Analysis of Conceptual Understanding of Botany and Metacognitive Skill in Pre-Service Biology Teacher in Indonesia

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Abstract

The achievement of learning objective of Biology, especially Phanerogamic Botany requires several important aspects, namely conceptual understanding and metacognitive skill. Analysis of conceptual understanding of Botany and metacognitive skill is needed to know to what extent are both aspects of achieving the learning objectives. The research aims to know and analyze the conceptual understanding and metacognitive skill of college students to achieve course objectives. The research is conducted in July 2018 at the Universitas Negeri Jakarta in Phanerogamic Botany course Eudicot sub-course material with 77 students as sample. The research includes quantitative research with descriptive approach. Results obtained are, among others, the mean of conceptual understanding of Botany and metacognitive skill is 63.07 and 50.15, respectively, which is low based on the achievement score. The analysis result indicates that conceptual understanding of Botany is considered as low due to the difficulty faced by students in finding an example for each *clade* and in understanding the scientific terms that are the base of the learning. Students, however, can apply the concept into problems faced and students' metacognitive skill in student planning aspect is unable to arrange goals to be achieved to prioritize the learning.

Keywords
botany, conceptual understanding, metacognitive

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Introduction

The achievement of Biology learning objectives requires several essential aspects, among others, conceptual understanding and metacognitive skill (Mariati, 2012; Darmawan, Brasilita, & Saptasari, 2018; Djamahar, Ristanto, Sartono, Ichsan, & Muhlisin, 2018). The importance of conceptual understanding is required to achieve learning objectives related to basic conceptual understanding to develop and add information during a learning activity (Ardila, 2012; Lukitasari, 2014; Dewi, Nilawarni, & Rusdi, 2015; Sartono, Komala, & Dumayanti, 2016; Ristanto, Zubaidah, Amin, & Rohman, 2018a). Whereas, metacognitive skill is needed in managing one's learning activity, such as strategies in planning, monitoring, and evaluating his/her cognitive activities (Schraw, Crippen, & Hartley, 2006; Fauziah, 2013; Djamahar et al., 2018).

For Biology pre-service teachers, Biological concept is vital to understand (Muhlisin, Susilo, Amin, & Rohman, 2016; Ristanto, Zubaidah, Amin, & Rohman, 2018a; 2018b; Ismirawati, Corebima, Zubaidah, & Syamsuri, 2018; Lestari, Ristanto, & Miarsyah, 2019). The understanding is the basic that connect knowledge and skill of the pre-service teachers in teaching; thus, they will be able to understand and develop themselves according to their role as the center of knowledge or as a facilitator (Sequeira, 2012; Ristanto, 2017). In line with that, the knowledge, understanding, and skills are obtained from self-learning from reading sources, so that they could develop their competence through teaching experience (Felder, 2005; Darmawan et al., 2018). It can be integrated by reflecting an understanding of the use of the learning model when they study (Abulon, 2014; Lestari, Ristanto, & Miarsyah, 2019).

Conceptual understanding can be obtained through reading and writing activities during learning, but it is not always emphasizing on memorizing activities (Zuhaida, 2018; Ristanto et al., 2018b). The existence of conceptual understanding aspect during learning facilitates someone in constructing content obtained with other materials (Afifah, & Sopiany, 2017; Ristanto et al., 2018). Since to understand a concept, it is necessitated to know the sample or application to problems related to those learned (Laying, 2013; Bustami, Riyati, & Julung, 2019).

Metacognitive skill can be trained in learning activity (Nurmaliah, 2009; Muhlisin, Susilo, Amin, & Rohman, 2018), such as the arrangement of learning strategy, both during learning and task completion (Parrott & Rubinstein, 2015; Livingston, 2003; Lestari et al., 2019), and time management in learning (Haryani, 2018; Djamahar et al., 2018). It can stimulate one's thinking arrangement either in thinking (Howard, 2004) or the arrangement of appropriate strategies (Palennari, 2016).

Several basic problems in Biology learning, especially Phanerogamic Botany, are a weak basic concept, abstract terms, and a considerable amount of content learned (Palenari, 2016; Hanif & Rohman, 2016). Another problem is the tendency of

student to wait for the lecturer order to look for information and tasks related to the content that causes lack of independence or weak metacognitive skill among the students (Halimah, 2014; Prayitno, 2015; Nurajizah, Sistiana, & Setiono, 2018).

Phanerogamic Botany course is essential to understand since it consists of classification and identification that base on classification terms mostly used in Plantae learning in high school or college; thus, pre-service teacher should master it. Indicators of achievement in Phanerogamic Botany course of Eudicot sub-course material are to explain and understand the reason for differences in Eudicot classification between APG II and APG IV; to identify the habitat characteristics, structure or morphology of Clade body, and phylogeny; to know and understand well on the role of Eudicot in Clade or species level. As for reading sources for the achievement of these indicators include Tjitrosoepomo (2004), Chase et al., (2016), and several journals relating to Botany Phanerogame.

Conceptual understanding can be observed from how to restate what has been learned, to group an object based on its nature and to explain the relevant samples, and to apply what has been discovered in the daily life (Wardhani, 2008; Tuaputty, 2012; Eggen & Kauchack, 2012). Whereas, the metacognitive skill can be observed from activities of planning, monitoring, and evaluating the learning activities (Livingston, 1997; Howard, 2004; Kusumaningtias, Zubaidah, & Indriwati, 2013; Pratama, 2018).

Based on the discussion, analysis of conceptual understanding of Botany and metacognitive skill of pre-service Biology teachers in Phanerogamic Botany course is needed to know to what extent are both aspects contribute to the achievement of learning objectives and its problems in Biology learning at the Universitas Negeri Jakarta.

Method

The research was a quantitative research with descriptive approach (Sugiyono, 2013). Research population was all college students (hereafter refers to students) who enrolled in Botany of Phanerogamae course semester 108 in Biology Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta in academic year of 2018/2019. Sample in this study uses the Nonprobability technique that is with saturated samples (total sampling). According to Sugiyono (2013), a saturated sample is a sampling technique by taking all members of the population as respondents or samples. So, the sample in this study was all students who were taking Botany Phanerogamae courses. The overall score will be obtained on average, according to the rubric, then the answers will be analyzed according to the rubric of metacognitive skill.

Instruments used were conceptual understanding of Botany in the form of test question with juxtaposing and essay types and metacognitive skill in kind of essay

type test. Juxtaposing test consisted of 20 questions and 23 answers aimed to know the understanding of the pre-service teachers of different terms in identification and classification, whereas essay consisted of one problem with two descriptions designed to identify and develop the concept understood.

Indicators for conceptual understanding of Botany were a modification from Indonesia National Education Standard Board (2016), and indicators for metacognitive skill were a modification from Metacognitive Awareness Inventory (MAI) from Harford Community College (2014) and the rubric of metacognitive using by Corebima (2014). The instruments were validated by validators who are an expert in their field and then distributed to students after participating in Eudicot content that should be completed in 90 minutes. Answers from respondents were analyzed based on indicators of conceptual understanding of Botany and student metacognitive skill (Table 1).

Table 1.

Indicator Concept Understanding and Metacognitive Skill

Variable	Indicator
Conceptual Understanding of Botany	Restate the learned concept. Classify objects according to certain properties. Give examples and non-examples of the concept. Present the concept in various representation forms. Develop the necessary condition and sufficient condition of the concept. Apply the concept to problems faced.
Metacognitive Skill	Planning Monitoring Evaluation

Data analysis in the research consisted of reducing, presenting in the form of descriptive form, and concluding the conceptual understanding of Botany Phanerogamic and metacognitive skill of students in completing Eudicot content questions. The result of instruments filling was analyzed for the mean of both aspects based on pass criteria at the Universitas Negeri Jakarta and described based on indicators and the determined rubric (Corebima, 2014).

Results and Discussion

The average of conceptual understanding and metacognitive skill scores of Biology Education students was 56.61. It considered as not-pass since the score was below 70. The percentage of non-pass students was 59%. Based on the data, it can be

seen that both aspects were low. It was due to, among others, students' weakness in understanding the basic concept such as scientific terms and the non-independence in obtaining content sources other than those learned and given by the lecturer (Table 3).

Table 3.

Indicators of Conceptual Understanding of Botany and Metacognitive Skill

Variable	Indicator	Mean	Total mean	Note	Percentage*	
					Pass	Not Pass
Conceptual Understanding of Botany	Restate the learned concept	13,3	63,07	C-	41%	59%
	Classify objects according to certain properties	13,3				
	Give examples and non-examples of the concept	4,9				
	Present the concept in various representation forms	13,3				
	Develop the necessary condition and sufficient condition of the concept	13,5				
	Apply the concept to problems faced	7,6				
Metacognitive Skill	Planning	26,6	50,15	NP		
	Monitoring	13,3				
	Evaluation	10,0				
	Total mean	56,61				

Note: Assessment criteria of UNJ: Not-Pass (< 61); C+around 61; minimum pass criteria for undergraduate is B-; *All pre-service biology teachers.

Based on the research result, the mean of student conceptual understanding was 63.7. It indicated that student conceptual understanding was low since the passing score for the university unit was above 66. According to Hanif & Rohman (2016), Suraida (2012), and Ristanto et al., (2018a) namely lack understanding on definition and foreign terms, identification of a reasonably complex species and differences in the classification of APH II and APG IV, are among factors contributing to the low conceptual understanding.

Student conceptual understanding of basic things such as definition and different terms in classification should be already understood (Djamahar et al., 2018). Basic knowledge of content will shape and develop a weak or wrong content, and it will have a direct impact on the content understanding or indirectly when constructing it with other material (Sands, 2014; Muhlisin et al., 2016). Also, the utilization of commonly used learning model is inappropriate for all contents either content topic, subject, and individual, as well as learning objectives; therefore, it creates ineffectiveness in learning and has an impact on the low understanding of student (Entwistle, 2008).

A heterogeneous group of student is also important to apply so that students who have low understanding on content could be assisted by other students who have a better understanding on content learned and it also helps in reducing misunderstanding on a definition of a term as well as the example in its classification (Malone, 2017). Basic understanding of content will lead to high-quality learning that can be seen from knowledge, skill, and basic understanding of content learned thus is able to give broader view on the content and the achievement of learning objectives emphasizing on interconnected or constructed knowledge and understanding (Abulon et al., 2014; Muhlisin et al., 2018).

Table 4.

Analysis of Conceptual Understanding of Botany (juxtaposing question)

No.	Indicators Should be Fulfilled	Analysis
1	Give examples and non-examples from the concept	Mistaken in determining samples from each clade
2	Develop necessary condition or sufficient condition of the concept	Difficulty in understanding scientific terms that are the basis of learning
3	Apply the concept to problems faced	Able to apply the concept to problem faced

Table 4 indicates that conceptual understanding of Botany, especially in Eudicot content was low. The weaknesses were related to the mistake among the students in determining samples from each clade with mean of 4.975, and difficulty in understanding scientific terms which are the basis of learning; however, students were able to apply the concept to problem faced with mean of 7.6 (Table 3). According to Sands (2014), conceptual understanding can be obtained from actual information by leading to a sample of problem faced; thus, it could reconstruct based on experience and learning obtained.

Conceptual understanding is not based on memorizing-based learning and rigid learning implementation (Viennot, 2008). Some problems of conceptual

understanding built on the one's perception on content that is learned, such as basic concept of a complicated content and it can be seen from the weak information used to explain a phenomenon, thus one finds difficult to understand completely (Kristian, Cari, & Sunarno, 2018; Ristanto et al., 2018b).

The mean of student metacognitive skill was 50.15 (Table 3). It indicates that student metacognitive skill was low since it was below 66, whereas the completeness score in the Universitas Negeri Jakarta should be B-. According to Hammond, Austin, & Cheung, (2017), Darmawan et al., (2018), and Pratama (2018) metacognitive skill is important to be empowered so students become more efficient and robust in the learning such as in finding information, additional information sources, and understanding of learning strategies. Evangeline (2012), added that developing metacognitive skill must be done by lecturer since it could help student to arrange to monitor and guide understanding in learning to familiar the students with self-learning that includes reflecting and arranging their learning ways or strategies.

Metacognitive skill involves strategic thinking ability in problem solving, planning, goal determination, ideas setting, and understanding of what known and unknown (Hogan, 2014). Learning on how to monitor self-thinking process thus a person could do self-correction without relying on others who emphasize more on seeing and criticizing what was done (Garcia, 2015; Ardila, 2012; Djamahar et al., 2018; Lestari et al., 2019).

The role of lecturer is related to the implementation of appropriate learning model in content to be learned and help in discussion and give encouragement or direction (Hogan, 2014; Susiati, Adisyahputra, & Miarsyah, 2018; Permana & Chamisijatin, 2019). Student-centered learning is also good to use to strengthen or empower metacognitive skill, such as considering knowledge, expertise, attitude, and believe in what can be done and want to be done (Coskun, 2018). It is important also to allow students to ponder on what they have learned to know their own understanding level (Garcia, 2016).
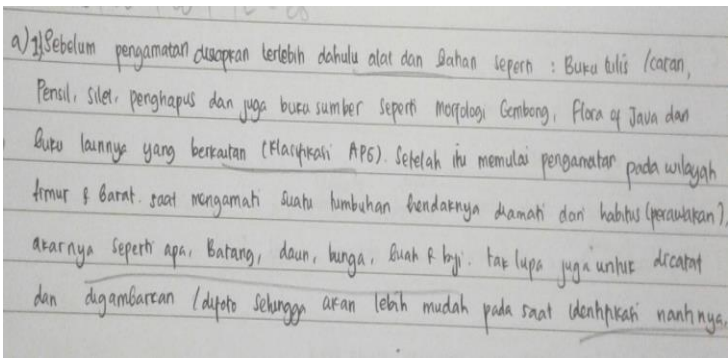
Planning aspect includes goal setting, steps and the allocation of things to be prioritized first in learning; monitoring issue includes learning assessment or the use of strategies; and evaluation aspect contains analysis about what has been done and effective strategy after learning implemented (Schraw, Crippen, & Hartley, 2006; Indariswati, 2016). The basic of metacognitive skill assessment are: (a) answers are written in their own sentences; (b) sequence of responses is harmonious and systematic; (c) answers are incorrect logic grammar and supported by analytic evaluative or creative explanation reason; (d) correct answer (Corebima, 2016).

Based on the analysis conducted, in planning aspect of student metacognitive skill indicated that students were still unable to set goals to be achieved and to allocate prioritize in learning. It can be seen in the mean value of 26.6 for planning aspect (Table 3), and the sequence of answers was unsystematic, no attention on correct

grammar, and the answers was not evaluative (Table 5). Understanding what should and will be done on a problem is needed so someone could implement strategy thoroughly and structured (Zuhaida, 2018; Muhlisin et al., 2016). Metacognitive skill is required so that someone could know the thinking process; thus, he/she could make a decision and solve a problem. The skill can be habituated or trained in daily activities (Nurmaliah, 2009; Lestari et al., 2019). In the planning aspect, someone is demanded to do their own time management (Haryani, 2018).

Table 5.

Analysis of Student Metacognitive Skill (Planning)

Component	Substance
Question	What are the steps to be obtained if you are going to do the observation, and what are the reading sources?
Answer	
Analysis	*Planning (metacognitive skill)* ▪ Unable to set goals ▪ Unable to allocate what to be prioritized first (ongoing and to be done)

The systematic of answer based on setting and good learning management was by the sequence of content should be learned first or prioritized (Veenman, 2005). The sequence setting of content to be learned, currently learn and has been learned or task completed then adjusted to how someone manages their own learning thus it leads to the understanding of content or responsibility learned or achieved (Parrot, 2015).

Based on Table 6, it can be seen that regarding student conceptual understanding of Botany it indicated that students had able to restate the Eudicot concept correctly with mean; however, they were unable to classify every Clade well and to present the concept in other applicative forms according to the content given. Mariati (2012) and Ismirawati et al., (2018) stated that one's activities in understanding a content could be seen on how he/she could deepen the content, for example by restating the

concept, classifying similar concept, constructing knowledge, and applying the concepts to a problem.
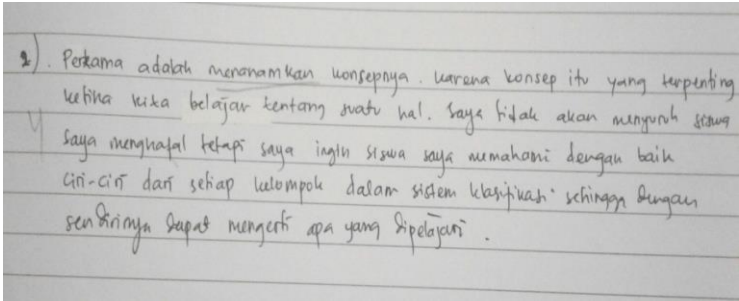
Table 6.

Analysis of Conceptual Understanding (Restating, Classifying, and Representative Concept) and Metacognitive Skill (Monitoring)

Component	Substance
Essay Question	Create a conceptual map for Spermatophyta topic in high school consisting of classification, the basic concept of classification, characteristics of each clade, an example of each species.
Answer	
Analysis	**Metacognitive Skill** — *Monitoring* ▪ Believe in the strategy chosen ▪ Did not conduct the steps steadily ▪ Did not check the truth of the steps from the chosen strategies **Conceptual Understanding** ▪ *Restating the concept learned:* Able to restate the concept, often confused. ▪ *Classifying objects according to certain properties:* Unable to categorize the content according to its clade ▪ *Presenting concept in various representative forms:* Unable to present the concept according to the content given

Regarding monitoring aspect of the metacognitive skill, the mean obtained was 13.3 of the total mean (Table 3), and the answer analysis indicated that students had able to choose learning strategy correctly but did not do the steps of the procedure properly as well as recheck the truth of the approach used (evaluative). It indicated that the answer was not coherent and systematic according to the sequence of Eudicot classification, and it did not provide a clear explanation (Table 6). The activity can be done for monitoring stage is by connecting information obtained to the existing theories or contents (Zuhaida, 2018). Indicators of task performance understanding that can be seen from the ability of learners in analyzing, connecting, and applying knowledge owned in problem-solving could also be developed in monitoring component aspect (Haryani, 2018).

Table 7.
Analysis of Metacognitive Skill (Evaluation)

Component	Substance
Question	After learning Phanerogamic Botany content, what tips will you prepare to teach Spermatophyta content in senior high school?
Answer	
Analysis:	▪ Unable to apply steps used for other questions ▪ Did not analyze actions from the strategies conducted ▪ Did not recheck the answer

Mean of evaluation aspect score from metacognitive skill was 10 out of the total score (Table 3), and the result of test answer analysis indicated that students were unable to apply steps used for other questions or construct it on different contents, unable to conduct analysis on stages of the strategies undertaken, and did not review the answer (Table 7). Efforts to know the ability level owned and make a summary of what have learned or interpreted it in daily activity (Zuhaida, 2018; Darmawan et al., 2018). Evaluation needed to be included how the strategy supported and appropriate, how to combine the strategies; thus, the goals are achieved, and alternative strategies from stages used (Parrott & Rubinstein, 2015). Evaluation components can be assessed from how someone faces a problem, evaluates goals of

the problem, and concludes it.

Conclusion

Based on the research result, it can be concluded that the mean of conceptual understanding of Botany and metacognitive skill was 63.07 and 50.15, respectively, which was lower than the achievement score. The analysis result indicated that conceptual understanding of Botany was weak due to the difficulties faced by the students in determining samples from each Clade and in understanding scientific terms, which are the basis of learning. However, students were able to apply the concept to the problems faced.

Regarding metacognitive skill in planning aspect, students were unable to set goals to be achieved and unable to allocate things to be prioritized first in learning. In the aspect of monitoring, students are skilled at choosing the right learning strategy but do not re-examine the strategy. In the evaluation aspect, student has not been absorbed in implementing the steps of the learning evaluation process and achievement.

The finding of this study has several implications related to students not yet reaching the level of conceptual understanding of Botany and metacognitive skills as expected. The student is less able to meet the standards or objectives of lectures well. It is difficult to direct constructive learning, and independence in learning will have an impact on their abilities as pre-service Biology teacher who emphasizes understanding the material, find sources of discussion material other than the material causes that have been determined. Biological learning processes in pre-service teacher should be designed and prepared to empower and further develop the ability for fonceptual understanding of Botany and metacognitive skills.

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