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Using Metacognitive Strategy to Teach Learning Strategies: A Study of Indonesian Pre-Service Biology Teachers

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Abstract

The research aims at exploring Indonesian pre-service biology teachers' metacognitive skills, measuring the development of learning strategies (LS) used by the teachers before and after the learning process, and describing the teachers' responses afterwards. There were 25 subjects studied using a pre-test-posttest design. Results showed that there was an increase in students' metacognitive skills and their LS knowledge. Morever, they stated that they had got a lot of benefits after the learning process. This research concludes that metacognitive strategy can be used to teach LS so that students can broaden their LS understanding and thus enable to choose LS that fits them.

Keywords: *learning strategies, metacognitive skills, pre-service biology teacher*

Introduction

It is crucial for pre-service teachers teaching with a good learning strategy that is relevant to students' needs and characters, along with contextual factors such as academic domain, task type, or task difficulty level (Callan & Cleary, 2014; Cleary & Chen, 2009; Hadwin, Winne, Stockley, Nesbit, & Woszczyna, 2001). When performing as a real teacher, they should prepare a learning activity by considering how their students can process the delivered information and associate it with their schemata. Moreover, the teacher must be able to create a situation where

students can easily process and understand the information being embedded to their long-term memory (Zakaria & Iksan, 2007). In such a situation, pre-service teachers need to be familiarized with kinds of learning strategy. Teachers' willingness to enhance science performance through more effective instructional strategy has increased their awareness in recent years. The importance of students' focus in a teaching and learning activity requires a knowledge of how students learn and understand particular concepts (Jegede, Alaiyemola, Okebukola, 1990).

One of the instructional strategies in biology class is metacognitive strategy. The use of metacognitive strategy often has a solid association with improving students' achievements especially in science learning as it involves awareness of self-thinking measured with an appropriate strategy in the learning context (Ibrahim, et al., 2017; Akyol, Sungur, dan Tekkaya, 2010; Callan, Marchant, Finch, German, 2016). Metacognition is a set of skills that enables students to recognize how they learn, evaluate and adapt the skills in order to achieve an effective learning process. Metacognitive skill plays an important role in most problem-solving activities faced by students in daily classes (Boyle, Ronsen, Forchelli, 2016). Metacognitive strategy is considered to be more salient than other ones in conducting practice-based learning (Kistner, Rakoczy, Otto, Klieme & Büttner, 2015). In this research, the metacognitive strategy is used to teach learning strategy to pre-service students, covering both the theoretical concept and modelling technique. As its implementation, lecturers either suggest they should use a certain strategy or inform them about a concrete way and situation where to apply the learning strategy (Paris & Paris, 2001).

Research Problem

In recent years, there have been numerous studies focusing on the metacognitive strategy in developing students' metacognitive skills in learning (Schellenberg, Negishi, & Eggen, 2011; Paulson & Bauber, 2011; Stewart, Seifert & Rolheiser, 2015; Milis, 2016). Several studies among them have explained explicitly how the metacognitive strategy can develop metacognitive skills, not yet defining how it can be used to teach other learning strategies. The metacognitive strategy is considered by some scholars as more salient in teaching a practice-based subject (Kistner, Rakoczy, Otto, Klieme & Büttner, 2015). The metacognitive strategy can be used to teach kinds of learning strategies to pre-service teachers, instead of only developing students' metacognition. This research aims at (1) exploring pre-service biology teachers' metacognitive skills during the learning process of learning strategy types using the metacognitive strategy, (2) measuring the improvement of pre-service teachers' knowledge related to learning strategies in the pre- and

post-learning process using the metacognitive strategy, and (3) describing pre-service teachers' responses at the end of the meetings.

Research Focus

This research focuses on how to teach a particular learning strategy to pre-service biology teachers. The teaching and learning process, revealed in this research, uses the metacognitive strategy. Through its application, it does not merely teach the pre-service teachers learning models or methods, rather, it develops students' metacognitive skills. As a basic idea, this research aims to explore pre-service teachers' metacognitive skills during the teaching and learning process of kinds of learning strategies using the metacognitive strategy, to measure the increase in pre-service teachers' knowledge about learning strategies, and, also, to obtain their responses after the learning process ended.

Research Methodology

Research General Background

Metacognitive strategy-based research involves a theoretical review of learning strategies, modelling regarding ecosystem topics, and workshop of constructing learning tools oriented at learning strategies. In the learning process in the metacognitive strategy applied in this research consisted in asking students to write their schemata, write the acquired knowledge, and compare both. Moreover, students finally assessed their conceptual understanding. All data of students' metacognitive skills and knowledge improvement about learning strategy were analyzed using n-gain score, while students' responses were analyzed qualitatively in the form of description.

Research Sample

The participants in the research were 25 pre-service biology teachers, who were in their second year of study and were enrolled in the Biology Department at Universitas Negeri Surabaya. Their age ranged from nineteen to twenty. They had already taken pedagogical courses such as Philosophy of Education, Learning Theory, Learning Media, and Process Assessment and Learning Outcomes. However, they had never had real classroom practice.

Data Collection and Analysis Methods

The pre-service teachers' metacognitive skills were measured using a Self-understanding Evaluation Sheet (SUES), which consisted of three types, namely

SUES I, II, and III. The indicators of the evaluated metacognitive skills included determining the self-confidence level, comparing concepts, and determining scores. Each indicator was assessed using 1 to 4 score, as shown in Table 1.

Table 1. Scoring technique for metacognitive skills.

Indicators	Scores			
	1	2	3	4
Self-confidence Level	The answer was wrong, but she/he was confident that the answer was correct.	The answer was correct, but she/he was not confident that the answer was correct.	The answer was wrong, and she/he was not confident that the answer was correct.	The answer was correct, and she/he was confident that the answer was correct.
Comparing Concepts	There was a difference between the schemata and the new knowledge. Then, she/he stated that they were similar to one another.	There was no difference between the schemata and the new knowledge. Then, she/he stated that they were different from one another.	There was a difference between the schemata and the new knowledge. Then, she/he stated that they were different from one another.	There was no difference between the schemata and the new knowledge. Then, she/he stated that they were similar to one another.
Determining scores	The difference between the scores given by the lecturer and the pre-service teachers' expectation was 10.	The difference between the scores given by the lecturer and the pre-service teachers' expectation was 8 to 10.	The difference between the scores given by the lecturer and the pre-service teachers' expectation was 4 to 7.	The difference between the scores given by the lecturer and the pre-service teachers' expectation was 0 to 3.

The pre-service teachers' learning strategies (LS) scores were given by the lecturer. There were five indicators in LS, namely explaining (1) the aims of LS application in the learning process, (2) various characteristics of LS, (3) basic theory of the LS-oriented learning process, (4) the characteristics of the LS learning process, and (5) steps of the learning process using LS. The tests were conducted twice, before and after the teaching and learning process using the metacognitive strategy. Then, the pretest and posttest scores, then, were analyzed using n-gain. Afterwards, the obtained N-gain score was interpreted according to the criteria adopted from Hake (1999) as: $0.7 \leq \text{“}< g >\text{”} \leq 1$, categorized as high; $0.3 \leq \text{“}< g >\text{”} < 0.7$, categorized as middle; and $0 \leq \text{“}< g >\text{”} < 0.3$, categorized as low.

The responses to the metacognitive strategy were obtained from the checklist sheet given to the pre-service teachers, which consists of 12 questions and an

open comment. The pre-service teachers answered "Yes" if they agreed with the provided statements, and "No" if they disagreed with the given statements. Afterwards, the responses were analyzed using a descriptive qualitative approach.

The implementation of the metacognitive strategy was conducted in three phases. The first phase was in accordance with the theoretical review of learning strategies. In this phase, the pre-service biology teachers were familiarized with kinds of learning strategies, syntax, teacher behaviors in each phase, and characteristics of the material, which were relevant to the learning strategy. The second phase was modelling of a learning strategy in which the pre-service biology teachers observed the modelling of a learning strategy in ecosystem topics. The last phase was a workshop consisting in composing biology learning tools oriented towards learning strategy. The pre-service biology teachers planned the teaching and learning process regarding the topic relevant to the characteristics of a learning strategy. The pre-service biology teachers' metacognitive skills were evaluated through their skills in determining the self-confidence level, comparing among concepts, and determining scores. The obtained data were in the form of metacognitive skills, which were recorded in SUES I, II, and III.

Research Results

Metacognitive Skills

The pre-service teachers' metacognitive skills were assessed by calculating the average score of their skills in determining the self-confidence level, comparing concepts, and determining scores. Data was recorded three times in SUES I, II, and III. The results of SUES were categorized as shown in Figure 1.

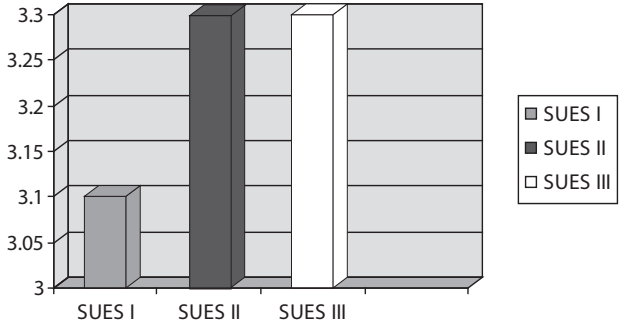

Figure 1. Comparison of scores obtained in SUES I, II, and III.

Learning Strategies

Improvement in the pre-service teachers' LS understanding was measured with the use of a test administered before and after the learning process, using the metacognitive strategy. The test covered five indicators. Table 2 shows each indicator completion percentages.

Table 2. Completion percentages of LS indicators

No.	Indicators	Completion (%)
1	Explaining the purpose of LS application in the learning process	96
2	Explaining various LS characteristics	64
3	Explaining the basic theory of learning oriented in LS	80
4	Explaining the characteristics of LS learning tools	64
5	Explaining learning steps using LS	78

Table 2 shows that the completion scores of each indicator are higher than 60%. The metacognitive strategy showed that the pre-service teachers can explain the purpose of applying LS in the learning process very well (96%), explain the characteristics of various LS (64%), explain the basic theory of the learning process oriented to LS very well (80%), explain the characteristics of LS learning tools well (64%) and explain the learning steps well (78%). This data could show how the metacognitive strategy helped the students in understanding and learning a particular learning strategy.

The results of n-gain scores from the pretest and posttest given to the pre-service teachers also indicated that the knowledge of LS increased. There were three

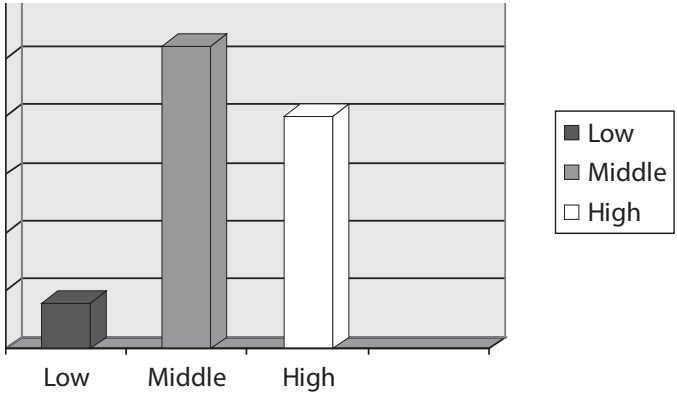

Figure 2. N-gain scores: Pretest and post-test of pre-service biology teachers' metacognitive skills.

categories of different levels of improvement, namely low, middle, and high. In this research, the n-gain scores obtained from 25 pre-service biology teachers were 8% (categorized in low level), 52% (categorized in middle level), and 40% (categorized in high level) (cf. Figure 2).

Pre-service Biology Teachers' Responses

Generally, all the pre-service biology teachers gave a positive response to the metacognitive strategy-based learning process. Most of them stated that the learning process using the metacognitive strategy helped to find a salient concept. Through the use of SUES, they could assess independently the understanding of the concept of LS. During the learning process, they were confident in admitting that their schemata were wrong. The statements that have the highest score are described as follows.

Statement 1: SUES helps to discover a prominent concept of LS. The pre-service teachers argued that SUES can help them in finding essential concepts during the teaching and learning process in both individual or group work. P1 argued, "LS learning process using the metacognitive strategy is attractive and makes students independent." P2 stated, "LS learning process is far from boring as students can share knowledge among group members." Moreover, P3 added, "SUES helps me in determining prominent concepts of what to learn, so that it can be applied in the learning process, especially in a certain material that promotes most misconceptions."

Statement 2: Students can conduct self-assessment regarding the understanding of the LS concept by using SUES. Some pre-service teachers argued that SUES indirectly helps them in assessing their understanding. Using SUES, they are actively involved in the learning process so that they can get a new knowledge and find differences between the new concepts and schemata. P4 said, "The LS learning process with the metacognitive strategy using SUES can help me assess my understanding about a particular concept. Moreover, it can also help me to know my ability before and after the learning process." P5 added, "The LS learning process tends to be more directed so that I can notice my fault directly and it gives me feedback. Then, I get a new knowledge of a learning strategy, namely metacognitive strategy, which I can apply."

Statement 3: SUES trains us to be honest. Based on the results of the questionnaire administered, 100% of the pre-service teachers stated that SUES can help them to promote honesty. This fact is supported by 92% of the pre-service teachers who are confident to admit that their schemata is incorrect. P6 stated, "By being honest and confident of admitting misconceptions, it helps me to know my initial and final potentials after the learning process."

Discussion

This research shows that the metacognitive strategy can help pre-service teachers in understanding learning strategies. This result indicates that the pre-service teachers' metacognitive skills can be explored with the use of the metacognitive strategy. The metacognitive strategy is assessed based on three indicators, namely determining the self-confidence level, comparing concepts, and determining scores using SUES. During the assessment of the pre-service teachers, some interesting findings related to indicators were revealed after they had been taught about LS through the metacognitive strategy. The pre-service teachers' capability of evaluating themselves, determining scores decreased at each meeting, whereas there was an increase in comparing concepts in the last SUES application. The students' self-evaluation results can give teachers a lot of important information about how well the students understand the tasks and how this information can improve the teaching and learning process (Montgomery, 2000). The improvement indicator in comparing concepts is relevant to the research conducted by Ozsoy & Ataman (2009), in which the steps in the metacognitive strategy may help the pre-service teachers to achieve the highest cognitive process and to find good solutions, to train to connect the previous with the recent information. The steps of the learning procedure in applying the metacognitive strategy in this research were the following: the students were asked to (1) write their schemata or previous knowledge, (2) write their recently acquired or new knowledge, (3) compare both, and (4) self-assess their concept understanding.

The test results of LS of each assessment show that the metacognitive learning strategy can help pre-service teachers to promote their pedagogical skills directly. Wilson & Bai (2010) explained that metacognitive knowledge had a significant metacognitive influence on the pedagogical understanding of metacognition. Their results show that teachers who have a good understanding of metacognition still need to possess the metacognitive concept and strategy to make students understand metacognition well. It shows the rationale of learning strategies taught with the use of the metacognitive strategy. LS is taught to make the pre-service teachers become good future teachers and reflective and critical thinkers. The improvement of LS completion is indicated through the increase in the pre-service teachers' N-gain scores. Both indicators of explaining the characteristics of various LS and the learning tools show the two lowest completion scores compared to others. Based on the students' response, it can be seen that it is important to provide students with intensive assistance, for them to understand various LS and their application in developing an appropriate learning tool regarding the used LS. The

metacognitive strategy-based learning process, generally, gets a positive response from the pre-service teachers. Most of them stated that the learning process using the metacognitive strategy helped them to find a salient concept. Through the use of SUES, they could assess independently their understanding of the concept of LS. During the learning process, they were confident in admitting that their schemata were wrong. They further argued that the metacognitive strategy could be implemented in some materials in which there are often misconceptions and help them in patterning materials for determining an appropriate learning strategy.

Conclusions

Overall, this research suggests that the metacognitive strategy can be used to teach other learning strategies to develop students' metacognitive skills. Students who have a knowledge related to learning strategies can determine a relevant strategy to learn materials precisely. There is a question found in the field regarding the implementation of this learning strategy, whether the metacognitive skills are indeed being demonstrated during the teaching and learning process. In accordance with that problem, it is important to further cooperate with teacher training centers to implement the metacognitive strategy in pedagogy as continuous efforts in advancing the implementation of learning strategies.

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