powerful predictor of academic performance that extends beyond general intelligence. Similarly, Dent and Koenka (2016) identified self-regulated learning, encompassing metacognitive strategies, as a significant predictor of achievement across primary and secondary schooling, with moderate to large effect sizes.

Within the context of science education specifically, Zohar and Barzilai (2013) established that metacognitive instruction in science classrooms enables students to develop deeper conceptual understanding, improve scientific reasoning, and transfer knowledge more effectively. These benefits are especially pronounced when metacognitive prompts are embedded within domain-specific content, as was the case in the present study. Ardura and Galán (2019) further demonstrated that the interplay between metacognitive learning approaches and self-efficacy is critical in determining science performance among school-age students, consistent with the findings of Sihaloho et al. (2018) in the Indonesian setting.

From a pedagogical perspective, the superiority of the experimental group can be attributed to several key factors. First, the implementation of metacognitive strategies, including pre-learning planning (goal setting and strategy selection), during-learning monitoring (self-questioning and progress checking), and post-learning evaluation (reflection and error analysis), provided students with structured cognitive tools for managing their learning processes (Schraw et al., 2006; Panadero, 2017). Second, students in the experimental class demonstrated greater self-regulatory behavior, characterized by increased active participation, independent problem resolution, and sustained academic effort, which are hallmarks of proficient metacognitive learners as described by Maulana (2008) and Flavell (1979).

Third, the pedagogical competence of the teacher in implementing metacognitive strategies plays an instrumental role. Teachers who possess strong metacognitive pedagogical knowledge are better equipped to scaffold student reflection and guide self-assessment, thereby creating a classroom environment that sustains metacognitive activity (Iskandar, 2014; Kristiani, 2009). This finding has direct implications for teacher professional development programs in the Sorong Regency, which should prioritize training in metacognitive instructional techniques to enhance the quality of elementary science education.

The results also align with national studies conducted in comparable elementary school settings. Putri and Misriandi (2020) demonstrated that metacognitive strategy application improved critical thinking skills in Indonesian elementary school students, while Nur'aini and Sutarman (2022) confirmed that metacognitive instruction produces significantly better science outcomes compared to conventional approaches. These convergent findings provide further validation for the pedagogical utility of metacognitive approaches across diverse elementary school contexts in Indonesia.

CONCLUSION

This study investigated the effect of a metacognitive learning approach on the science learning outcomes of fourth-grade students at SD Inpres 16, Sorong Regency. The results demonstrate that the implementation of metacognitive learning strategies produced significantly better posttest outcomes in the experimental class (mean = 88.15) compared to the control class, which received conventional instruction (mean = 80.86). The statistical analysis confirmed this difference, with a t-calculated value of 4.445 substantially exceeding the t-table value of 0.532, indicating a statistically significant effect of the metacognitive intervention on science learning outcomes.

These findings contribute to the growing evidence base supporting the integration of metacognitive strategies into elementary science education, particularly in the eastern Indonesian context. It is recommended that teachers at the elementary school level systematically incorporate metacognitive learning strategies into their instructional practice. Future research should examine the long-term effects of sustained metacognitive instruction across multiple subject areas and grade levels and explore the role of teacher competence in mediating the effectiveness of metacognitive approaches in the classroom.

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Declarations

Author Contribution	:	Rosila Syufan: Conceptualization, Writing – Original Draft, Data Collection, and Visualization; Ribut Purwojuono: Writing – Review & Editing, Formal Analysis, and Methodology; Anis Alfian Fitriani: Validation and Supervision.

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