Metacognitive Learning Strategy with Reflective-Lesson Log Toward Students’ Physics Achievement

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Abstract. The study examined the effect of metacognitive learning strategies with a reflective-lesson log toward students’ physics achievement on Senior High School. The research employed the experimental method used groups within treatment designs and conducted at SMAN 4 and SMAN 7 Pontianak involving 117 students taken randomly through cluster random sampling technique. Data analysis was performed by comparing the post-test of students who studied by metacognitive strategies and students who studied by traditional teaching. Data were analyzed using the t-test. The result showed that the students’ physics achievement who studied by metacognitive strategy with a reflective-lesson log was higher than students’ by traditional strategy. Thus, it was recommended that physics senior high schools’ teachers could implement the metacognitive strategy with a reflective-lesson log as one of innovation physics teaching.

1. Introduction
A teacher is a factor that determines the success of a learning program because the teacher has a role in doing the planning and implementation of the learning process to achieve learning objectives. One of the essential things in the success of a learning process is determined by the learning strategy chosen by the teacher, who will set the direction and scenario of the learning process that is taking place. The strategy is a method or technique that is carried out by a person in learning to obtain the objectives to be achieved [1]. Training students learning strategies will be able to help students overcome the difficulties they experienced in the learning process.

The implementation of the 2013 curriculum in schools brings several changes, including core competencies, which included specific components of attitudes, knowledge, and skills, including meta-cognitive knowledge at the high school level. According to Anderson & Krathwohl [2], meta-cognitive knowledge is knowledge about cognition in general, as well as awareness and knowledge of its cognition. This category of knowledge is one of the things that are important for students when learning because it will affect the way students develop their thinking abilities. Herlianti’s research [3] showed that metacognitive awareness and metacognitive knowledge of students,
especially in high school, students play a role in achieving graduation standards in the 2013 curriculum.

A meta-cognitive strategy is a way or technique of learning that is carried out by a student in monitoring the planning, implementation, and evaluation of his learning process. Meta-cognitive strategies are distinguished from meta-cognitive knowledge, where meta-cognitive knowledge is a mental activity of a student when reflecting on learning, while metacognitive strategies occur when the learner consciously applies his metacognitive knowledge in the learning process [2, 4, 5].

Michael Pressley and his colleagues developed a meta-cognitive model called the good information processing model. The emphasis of this model is competent cognition derived from the interaction of several factors, namely strategy, material knowledge, motivation, and metacognition [5, 6]. The application of metacognitive strategies in learning Physics includes practicing repeat strategies for students. By paying attention to concepts or principles that are important in learning physics, then doing repetition is expected to help students process and store information in long-term memory.

In the implementation of the 2013 curriculum in schools, the application of constructivism in learning is explicitly stated in the curriculum document. Constructivism is the study of how a student gains his knowledge. The rehearsal implementation of metacognitive strategies is an activity carried out by students in building knowledge in their cognitive structures. The activity of building one’s knowledge by students who are learning is an important constructivist implementation in classroom learning [7, 8]. The repeating strategy is expected to help students understand and then be able to implement it in solving the physics problems given to them.

The implementation of metacognitive strategies in classroom learning has not been done much; this was revealed from interviews with several physics teachers and Amnah's research [9]. This study applies a repetitive metacognitive strategy with the help of self-monitoring sheets developed as tools in classroom learning [10].

2. Method
The method used in this study was an experimental method to test the effect of independent variables such as referring to the opinion of Gall, Gall, and Borg [11] with the experimental design groups within treatments design or abbreviated as the G-W-T pattern [12]. Research with the G-W-T design was carried out by conducting experiments on the application of meta-cognitive strategies assisted by self-monitoring sheets in physics learning at two high schools in Pontianak. Learning in two classes in each school where the research implemented meta-cognitive strategies. The experimental design with the G-W-T design is described as follows:

| SCHOOL    | Learning Strategies     | Conventional (B) |
|-----------|-------------------------|------------------|
| SMAN X (1)| A1 Meta-cognitive (A)   | B1 Conventional   |
| SMAN Y (2)| A2 Meta-cognitive (A)   | B2 Conventional   |
Treatment Remarks:
A1, A2: Groups of students who are treated with Self-Monitoring Assisted Metacognitive Strategies
B1, B2: Groups of students who are given the Conventional Learning treatment

The population in this study were all students of class XI MIA SMAN 4 and SMAN 7 Pontianak in 2015 with a sample of 117 students taken by multistage cluster random sampling. Random selection was made to choose two MIA classes in SMAN 4 and SMAN 7 as a learning group, and then through the draw, every class was given learning with a metacognitive strategy assisted with self-monitoring sheets and one conventional learning class.

Data collection techniques used 31 multiple-choice tests to measure physics learning outcomes with a reliability coefficient of 0.71 and 33 multiple-choice tests to determine students’ initial abilities with a reliability coefficient of 0.82. Before being tested, experts and panel validated the test instrument. The self-monitoring sheet was developed to find out the metacognitive strategies undertaken by students in the implementation of learning.

Research with the G-W-T design was conducted to test the differences in the effect of metacognitive learning strategies using self-monitoring sheets and conventional learning as independent variables on the dependent variable of physics learning outcomes. Analysis of research data using the t-test after fulfilling the test requirements include normality test for all groups following the design of the treatment and homogeneity variance test. The significance tests used are as follows:

\[ t = \frac{M_A - M_B}{\sqrt{SD_{M_A}^2 + SD_{M_B}^2}} \]  

The implementation of learning with metacognitive strategies was carried out using learning tools in the form of learning guidelines, which were the operationalization of the lesson plan for each meeting. A journal or self-monitoring sheet was used to monitor metacognitive strategies carried out by students, which was filled out by students in each learning process in the experimental class. The metacognitive strategy contained in the self-monitoring sheet consisted of simple repeating strategies, underlining, making summaries, and making marginal notes. The development of learning guidelines and self-monitoring sheets was carried out before the implementation of the study by following the simplified steps of development research by Gall, Gall, and Borg [11].

The learning guidance tool was developed based on a theoretical and practical study of metacognitive strategies that refer to the learning process that was under the 2013 curriculum. Lecturers and physics teachers validated the draft device and revised it based on input provided and then tested in schools [13].

3. Results and Discussion
This study aimed to analyze the effectiveness of the implementation of metacognitive strategies assisted by self-monitoring in improving student physics learning outcomes in class XI in the 2013 curriculum implementation. The following table presents a recapitulation of student learning outcomes scores:
Table 2. Recapitulation of Student Learning Outcomes Scores

| School       | Average Score of Learning Outcomes Metacognitive Strategies (A) | Average Score of Learning Outcomes of Conventional Learning (B) |
|--------------|---------------------------------------------------------------|---------------------------------------------------------------|
|              | Pretest (A₁)      | Posttest (A₂)     | Pretest (B₁)     | Posttest (B₂)     |
| SMAN X (1)   | 10.47             | 15.78             | 10.38            | 12.22             |
| SMAN Y (2)   | 11.34             | 17.15             | 10.96            | 13.22             |

The percentage of the mean in the experimental group was higher than the mean in the control group seen based on the comparison of the results of the pre-test and post-test in each treatment group. It showed that the group of students who studied in the experimental group achieved higher learning achievement than the group of students who studied conventionally. Figure 1 illustrated the comparison of learning outcomes of students who learn to implement a repeat metacognitive strategy using self-monitoring sheets with conventional learning in each school:

![Figure 1. The Comparison of Student Learning Outcomes](image)

After processing the data, the result of normality was obtained from the post-tests results of both study groups. A normality test was carried out to find out whether the data were normally distributed or not using SPSS. Because the test showed that the group has a normal distribution, it was followed by a homogeneity test using an independent sample T-test on approval or $p$ (sig)> 0.05. From the result of the homogeneity test, it can be the two groups come from homogeneous populations, which means the hypothesis testing to see a significant difference was made using parametric tests.

The difference significance testing of the two strategies' effect using the t-test and the results obtained was $t = 7.50$. This $t$ value was higher than $t_{0.05, 1} = 6.341$, so it can be interpreted that there was a significant influence difference between metacognitive strategies assisted by self-monitoring and conventional learning.
The results of this study indicated that students' learning outcomes using metacognitive strategies were higher than students' learning outcomes using conventional learning strategies. The metacognitive strategy was a learning strategy that was implemented in the Physics learning process by optimizing students' thinking processes about what they do in the Physics learning process in class. Thinking about what they think, encouraging students to actively think about what they need to do in planning, monitoring, and evaluating their learning, so it is expected that there will be a continuous reflection that can lead to improvements in students' learning strategies in learning physics. Reflections that are done continuously by students about the repeat strategy will help students to find the right strategy for themselves in learning [1]. Students who study physics with metacognitive strategies will be able to optimize their abilities in solving physics problems better because they can find ways that are more suitable for themselves to understand concepts and to solve physics problems. This statement is in line with the results of [14] research, which claims that there is a positive correlation between metacognitive awareness and students' ability to solve problems.

The application of repeating metacognitive strategies in physics learning takes about two (2) months in mechanics topics. The repeating strategy chosen by students varies in simple repetitious strategy and underlining strategy because those were considered very easy to do, so many students that implement them, especially at the beginning of learning activities. At the next meeting, some students began to try applying the strategy of making marginal notes and summarising, because those were considered very helpful in remembering and documenting physics' problem-solving procedures. Repetition can help students' learning because metacognitive strategies play a role in students' cognitive functions in the process of storing information in long term memory [15, 16]. Research about the policy of repeating by underlining and making a summary was also carried out by Amnah [9] in biology education students.

4. Conclusion
The results of this study were that physics learning outcomes of students who used metacognitive strategies using self-monitoring were higher than physics learning outcomes of students who study conventionally. We recommend implementing self-monitoring metacognitive strategies in the physics learning process for class XI high school students to improve student learning outcomes.

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