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The Implementation of Problem-Based Learning Model to Increase Students' Metacognitive Awareness of Environmental Change

Mira Salviana[1], Andi Ulfa Tenri Pada[2], Cut Nurmaliah[3]
[1]*Student of Masters in Biology Education at Syiah Kuala University, Banda Aceh*
[2]*Lecturer at Masters in Biology Education at Syiah Kuala University, Banda Aceh*
[3]*Lecturer at Masters in Biology Education at Syiah Kuala University, Banda Aceh*

Abstract:
One way to achieve learning objectives is by applying various learning models to assist students in managing and monitoring their metacognitive awareness. One learning model meeting these criteria is the Problem-Based Learning (PBL) model. This study aimed to examine the influence of the PBL on students' metacognitive awareness, especially on the topic of environmental changes. This study employed the quantitative method, the pretest posttest control group design. The research subjects were 122 students from one of the senior high schools in South Aceh, Indonesia. The parameter measured was metacognitive awareness, and this research was conducted in October 2020. The data on metacognitive awareness were analyzed using parametric statistics: the independent sample t-test. The N-Gain test of metacognitive awareness between the control and experimental groups showed a significant difference between the two groups (p <0.05).

Keywords: *Problem-Based Learning, Metacognitive Awareness, environmental change.*

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I. Introduction

Metacognitive is one's awareness of how s/he learns, the ability to assess the difficulty of a problem, observe her/his level of understanding, use various information to achieve goals, and assess her/his learning progress. Metacognitive activities, which require students to reflect on what they know, what they care about, and what they can do, help students build self-awareness and provide valuable information for the teacher[4]. Hence, it is crucial for teachers to frequently give students the opportunities to reflect on their learning to know what they do when they succeed or fail in learning.

Metacognitive awareness is often ignored despite its importance in achieving educational goals. Metacognitive awareness is not easy to obtain as it requires a full understanding of metacognition and how every student can have metacognitive awareness. It is an important awareness in the learning during the industrial era 4.0 and today's education. It affects one's success or failure in problem- solving[11]. Students who can reflect on metacognitive have the awareness to discover the right solution, conduct an evaluation after completing a task, correct mistakes, and solve other problems[9].

Learners' knowledge of general strategies for learning and thinking (knowledge of strategies), knowledge for cognitive tasks, and understanding when and why to use different strategies include contextual knowledge. Many students will acquire metacognitive abilities through learning experiences[2]. When students recognize their metacognitive awareness, teachers need to provide guidance and observation. Teachers can easily examine the depth of students' metacognitive awareness through discussion. It also helps teachers to adjust the teaching methods to help students gain metacognitive awareness[2].

Environmental change is taught in the second semester of Year 10. This topic is among the topics with low absorption on national examination with an average score of 42.918[8]. The topic is closely related to everyday life, such as environmental problems and waste triggering environmental pollution so that students are required to find multiple solutions in solving the problems.

One way to achieve learning objectives is by implementing various learning models to assist students in managing and monitoring their metacognitive awareness. Students should complete tasks or questions related to a problem to achieve the learning objectives. One learning model that fits these criteria is the Problem-Based Learning (PBL) model.

II. Material And Methods

This study employed a quantitative approach, applied research based on students' low metacognitive awareness. This research was conducted at two public senior high schools in South Aceh, Aceh, Indonesia. The participants were Year 10 students of the academic year of 2020/2021.

Study Design: Pretest posttest control group design
Study locations: SMA Negeri 1 Meukek and SMA Negeri 1 Tapaktuan, South Aceh, Aceh Indonesia.
Study Duration: October to November 2020.
Sample Size: 122 students
Sample size calculation: The population in this study were 239 Year 10 students of SMA Negeri 1 Meukek and SMA Negeri 1 Tapaktuan in the academic year of 2020/2021. The schools were chosen based on the scores of the 2018 National Examination. The samples were selected randomly from a homogeneous population, resulting in 122 students for the control and the experimental classes.

Method: This study used an experimental method. Data collection was conducted using Metacognitive Awareness Inventory (MAI) Questionnaire consisting of 52 items administered in the pretest and posttest. The questionnaire was modified to the criteria and indicators of metacognitive awareness consisting of self-planning, self-monitoring, and self-evaluation.
Statistical analysis: The data of the metacognitive awareness pretest and posttest were analyzed descriptively. The descriptive analysis resulted in the average scores of the pretest and posttest students' metacognitive awareness in the experimental and the control classes. The score was then calculated and normalized (N-Gain) using the Meltzer formula as follows.

$$\text{N\_}Gain = \frac{Posttest\ Score - Pretes\ Score}{Maximum\ Possible\ Score - Pretest\ Score}\ x\ 100$$

where:
High : N-Gain> 70
Moderate: 30 ≤ N-Gain ≤ 70
Low: N-Gain <30

The mean of pretest score and normalized N-Gain were taken to compare students' metacognitive awareness between the control and the experimental classes. An independent-test will be conducted if the averages of pretest score and N-Gain of students' metacognitive awareness are normally distributed and homogeneous. If the data is not normally distributed nor homogeneous, the mean difference test is performed using a non-parametric test using the Mann-Whitney test.

III. Results and Discussion

The assessment of the implementation of the Problem-Based Learning (PBL) model and conventional method can be seen from the metacognitive awareness indicator from the pretest and posttest scores. The results of the application of the PBL model were assessed based on the three metacognitive awareness indicators: self-planning, self-monitoring, and self-evaluation. The average indicators of metacognitive awareness in the experimental class are presented in Figure 1.

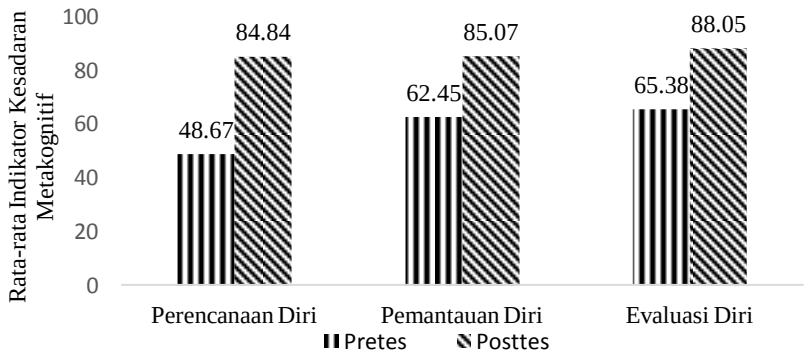

Figure 1. The Scores of Metacognitive Awareness Indicators of Students in Experiment Class

Figure 1 above shows that the pretest and posttest scores of the self-planning indicator are 48.87 (very low) and 84.84 (good), respectively. This shows that students could design and compile specific goals to be achieved in the learning process well. Students also understood what the teacher expected from the materials taught, that is, environmental changes. The pretest score was 62.45 (adequate) for the self-monitoring indicator, while the posttest score was 85.07 (good). These results indicate that students could focus their attention on important information conveyed by the teacher during the learning process. As for the indicator of self-evaluation, the pretest and posttest scores were 65.38 (adequate) and 88.05 (excellent), indicating that students could ask themselves about how well they achieve their goals in completing the task on environmental changes and conduct an appropriate analysis of the learning strategies used.

The mean score of the metacognitive awareness indicators in the control class taught using the conventional method is presented in Figure 2.

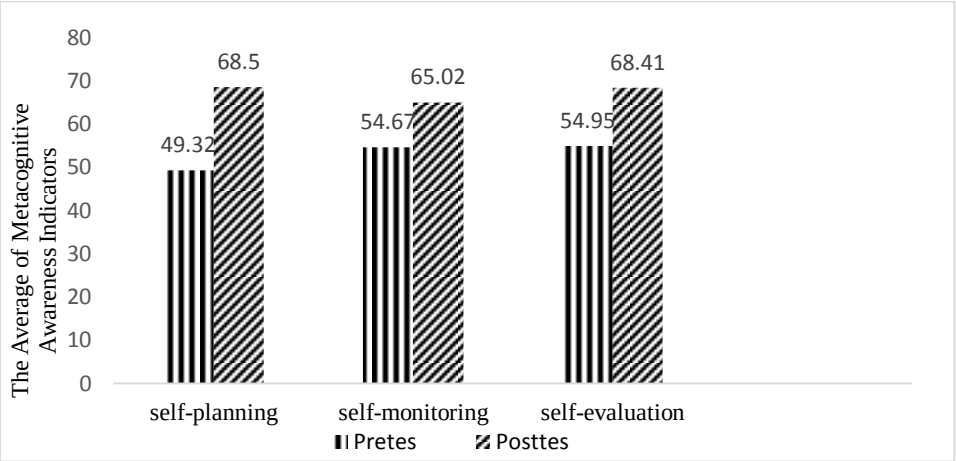

Figure 2. The Scores of Metacognitive Awareness Indicators of Students in Control Class

Figure 2 shows that the pretest and posttest scores of self-planning indicators in the control class were 49.32 (very low) and 65.50 (adequate), indicating that students had started to plan to be involved in the learning. For the self-monitoring indicator, the pretest score was 54.67, and the posttest score was 65.02; both were in the adequate category. These results show that students began to organize strategies compiled in the self-planning to be used during the learning process. As for the self-evaluation indicator, the pretest and posttest scores were 54.95 (adequate) and 68.41(moderate), indicating that students had sufficient ability to carry out a simple analysis of the usefulness of the strategies designed at the self-monitoring stage.

Before testing the hypothesis, the prerequisite tests for the independent sample t-test, the normality and homogeneity tests, were conducted, and the results are presented in Table 1.

Table 1. Normality and Homogeneity Tests for Students' Metacognitive Consciousness

Class	Normality test	Homogeneity test
Experiment	ρ (0.187) > α 0.05 (normal)	ρ (0.174) > α 0.05 (homogenous)
Control	ρ (0.173) > α 0.05 (normal)	

Table 1 shows that the data in experimental and control classes were normally distributed, and the metacognitive awareness posttest scores in both classes were homogeneous. Next, the independent sample t-test of the metacognitive awareness posttest between the two classes can be seen in Table 2.

Table 2. The Independent Sample t-test of Students' Metacognitive Awareness

Class	Mean	ρ value
Experiment	72.15	ρ <.005
Control	57.46	

Table 2 presents the results of the independent sample t-test of metacognitive awareness. It indicates that Ha is accepted (ρ <.005). Thus, it is concluded that there is a significant difference in metacognitive awareness between the experimental and the control classes on environmental changes topic in Year 10 students. The learning using the PBL model shows significantly better metacognitive awareness than the conventional method.

The mean difference in the pretest, posttest, and N-Gain of learning motivation in the experimental and control classes is displayed in Table 3.

Table 3. The average pretest, posttest, and gain in metacognitive awareness in the experimental and control classes

Class	N	Mean of Pretest	Mean of Posttest	Mean of N-Gain
Experiment	62	49.40	72.15	53.15
Control	60	45.89	57.46	40.05

Table 3 shows the mean difference between the participants' metacognitive awareness between the experimental and the control classes. The posttest mean of metacognitive awareness was 72.15 and 57.46 in the experimental and the control class. The n-gain mean of metacognitive awareness in the experimental class was 53.15, and it was 40.05 for the control class. Based on the results in the experimental and control groups, it can be seen that the average metacognitive awareness in the experimental group is higher than the control group. These findings indicate that implementing the PBL model results in significantly better metacognitive awareness than the conventional method.

Environmental changes present problems related to the surrounding environment, which requires students to solve problems through PBL stages. Hence, students are more engaged in the learning process. In PBL, students solve real-life problems. The real problems related to environmental changes include air, water, and soil pollution. The characteristics of PBL learning in this topic of environmental changes develop students' awareness of problems in the surrounding environment and encourage students to find solutions. Thus, it increases students' metacognitive awareness.

After learning using the PBL learning model, students' metacognitive awareness was better than those taught using the conventional method[5]. The use of PBL strategies can significantly increase students' metacognitive awareness[3]. The students learning with PBL had higher metacognitive abilities than the non-PBL group[2]. This conclusion refers to the syntax or PBL steps that allow students to manage the metacognitive activities. The previous study results also showed a strong relationship between metacognitive and academic achievement[1,10].

The metacognitive awareness in the control class using the conventional method also increased. Yet, it was not as good as the experimental class because the conventional method using multiple strategies. Among the learning strategies applied may be strategies that have the potential to increase learners' metacognitive awareness. However, this argument is rather weak because, in general, learning with conventional methods is more dominated by lecture style, discussions, and questions and answers[12].

IV. Conclusion

Based on the study results, it can be concluded that there are differences in metacognitive awareness of the experimental and the control classes on the topic of environmental change in Year 10 students in two public senior high schools in South Aceh, Indonesia. The implementation of the PBL model is more effective than the conventional method.

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