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Environmental Issues-based Discovery Learning to Enhance Metacognitive Awareness and Students' Higher-Order Thinking Skills

Wisnu Juli Wiono*, Nadya Meriza
Department of Biology Education, Universitas Lampung, Indonesia

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***Correspondence Address:**
wisnu.juli@fkip.unila.ac.id

Abstract: This study aimed to describe students' metacognitive awareness and higher-order thinking skills through environmental issues-discovery. The research design was quasi-experimental with a pretest-posttest design. The data were collected through 52 Metacognitive Awareness Inventory (MAI) statements and the critical thinking test. The results show that the levels of students' metacognitive awareness are undeveloped (18 Percent), at-risk (8 Percent), poor (15 Percent), developed (22 Percent), high (14 Percent), and excellent (23 Percent). The discovery learning model significantly affects students' higher-order thinking skills (significant value of 0.000 with a 0.05 confidence level). Therefore, teachers are advised to utilize the surrounding environment in the discovery learning model to improve higher-order thinking skills and metacognitive awareness. Studies on other learning models need to be carried out to add references in organizing the learning process.

INTRODUCTION

One of the important factors that affect student learning outcomes is the metacognitive aspect (Bahri & Corebima, 2015; Marantika, 2021; Schraw, 1998). A good student's metacognitive level has a positive relationship with his skills in managing and operating memory (Rahman, 2017). Besides, metacognition mastery can be seen from a person's proficiency in determining the right strategy when following the learning process (Alawiyah et al., 2019). Regarding the mastery of metacognitive abilities, students are grouped into tacit, aware, strategic, and reflective (Krathwohl, 2002). Tacit learners refer to students who tend to accept what is known and unknown and do not have strategies for learning. Aware learners refer to students who have various ways of thinking but are not accompanied by planned thinking skills. Strategic learners are groups of students who already know and can apply learning strategies such as organizing ways of thinking. Reflective learners are groups of students who tend to think strategically and can revise the learning strategies used (Pintrich, 2002; Teng & Zhang, 2020).

Metacognitive awareness focuses on aspects of a person's learning process (Li & Nietfeld, 2007). Metacognitive awareness has four components: cognitive knowledge, planning, monitoring, and evaluation (Anderson & Krathwohl, 2001). Metacognitive knowledge has derivatives in metacognitive awareness and metacognitive skills (Bogdanović et al., 2017). A good level of metacognitive awareness is closely related to the absorption and the ability to manage information. The abilities include managing cognitive intelligence and the

ability to see one's weaknesses. Furthermore, metacognitive awareness will lead students to design, monitor, and reflect consciously on the learning process (Jaleel & Premachandran, 2016).

Higher-order thinking skills are complex thinking processes in describing the material, concluding, building representations, analyzing, and building relationships by involving the most basic mental activities (Ariyana et al., 2018). Two components that characterize higher-order thinking are critical and creative thinking (Rustaman, 2011). Bloom's Taxonomy classifies the level of thinking into C4 (analyzing), C5 (evaluating), and C6 (creating) (Syafryadin et al., 2021). They are the concrete forms of students' higher-order thinking skills. Some of the activities that are thought to improve higher-order thinking skills are 1) opening and ending the lesson with questions, 2) placing brainstorming in the middle of learning to encourage students to find new ideas, and 3) providing open-ended tasks (Azevedo, 2019).

Discovery learning is one of the learning models that gets special emphasis in the learning process from the Ministry of Education and Culture of the Republic of Indonesia (Kunandar, 2013). Its development is based on the view of constructivism. It is a method that becomes a solution for teachers and students to present friendly, flexible, and student-oriented learning. It also shows how to think and solve problems logically and creatively (Subagis, 2021). Discovery learning is an attempt to develop students' independence in learning. Student activities in discovery learning include stimulation, problem statements, data collection, data processing, verification, and generalization (Rahman, 2017). Some of the positive impacts of using discovery learning in empirical learning are increasing students' mathematical reasoning (Ramdhani et al., 2017), improving students' understanding of concepts (Maharani & Hardini, 2017), improving student learning outcomes and activities (Putri et al., 2017), improving students' critical thinking skills (Nurrohmi et al., 2017), encouraging students' creative thinking skills (Rahman, 2017), and increasing students' learning motivation (In'am & Hajar, 2017).

Learning by presenting problems in the surrounding environment will make it easier for students to form prior knowledge (Rustaman, 2011). Bukit Barisan Selatan National Park (BBSNP) 2004 was designated as a natural cluster world heritage site by UNESCO. This status was achieved because of the high conservation value possessed by the tropical rainforest area. Many types of plants can absorb high carbon emissions. So that its existence helps reduce the greenhouse effect that causes global warming (Alimudin et al., 2017). The advocacy and education study agency reported that in 2014 the rate of encroachment on the national park area reached an alarming level (7.5 hectares per day), and some of the problems surrounding BBSNP are security, encroachment, pooching, animal and human conflicts, and plastic waste (Wiono & Meriza, 2021). Around 300 cleaners were deployed to comb the Sanggi-Bengkunat road and collected 1,050 kg. Along the Liwa-Krui road section, 11 tons of garbage were collected (Ichsan et al., 2019). Further research indicates that age and formal education are variables that greatly influence people's perceptions of the ecological function of BBSNP (Firnanda et al., 2020).

The complexity of the problems in BBSNP and its conservation potential for sustainably living things makes it worthy of being studied. This article reveals the effectiveness of environmental issues-based discovery learning to enhance students' higher-order thinking skills in their metacognitive awareness. This effort is to introduce early to students to be

sensitive to changes in the surrounding environment.

METHOD

This study applied the quasi-experimental method of pretest-posttest design to get an idea of the level of development of students' metacognition awareness and higher-order thinking skills. The research design is illustrated in Figure 1.

The model had six syntaxes (Figure 2), namely (1) stimulation, (2) problem statements, (3) data collection, (4) data processing, (5) verification, and (6) generalization (Rahman, 2017). Data on the level of students' metacognitive awareness were described qualitatively. Furthermore, the application of the discovery learning model will be associated with students' higher-order thinking skills.

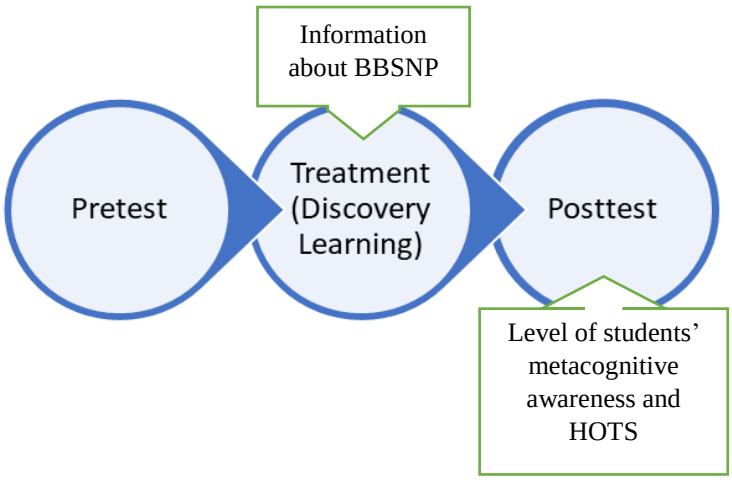

Figure 1. Design Scheme of The Research

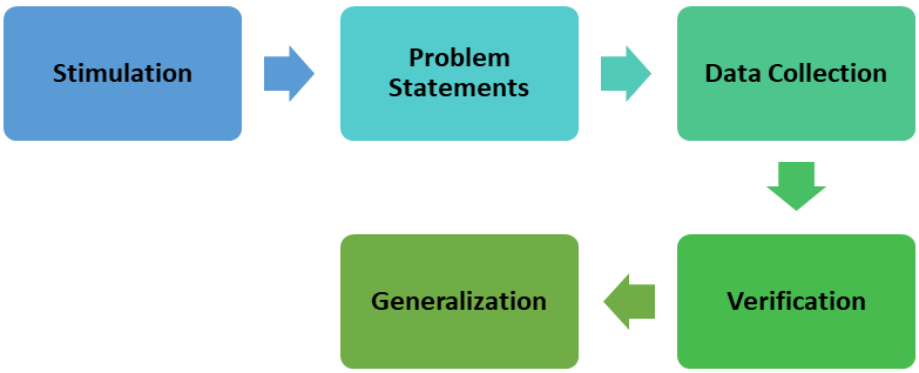

Figure 2. Syntaxes of Discovery Learning Model

The research was conducted on seventh-grade students in one of the junior high schools in the Pesisir Barat area, Lampung. The sample was determined by applying a non-probability sampling technique using random cluster sampling so that all classes and students have the same opportunities and characteristics for research.

The instrument used in this research was the Metacognitive Awareness Inventory (MAI), modified from Schraw & Dannison (Kallio et al., 2018). The questionnaire consisted of 52 statements that were translated into Indonesian. There were eight indicators in the questionnaire grouped into aspects of knowledge about cognition and aspects of the regulation of cognition. Aspects of

knowledge about cognition consisted of declarative, procedural, and conditional knowledge. Meanwhile, cognitive regulation consisted of planning, information management strategies, monitoring of understanding, improvement, and evaluation strategies. All statements in this questionnaire were positive statements. This instrument was answered using the Guttman scale, choosing "yes or no" (Sugiyono, 2017). The "yes" response will be scored 1, while the response "no" will be scored 0. The validity of the questionnaire was tested using the product-moment correlation formula, while the reliability test of the questionnaire was carried out by applying the Cronbach Alpha formula. Furthermore, the students' higher-order thinking skills were measured using multiple-choice test instruments validated by experts with criteria for thinking levels from C4 to C6.

Table 1. Metacognitive Awareness Levels (Schraw, 1998)

Score Interval	Level	Term	Description
0 – 18	0	Undeveloped	Not yet lead to cognition.
19 – 36	1	At-risk	Seems to have no awareness of thinking as a process.
37 – 54	2	Poor	Unable to separate what he thinks from how he thinks.
55 – 72	3	Developed	Can be helped towards self-thinking awareness if stimulated or supported.
73 – 90	4	High	Aware of his thinking and can distinguish the input stages of self-elaboration and the output of his mind.
91 – 100	5	Excellent	Able to use metacognitive skills regularly to regulate their thinking and learning processes. Aware of many kinds of thinking possibilities, able to use them fluently and reflect on their thought processes.

The data were analyzed by changing the questionnaire data on a scale of 100, and the numbers obtained were then interpreted using the Green (Kallio et al., 2018) reference, as shown in Table 2, to determine the level of students' metacognitive awareness (Schraw & Dennison, 1994). Data on higher-order thinking skills were analyzed using a one-way ANOVA test by first performing the prerequisite tests to test the normality and homogeneity. The normality was tested using Kolmogorov-Smirnov, and the homogeneity was tested using the Levene Test of Equality of Variances Error, each at a significance level of 5%. The data were analyzed with the help of SPSS version 25.

RESULT AND DISCUSSION

The Percentage of Students' Metacognitive Awareness Level on Each Indicator

The overall results of data analysis on the development of students' metacognitive awareness are shown in Figures 3 and 4. There are eight indicators in metacognitive awareness grouped into two aspects, namely knowledge of cognition and cognitive regulation. Knowledge of cognition includes declarative knowledge, procedural knowledge, and conditional knowledge indicators. Meanwhile, aspects of cognitive regulation include planning indicators, information management strategies, monitoring of understanding, improvement, and evaluation strategies. The results of each measurement on aspects of knowledge about cognition and cognitive regulation are presented in Figures 5 and 6.

Figure 3 shows that students' metacognitive awareness of each indicator is diverse. The highest percentage is seen in the declarative knowledge indicator, where almost half of the students have an 'excellent' level of awareness (47 %). In contrast, only 6 % of students have an 'excellent' awareness of the planning

indicator. In the indicators of declarative and procedural knowledge, there are no students at the level of 'developing' and 'at risk' awareness.

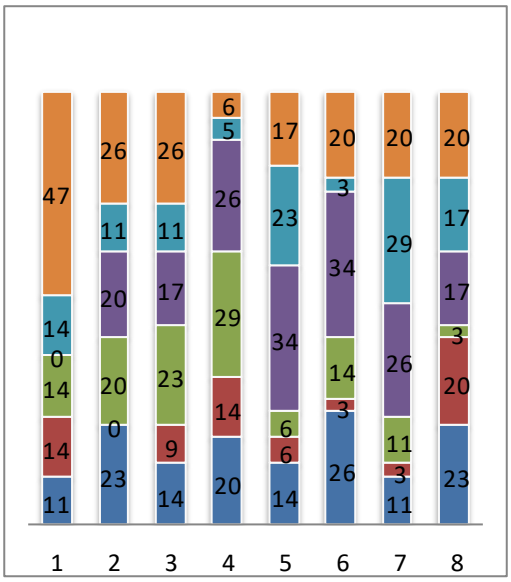

Figure 3. Percentage of Students' Metacognitive Awareness Level on Each Indicator

Figure 4 shows that 23 % of students have an 'excellent' level of metacognitive awareness development. Also, very few students have metacognitive awareness at the 'at risk' level (8 %). The surprising fact is that 18 % of students are at an undeveloped level of consciousness. Figure 5 shows that in the aspect of knowledge about cognition, 32 % of students have an 'excellent' level of metacognitive awareness, while the other 8 % are in the 'at risk' level. It was also found that 16% of students were at the under-developed level.

Furthermore, the percentage on aspects of cognitive regulation in Figure 6 shows that 27 % of students have metacognitive awareness at the 'developing' level. In the aspect of knowledge about cognition, the least students in regulating cognition are at the 'at risk' level (9 %). It was also found that 19 % (higher than the level of 'no awareness') of students were 'under-developed.'

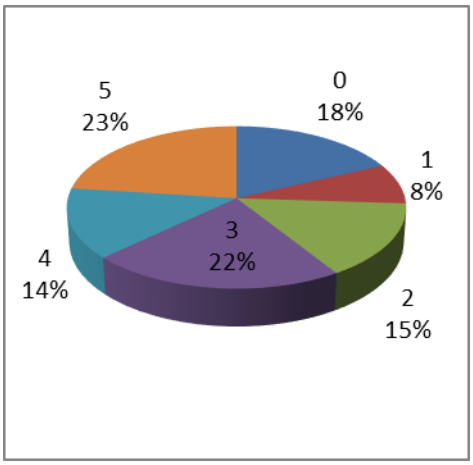

Figure 4. Percentage of Students' Metacognitive Awareness Based on Level of Development

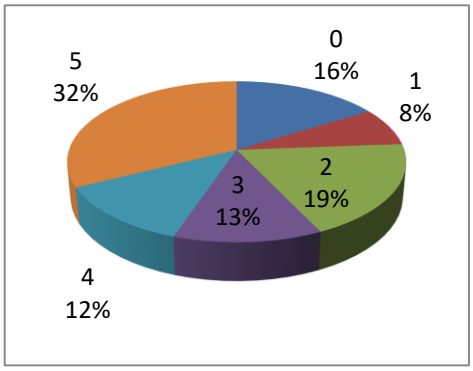

Figure 5. Percentage of Knowledge Level of Students' Cognition

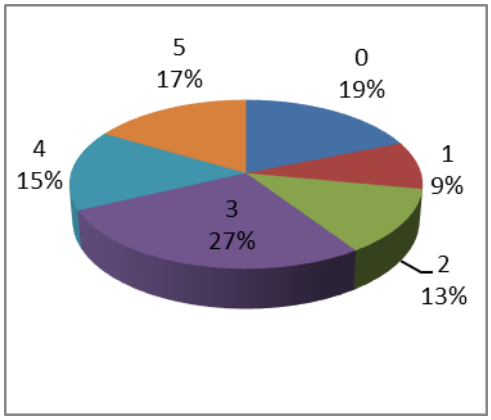

Figure 6. Percentage Level of Student Cognition Arrangement

The analysis of the aspects of knowledge about cognition, namely declarative knowledge, procedural knowledge, and conditional knowledge in Figure 5, shows that the average metacognitive awareness of students is at the level of 'excellent' (32%). 32 % of students can use metacognitive skills

regularly to regulate their thinking and learning processes and are aware of many kinds of thinking possibilities. They can use them fluently and reflect on their thinking processes. Furthermore, in cognitive regulation, namely planning indicators, strategies for managing information, monitoring of understanding, improvement, and evaluation strategies, the average student is at the 'developing' level (27 %). This means that 27 % of students know their way of thinking and can distinguish the input stages of self-elaboration and the output of their thoughts (Kallio et al., 2018). A comparison of the percentage level of knowledge about students' cognition and cognitive regulation is presented in Figures 5 and 6.

The Effect of BBSNP Information-Assisted Discovery Learning on Students' Higher-Order Thinking Skills

Data from the test results of students' higher-order thinking skills were then tested for prerequisites, namely normality and homogeneity tests. Based on Table 2, the data was normally distributed because the value of sig (0.183) was higher than 0.05. Furthermore, based on the homogeneity test results, it was found that the value of sig (0.99) was also higher than 0.05. it means that the variance between the value variables was homogeneous.

Table 2. Prerequisite Test Results

One-Sample Kolmogorov Smirnov Test			
N	Mean	sd	Sig.
32	76.91	10.442	0.183
Levene's Test of Equality of Error Variance			
F	Df1	Df2	Sig.
1.255	1	65	0.99

After going through the prerequisite test, the data was tested using one-way ANOVA to determine the effect of the independent variable on the dependent variable. The test results in Table 3 show that the sig (0.000) value was lower than 0.05. Therefore, there was a significant effect of applying BBSNP information-assisted discovery learning on students' higher-order thinking skills.

Table 3. One-Way ANOVA Test Results

Df	**F**	**Sig.**
1	32.546	.000

The learning process that applies discovery learning assisted by BBSNP information in videos and pictures can significantly increase students' motivation and curiosity. It has been scientifically proven that video in learning can increase students' interest in learning (Jaleel & Premachandran, 2016). The facts of the surrounding environment, namely BBSNP presented in learning, can stimulate and increase students' critical attitudes. One of the characteristics of higher-order thinking is critical thinking (Nurrohmi et al., 2017). Also, learning that addresses issues around the place of residence is proven to be more meaningful and long-lasting in students' memories (Palincsar & Herrenkohl, 2002).

The steps of the discovery model are designed to increase student involvement actively and purposefully in learning activities. This statement is supported by the research results, which state an increase in student learning activities that directly affect learning outcomes (Putri et al., 2017). Some typical activities found in discovery learning are 1) exploring and solving problems to create, combine, and generalize knowledge; 2) student-centered; 3) combining new knowledge with previous knowledge. These activities support the improvement of students' higher-order thinking skills, namely analyzing, evaluating, and creating.

Analytical skills are shown by students in observing videos about residents' activities in the border area of BBSNP with residential areas. The area often exploits the trees found in BBSNP to be cut down and used as building materials. The ideas raised by students

from these activities are the formulation of questions that will be developed in learning. Some of the questions that emerged from the students were 1) Why are people allowed to live on the border of BBSNP?; 2) Are these people not afraid of wild animals in BBSNP?; 3) Do people dump their household waste into BBSNP?; 4) Is it permissible to build tourist attractions in BBSNP?; and 5) Does the community hunts animals in BBSNP?. The discovery learning begins by inviting students to recognize facts or phenomena, followed by formulating problems in the form of questions. The syntax that accommodates analyzing activities is stimulation and problem statements. This activity is the hallmark of a learning model based on a scientific approach and has been proven to hone analytical skills (Veenman et al., 2004).

Students show evaluation skills in providing an assessment in the form of a statement of opinion about the content of the learning video containing information on BBSNP. The opinions expressed by students are linear with the previous analysis questions. The activity of evaluating is accommodated in discovery learning when collecting and processing information, namely the syntax of data collection and data processing. Among the results of the evaluation carried out by students are 1) the community needs a place to live and a livelihood; 2) people's houses are made on stilts to avoid disturbance of wild animals; 3) people make holes to dispose of household waste; 4) tourist attractions that are built must not damage BBSNP; 5) the community does not consume wild animals. Facts or phenomena that students have recognized will make it easier for them to provide criticism (Austgulen, 2016).

Furthermore, students' creative skills are shown in making statements that are poured into the form of posters. Statements made by students are based on the results of verification and generalization in discovery learning syntax. References used by students in conducting verification are textbooks, information from the media, people, and personal experiences. The activities directly impact students' higher-order thinking skills (Aisyah et al., 2019).

Metacognitive Awareness, BBSNP Information-Assisted Discovery Learning, and Students' Higher-Order Thinking Skills

The percentage of students who have a level of metacognitive awareness development ranging from developing, high, and excellent reach 59% (Figure 2). Statistical analysis was not carried out in this study to see the relationship between metacognitive awareness and students' higher-order thinking skills. However, based on the study results, it was proven that metacognitive awareness had a significant effect on student learning outcomes (Yıldız & Akdağ, 2017). In particular, the level of students' metacognitive awareness did not significantly affect lower-order thinking skills. Still, the opposite happened to higher-order thinking skills (Wiono et al., 2021), presumably because metacognitive knowledge is related to thinking about what is thought. The level above is remembering, explaining, and applying.

The application of the discovery learning model in learning has been proven to significantly influence and improve student learning outcomes, activities, and motivation (Putri et al., 2017; Sulfemi, 2019). The learning outcomes include conceptual understanding, mathematical reasoning, critical thinking, and creative thinking. All of which are included in higher-order thinking skills (Burais et al., 2016; Nurrohmi et al., 2017; Rahman, 2017). Referring to the research results above, the discovery learning model combined with BBSNP information as learning material significantly affected students' higher-order thinking skills. Explained

that discovery learning can also be applied to students at various educational levels, ranging from elementary school to university (Tomlinson et al., 2016). Discovery learning is not limited to being applied to the natural sciences but also social sciences and languages (In'am, 2017; Yulianingtyas et al., 2017).

Some of the issues raised in this research are security, encroachment, hunting, animal and human conflicts, and plastic waste. The applied materials and methods also have an important role in improving students' higher-order thinking skills. Videos with environmental pollution content improve students' higher-order thinking skills. In particular, the teaching materials used in this research are information about the potential problems that exist in BBSNP. It is proven that discovery learning models can improve students' higher-order thinking skills. It is seen that students' metacognitive awareness also has a relationship with the level of students' higher-order thinking skills.

CONCLUSION

The results showed that the levels of students' metacognitive awareness were undeveloped (18 %), at-risk (8 %), poor (15 %), developed (22 %), high (14 %), and excellent (23 %). The percentage of students with a good level of metacognitive awareness is 59 % (developed, high, and excellent). The level of metacognitive awareness affects students' higher-order thinking skills. The discovery learning model also has a significant effect on students' higher-order thinking skills. This research implies that discovery learning based on environmental issues in BBSNP can be used as an alternative to enhance students' metacognitive awareness and higher-order thinking skills. Furthermore, this study can be used to compare and reference material to deepen further research with a larger population and different variables.

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