Students Metacognitive Awareness and Creativity in Biodiversity Conservation

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Abstract

The decline in biodiversity is a global problem facing the world community. Metacognitive awareness affects the formation of a coherent mindset and creativity in students in solving biodiversity conservation problems. The purpose of this study was to determine metacognition awareness, creativity, and the relationship between metacognition awareness and student creativity in preserving biodiversity. This research method is a non-experimental survey involving 226 high school students. The instrument in this study was a metacognition awareness questionnaire and a test of students' creative essays. The results showed that the students' metacognitive awareness of cognitive knowledge aspects was 91.55 "Super" categories and cognitive regulatory aspects 60.36 "Developed" categories. The results showed that the student's creativity in the highest curiosity aspect was 54.65 basic categories; the highest fluency is 53.76 basic categories; the highest originality is 55.97 for the beginner category; the highest elaboration is 52.21 basic categories; the highest flexibility, namely 52.88 for the beginner category; and the highest divergent thinking is 54.42 in the beginner category. There is a relationship between metacognitive awareness and student creativity. Based on the research results, it is suggested that training to empower students 'metacognitive awareness to increase student's creativity.

Keywords
Metacognition awareness, creativity, biodiversity, conservation, students high school

1. Introduction

Mnguni et al (2016) stated learning science is able to provide solutions to social problems that occur in the environment. Science learning provides scientific knowledge for survival. Hadzigeorgiou et al (2012) stated science learning not only provides scientific knowledge but also thinking skills to solve problems in everyday life. Biasutti and Frate (2018) stated thinking skills can be trained through metacognition empowerment. Sukesi et al (2019) stated empowerment of metacognition awareness is an important goal and focus in learning in Indonesia and the world. Flavel (1979) stated metacognition is defined as "cognition about cognition" or "thinking about thinking". Hargrove (2013) and Naoyuki et al (2019) metacognition has an important role in student success. Kearney (2004) metacognition empowerment trains students to think intelligently in dealing with problems. Razumnikova and Yashanina (2015)

metacognition accounts for about 17% of a child's ability to succeed in school, while intelligence accounts for about 10%.

Kozikoglu (2019) stated good creativity is also influenced by good metacognition. Puryear (2015) and Modrek et al (2018) metacognition is related to four interconnected things, namely metacognition knowledge, metacognition experience, tasks and strategies in problem solving, this shows that metacognition is related to creativity, cognition and students' thinking ability to achieve a goal. Thomas (2012) structured metacognition abilities can develop student creativity. Al-Hilawani and Yaser (2017) Creativity has a very fundamental role in learning. Greenstein (2012) creativity is a metacognition process in generating new associations in solving problems, producing plans, or producing patterns, structures, or products that have never existed. Tabachuk et al (2018) metacognition awareness has a positive correlation with creativity in problem solving. Kaufman and Beghetto (2013) students need to develop metacognition-creative awareness by combining self-knowledge and creativity, as well as contextual knowledge.

Puryear (2014) the relationship between metacognitive awareness and creativity has been observed to be significant. This study examines the relationship between metacognition and students' creativity in preserving biodiversity. The novelty in this research lies in the metacognition awareness and creativity of students in preserving biodiversity, which has never been studied before. This research is closely related to the urgency of preserving biodiversity in Indonesia. Dillion and Scott (2002) most of the research on biodiversity has generally focused on educational programs and students' knowledge of biodiversity conservation. Research on biodiversity conservation has not discussed much about metacognition awareness and students' creativity in expressing ideas related to biodiversity conservation. Chalmin-Pui and Perkins (2016) stated the studies that have been carried out related to the preservation of biodiversity are only about knowledge, attitudes, and Venuste et al (2017) stated awareness of students in preserving biodiversity have not paid attention to metacognitive awareness and students' creativity.

The issue of biodiversity is very important to pay attention to, because of the decline in biodiversity in nature. Shah and Parsons (2018) stated social research related to the environment has been widely studied such as student knowledge about biodiversity. Besides Stamm et al (2000), Draheim et al (2011), O'Bryhim and Parsons (2015), Parsons et al (2010), Sitar-Gonzales and Parsons (2012) stated other social research related to the environment, namely global warming and material recycling, or knowledge and attitudes towards certain species. Siegel (2006) stated biodiversity needs to be protected for environmental sustainability. Biodiversity, according to the biological definition, is the variety of living things from an ecological complex consisting of species diversity, between species, and ecosystems. Peterson (2003) biodiversity is directly related to the quality of human life. Beckrich (2011) the rapid decline in biodiversity due to human activities is one of the most pressing environmental problems. Mahipal (2008) the decline in biodiversity in Indonesia is caused by a lack of understanding of the moral and social values of the existence of biodiversity, weak management strategies and methods, focusing only on conservation area management, and a lack of community involvement in management. Therefore, students need to be equipped with complete knowledge and practice creativity in overcoming problems of biodiversity.

1.1 Objectives

This study aims to determine the profile of students' metacognitive awareness and creativity in learning biology, especially in biodiversity conservation material. This has never been revealed by previous research. In this study, the researcher wanted to know specifically how the students' creativity in thinking about biodiversity conservation efforts in Indonesia. This is related to rampant illegal forest burning, which has resulted in a decrease in biodiversity. Then the researcher also wanted to reveal whether there was a relationship between metacognitive awareness and student creativity in learning.

2. Literature Review

Al-Hilawani and Yaser (2017) explain that metacognitive awareness is a high-order thinking skill that can help students solve daily problems. Kozikoglu (2018) and Modrek et al (2018) that metacognition awareness is thought to be able to help students think more creatively. Naoyuki et al (2019) creativity is part of metacognition awareness. Erbas et al (2015) and Puryear (2014) students who are accustomed to doing metacognitive activities are believed to be able to improve achievement and problem-solving abilities. Kaufman et al (2013) explained that metacognitive

awareness is the ability to reflect on thoughts, analyze and place thoughts on future use. Thomas (2012) states that metacognition, thinking, and learning are continuous transformations if there are different aspects of the same event. Metacognition can be said as a thought process to think.

Metacognition awareness consists of dividing metacognition awareness into declarative knowledge, procedural knowledge, conditional knowledge, planning, information management strategies, monitoring, debugging/settlement strategies problems, and learning evaluation. The operational definition of metacognitive awareness developed by Scraw and Dennison (1994) is as follows. Knowledge of cognition consist of declarative knowledge, procedural knowledge, and conditional knowledge. Declarative knowledge is knowledge of a person's skills, intellectual resources, and abilities as a learner. Procedural knowledge is knowledge of how to apply learning procedures. Conditional knowledge is knowledge of when and why to use learning procedures. Regulation of cognition consist of planning, information management, monitoring, debugging strategies, and evaluation. Planning consist of planning, setting goals, and allocating resources before learning. Information management consist of beginner skills and sequences are used on-line to process information more efficiently (eg organizing, elaborating, summarizing, selective focus). Monitoring consist of assessment of learning or use of strategies. Debugging strategies used to correct misunderstanding and performance. Evaluation consist of analysis of performance and effectiveness after learning activities.

Metacognition awareness has a very important role in learning, Biasutti & Frate (2018) explained that metacognition refers to a person's ability to understand and develop an awareness of his or her own cognitive processes and to control this process for maximum learning activities. Venuste et al (2017) metacognition is considered an important process for raising awareness, controlling cognitive elaboration of information and developing organized strategies during learning.

Sukesi et al (2019) explain that creativity is an original and useful thought or idea and product. Tabachuk et al (2018) stated that creativity is characterized by the ability or power to create or produce new products through imaginative skills. Razumnikova et al (2015) stated that creativity can be said as a relationship between objects and ideas and rearranging them into new forms. Puryear (2015) explains that creativity plays a role in helping solve everyday problems. Student creativity can be developed through unique opportunities to use different thinking.

Greenstein (2012) states that the main concepts in creativity are originality, uniqueness, imagination, flexibility, fluency, making connections, forming new patterns, and personal expression. While curiosity or curiosity is the core of creative thinking. Indicators in creativity according to Greenstein (2012); (1) curiosity: investigating, asking questions, looking for deeper meaning, (2) fluency: production of a number of ideas, (3) originality: new, fresh, unique, or unusual ideas, (4) elaboration : an idea that displays intensive details or adds to existing details, (5) flexibility: an idea that shows a variety of possibilities, (6) divergent: a combination, adaptation, or modification of several ideas for problem solving.

The creativity assessment strategy, namely using rubrics, checklists, peer / self assessment, and reflection can also be supported by progress notes, observations, and anecdotal notes (Greenstein, 2012). The form of assessment used must be tailored to the targets, objectives and learning outcomes.

3. Methods

A non-experimental survey design was used for data collection in this study from Maree and Pietersen (2007). This survey aims to measure students' metacognitive awareness which consists of knowledge about cognition and cognitive regulation regarding biodiversity learning. Student creativity is focused on efforts or finding ideas about preserving biodiversity. This survey involved students aged 15-17 years at the high school level. A non-probability convenience sampling approach was used to select students who would participate in this study. The student age range ranges from 14-16 years. Respondents in this study were 266 students who were in ten grade senior high school.

4. Data Collection

Students' responses to statement items in the metacognition awareness questionnaire were scored, 0-1. Metacognition awareness inventory consisting of 20 questions spread over 2 parts, namely knowledge about cognition and cognitive regulation. Students who do not respond will be given a score of zero. All scores obtained will be calculated as a percentage. Data on student creativity were obtained from the results of written tests adjusted to the creativity rubric scores 1-4. Creativity refers to the 5 aspects referred to by Greenstein (2012), namely curiosity, fluency, originality, flexibility, and divergent which are classified into 4 levels, namely advanced, advanced, basic, and beginner. The student creativity rubric in Table 1.

Table 1. Rubric of Students Creativity

Aspects of creativity	Score	Descriptors
Curiosity	4	Answers present 4 relevant questions about a phenomenon
	3	Answers show 2 questions that are relevant about a phenomenon
	2	Answers display 1 question on the discourse
	1	Answers do not display relevant questions
Fluency	4	The answer raises several alternative ways of solving the problem and its purpose
	3	The answer raises several alternative solutions
	2	The answer raises 1 alternative solution without specifying the goal
	1	The answer does not come up with a relevant alternative solution
Originality	4	The answer gives to 2 new ideas and an innovative product
	3	Answers bring up 1 new, innovative idea
	2	The answers bring out the existing ideas in discourse
	1	The answers give rise to no ideas
Elaboration	4	Answers provide a detailed explanation and add some facts
	3	The answer provides a detailed explanation and adds 1 fact
	2	Answers provide explanations and do not add facts
	1	Answers provide no explanation and add no facts
Flexibility	4	Answers present 4 new possibilities that will occur in learning and in everyday life
	3	The answer presents 2 possibilities that will occur in learning and everyday life
	2	Answers present 1 possibility that will occur in learning and in everyday life
	1	Answers do not represent the possibilities that will occur in learning and in everyday life
Divergent thinking	4	Answer refers to the combination, adaptation, or modification of several ideas to solve a problem
	3	Answer refers to the combination, adaptation, or modification of 1 idea to solve a problem
	2	Answers refer to existing ideas to solve the problem (no combination, adaptation, or modification)
	1	The answer does not raise the problem solving

Source: Modification from Greenstein 2012

The profile data of metacognition awareness and creativity were analyzed using descriptive statistics. The relationship between metacognition awareness and creativity was analyzed using a simple linearity test.

5. Results and Discussion

5.1 Numerical Results of students metacognitive awareness and students creativity

Data regarding students 'metacognitive awareness regarding biodiversity learning is presented in Table 2.

Table 2. Students metacognition awareness

No	Aspects of metacognition awareness	Percentage (%)	Category
Knowledge of cognition			

1.	Declarative knowledge	97.61	Super
2.	Procedural knowledge	84.73	Ok
3.	Conditional knowledge	92.30	Super
	Mean	91.55	Super
Regulation of cognition			
4.	Planing	66.28	Developing
5.	Information management strategy	58.67	Developing
6.	Monitoring	59.42	Developing
7.	Debugging strategy	59.73	Developing
8.	Evaluate	57.67	Developing
	Mean	60.36	Developing

Based on Table 2, it is known that the declarative knowledge aspect reaches a percentage of 97.61 in the super category. The percentage of procedural knowledge aspects reached 84.73 categories ok. The percentage of conditional knowledge aspects reached 92.30 super categories. The average of all aspects of knowledge of cognition is 91.55 super categories.

This study provides data regarding the profile of students' metacognitive awareness and creativity. Table 2 shows that the regulation of students 'cognition still needs to be developed. It is not comparable with the knowledge of students' cognition regarding biodiversity material. Knowledge of cognition about students' biodiversity reaches 91.55% in the super category, meaning that students have a lot of knowledge about biodiversity, but in the regulatory aspect of cognition it reaches 60.36% in the developing category, which means that students have not used appropriate learning strategies to acquire this knowledge.

Schraw and Dennison (1994) knowledge of cognition is a prerequisite for the regulation of cognition. Knowledge is used to organize learning before doing assignments. In the study, students have good knowledge of cognition, but it is not fully used to choose appropriate learning strategies for studying biodiversity material. Kozikoglu (2019) cognition regulation has an effect on students to practice thinking skills in the learning process. Biasutti and Frate (2018) awareness can be used as a reference for a person's ability to understand and develop an awareness of his own cognitive processes and control the process to obtain maximum learning activities. Modrek et al (2018) stated good metacognition awareness can help students to control and manage their own learning processes and strategies. Veenman (2012) and Hargrove (2013) stated metacognitive awareness is referred to as high-level cognition which is able to hone creativity in thinking. Data regarding students creativity can be seen in Table 3.

Table 3. Students creativity

No	Aspects of creativity	Level 1 (Beginners)	Level 2 (Basic)	Level 3 (Proficient)	Level 4 (Advanced)
1.	Curiosity	37.39	54.65	6.42	0.66
2.	Fluency	39.05	53.76	6.64	0.22
3.	Originality	55.97	37.17	6.19	0.00
4.	Elaboration	38.05	52.21	7.08	2.43
5.	Flexibility	52.88	38.50	7.96	0.66
6.	Divergent thinking	54.42	36.73	6.86	1.99

Based on Table 3, it is known that the highest curiosity aspect is at level 2 in the basic category with a percentage of 54.65 and the lowest at level 4 for the advanced category with a percentage of 0.66. The highest fluency aspect at level 2 basic category with a percentage of 53.76 and the lowest at level 4 category advanced percentage 0.22. The highest originality aspect was at level 1 for beginners category with a percentage of 55.97 and the lowest at level 4 for the advanced category with a percentage of 0.00. The highest elaboration aspect is at level 2 basic category with a percentage of 52.21 and the lowest is at level 4 the advanced category is 2.43. The highest flexibility aspect is at level 1 in the beginners category with a percentage of 52.88 and the lowest is at level 4 advanced 0.66. The highest divergent thinking aspect is at level 1 in the beginners category with the percentage of 54.42 and the lowest at level 4 advanced 1.99.

Tabachuk et al (2018) stated creativity is the ability to solve everyday problems, empathy, and insight into social relationships. Greenstein (2012) creativity consists of curiosity, fluency, originality, elaboration, flexibility, and divergent. Tabachuk et al (2018) every student has a creative personality. Table 3 shows that the curiosity aspect of students is dominated by the basic level, which means that students are still not able to explore deep curiosity. Students are only able to ask 1 to 2 questions in biodiversity learning. The questions asked by students are still at a basic level such as What is the definition of biodiversity? or What is the function of biodiversity ?. Students have not been able to ask questions that are analytical. In formulating a problem, students must have initial knowledge as an initiator to think deeper. Siegel (2006) creativity is a combination of knowledge, mental processing speed, and focused control abilities.

The fluency aspect of students (see Table 3) is dominated by the basic level, meaning that students have not been able to come up with alternative solutions to problems and goal solutions regarding the reduction of biodiversity. The solution given by the students to reduce biodiversity is by replanting, or not carrying out illegal logging. Students have not been able to present solutions and explain the objectives of these solutions. This question requires students to answer the direction of modern biology by presenting clear objectives. Students may find it difficult to find new innovative ideas about biodiversity conservation, this is because students are not directly involved in it. Sukesi et al (2019) stated student creativity can be increased through activities that involve students maximally.

The originality aspect of students is dominated by the beginner level, meaning that students have not been able to design two relevant and innovative products to solve the problem of biodiversity. 6.19% were able to answer the question about the solution to reducing biodiversity by making a poster about the importance of biodiversity. Meanwhile, 55.97% of students did not make product designs, some even wrote *sorry, I was unable to think about that.* This problem provides its own challenges for students. Sukesi et al (2019) stated students who have high creativity will prefer to work on difficult questions or questions that involve high-order thinking.

The elaboration aspect of students is dominated by basic level, meaning that students have not been able to provide detailed explanations and add facts related to biodiversity. Students are only able to provide an explanation of the importance of conserving biodiversity, without adding facts that support the importance of the existence of biodiversity. The student's answer was that biodiversity plays a role in maintaining the balance of the ecosystem or biodiversity is a source of food security, the student's answer did not display supporting facts related to the explanation given. The ability to elaborate is obtained from the basic knowledge possessed by students, elaboration is the ability to write or explore as much knowledge as possible with a specific purpose. Hargrove (2013) students who have high creativity will find it easier to elaborate or write well academically.

The flexibility aspect of students is dominated by the basic level, meaning that students are able to present a possibility that will occur if the decline in biodiversity continues. Good flexibility ability, will be obtained if students are able to predict several possibilities that will occur based on a phenomenon. Al-Hilawani and Yaser (2017) stated students are able to make predictions if students have read literature or observed a phenomenon.

The divergent aspect of students is dominated by the beginner level, meaning that students do not combine, adapt or modify an idea in solving a problem regarding biodiversity. Students answered with existing thoughts, namely, replanting plants that were almost extinct, 54.42% of students did not answer questions on the divergent aspect. Puryear (2015) creativity refers to divergent abilities, namely by combining several ideas to solve a problem. The ability to combine, adapt or modify to find solutions can be honed through careful planning and use of efficient strategies.

5.2 Result of Statistical Analyses

Students' awareness of metacognition in learning biodiversity is divided into two things, namely knowledge about cognition and regulation of cognition. 91.55% of students 'knowledge of cognition is in the super category. 60.36% of students' cognitive regulation is in the developing category. The dominance of students' creativity in learning biodiversity, namely curiosity at the basic level, fluency at the basic level, originality at the beginners level, elaboration at the basic level, flexibility at the beginners level, and divergent at the beginners level. Data on the relationship between metacognition awareness and student creativity are presented in Table 4.

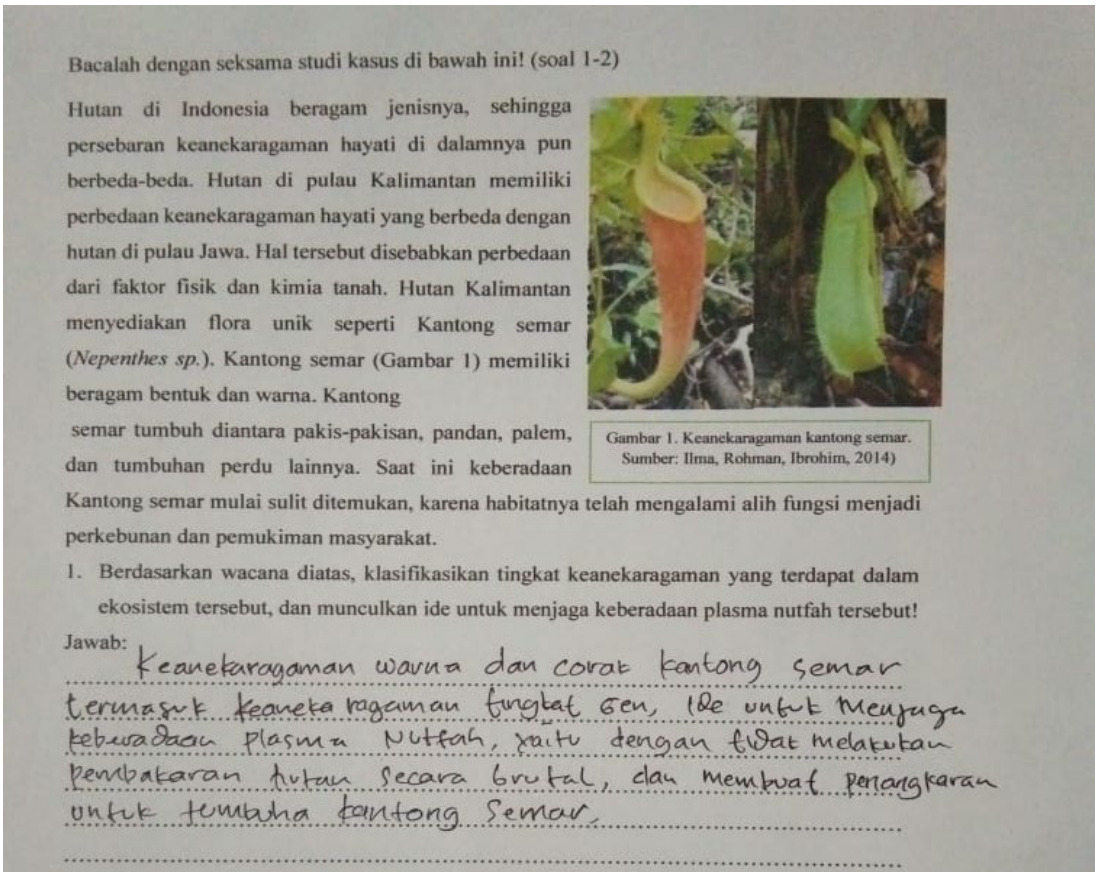
Table 4. Summary of simple linear regression analysis of metacognition awareness of student creativity

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.982	.056		35.656	.000
	Creativity	-.064	.032	-.131	-1.975	.049

a.Dependent Variable: Metacognition Awareness

Simple linear regression analysis of metacognition awareness on student creativity with the regression equation Y` = 1.982+ -0.064x, with a T count of -1.97 and T table 1.97 which shows that there is an effect of metacognitive awareness on student creativity.

Al-Hilawani and Yaser (2017), Erbas and Bas (2015) stated there is a relationship between metacognition awareness and student creativity in learning biodiversity. Several previous studies have revealed similar things. Naoyuki et al (2019) metacognitive awareness and creativity are played by an important part of the brain, namely the prefrontal cortex. Khaterine et al (2017) stated creativity can be done well, if students have good cognitive regulation. Borodina et al (2019) creativity has a relationship with reading, analyzing, and how to regulate the reading and analyzing process. Setting the reading and analyzing process is a form of cognition regulation in acquiring knowledge. Kayumova et al (2010) creativity is a very complex thing, so that in studies students need initial knowledge of biodiversity to make an innovation and development in biodiversity conservation. One of the students' answers regarding biodiversity conservation is shown in Figure 1.



Bacalah dengan seksama studi kasus di bawah ini! (soal 1-2)

Hutan di Indonesia beragam jenisnya, sehingga persebaran keanekaragaman hayati di dalamnya pun berbeda-beda. Hutan di pulau Kalimantan memiliki perbedaan keanekaragaman hayati yang berbeda dengan hutan di pulau Jawa. Hal tersebut disebabkan perbedaan dari faktor fisik dan kimia tanah. Hutan Kalimantan menyediakan flora unik seperti Kantong semar (*Nepenthes sp.*). Kantong semar (Gambar 1) memiliki beragam bentuk dan warna. Kantong semar tumbuh diantara pakis-pakisan, pandan, palem, dan tumbuhan perdu lainnya. Saat ini keberadaan Kantong semar mulai sulit ditemukan, karena habitatnya telah mengalami alih fungsi menjadi perkebunan dan pemukiman masyarakat.

Gambar 1. Keanekaragaman kantong semar. Sumber: Ilma, Rohman, Ibrohim, 2014)

1. Berdasarkan wacana diatas, klasifikasikan tingkat keanekaragaman yang terdapat dalam ekosistem tersebut, dan munculkan ide untuk menjaga keberadaan plasma nutfah tersebut!

Jawab:
Keanekaragaman warna dan corak kantong semar termasuk keanekaragaman tingkat Gen, Ide untuk Menjaga keberadaan plasma Nutfah, yaitu dengan tidak melakukan pembakaran hutan secara brutal, dan membuat penangkaran untuk tumbuhan kantong Semar.

Read carefully the case study below! (Questions 1-2)
Forests in Indonesia have a variety of species. The distribution of biodiversity in it is also different. Forests on the island of Kalimantan, Indonesia have different biodiversity differences from forests on the island of Java. This is due to differences in soil physical and chemical factors. Kalimantan forests provide unique flora such as pitcher plant *(Nepenthes, sp.) Nepenthes* (Figure 1) has a variety of shapes and colors. Semar bags grow among ferns, pandanus, palms, and other shrubs. Currently the existence of semar bags is starting to be difficult to find, because their habitat has been converted into plantations and community settlements.
1. Based on the above discourse, classify the level of diversity contained in the ecosystem, and come up with an idea to maintain the existence of the germplasm!
Answer:
The diversity of colors and patterns of semar bags including gene level diversity.
The idea to maintain the presence of germplasm is by not illegally burning forests and creating a breeding ground for the pitcher plant.

Figure 1. Student Creativity Essay Test

Figure 1 shows the results of students' answers on the aspect of fluency. Figure 1 is an example of a student's answer with a score of 4, which means that the student's answer is able to mention some relevant ideas. The prerequisite for answering questions on the fluency aspect is basic knowledge. In this case students already have knowledge of the definition of biodiversity, germplasm, levels of biodiversity, threats, and conservation efforts. so that students are able to come up with some ideas for preserving biodiversity. Puryear (2015) explained that basic knowledge is part of declarative knowledge. Declarative knowledge is knowledge about a person's skills, intellectual resources, and abilities as learners. The relationship between metacognitive awareness and student creativity needs to be considered in more detail, not just paying attention to the cognitive aspects alone. Hargrove (2013) explained that metacognition awareness can improve students' higher order thinking skills. In more detail, Kozikoglu (2019) adds that metacognitive awareness plays a role in the formation of critical thinking patterns, creativity, and problem solving. Therefore, it is important to develop metacognitive awareness and creativity of students in learning.

5.3 Validation

The metacognition awareness questionnaire has been validated with Cronbach's Alpha coefficient is 0.18> 0.11, this figure shows that the instrument that has been compiled is valid and reliable. Creativity has been validated with Cronbach's Alpha coefficient is 0.79> 0.11, this figure shows that the creativity description test instrument that has been prepared is valid and reliable.

6. Conclusion

The conclusions in this study are as follows.
1. The profile of students 'metacognition awareness on the aspect of knowledge about cognition is 91.55% in the super category. 60.36% of students' cognitive regulation is in the developing category.
2. The profile of students' creativity in learning biodiversity, the highest curiosity aspect is at level 2 in the basic category with a percentage of 54.65 and the lowest at level 4 for the advanced category with a percentage of 0.66. The highest fluency aspect at level 2 basic category with a percentage of 53.76 and the lowest at level 4 category advanced percentage 0.22. The highest originality aspect was at level 1 for beginners category with a percentage of 55.97 and the lowest at level 4 for the advanced category with a percentage of 0.00. The highest elaboration aspect is at level 2 basic category with a percentage of 52.21 and the lowest is at level 4 the advanced category is 2.43. The highest flexibility aspect is at level 1 in the beginners category with a percentage of 52.88 and the lowest is at level 4 advanced 0.66. The highest divergent thinking aspect is at level 1 in the beginners category with the percentage of 54.42 and the lowest at level 4 advanced 1.99.
3. There is a relationship between metacognition awareness and student creativity in learning biodiversity.

The recommendation of this research is to conduct a more in-depth study of the factors that influence the level of metacognitive awareness and creativity of students, studies of teacher metacognition awareness, and conduct studies on special treatments in learning to empower students' metacognitive awareness and creativity.

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