Students’ Cognitive Abilities in Plant Anatomy Practical Work

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Abstract. Cognitive abilities is fundamental for the students, as it is closely related to higher thinking skills such as the ability to think critically, creatively, and problem solving. This descriptive study aims to investigate the cognitive abilities of biology prospective teachers in the course of Plant Anatomy Practicum based on the cognitive process dimension and dimensions of knowledge the using the framework of Revision of Bloom taxonomy. A number of biology prospective teachers was involved in this study (n=42). The instrument used to collect data for students' cognitive process mastery in the form of multiple choice with 5 options. Research finding shows that the average student's cognitive ability is 68.10. The acquisition of knowledge mastery of cognitive ability is still under the criterion of mastery in the course of the Plant Anatomy Practicum (75). Validity and reliability of the instrument (0,71) and (0,81). It is necessary to design lecture programs both in the class and laboratory to develop student’ cognitive abilities.

1. Introduction
Cognitive abilities are the abilities to carry out brain activity (thinking activity) to gain knowledge. Cognitive abilities based on revised bloom taxonomy [1] include the ability to memorize, understand, apply, analyze, evaluate, and create. These cognitive abilities show the gap ranging from simple cognitive processes to more complex cognitive processes. Cognitive abilities are fundamental to be mastered by students, especially for a pre-service biology teacher. Students' cognitive abilities become an important factor in determining the success of students in their studies [2]; [3]. Cognitive abilities possessed by students become the basis for the formation of other capabilities that must be owned by students. The ability to think critically, creatively, and problem solving requires a complex cognitive process, so that this cognitive ability becomes an important position [3]. The process of cognition encompasses various aspects, such as perception, memory, thought, symbols, reasoning, and problem solving. Based on Piaget's opinion, developing cognitive abilities in the student is important so that students: 1) Are able to develop their perception based on what he sees, hears, and feels so that the child will have a complete and comprehensive understanding; 2) Are able to train his memory of all events and occasions he experiences; 3) Are able to develop his thoughts in order to connect one event with another. 4) Are able to understand the various symbols scattered around the environment; 5) and able to do good reasoning that is occurred through a natural process (spontaneous) or through a
scientific process (experiment). Students' success in learning is influenced by mastery of prerequisite materials before accepting new material. The most important factor in influencing the learning process is what the students already know [4]. New concepts or new information must be linked to existing concepts in the student's cognitive structure "[6]. So before students learn a material, relevant concepts must already be exist in the student's cognitive structure, so that students will have no difficulty in accepting new material. A complex concept in science can only be understood if the more fundamental concepts involved in the formation of a new concept have been fully understood [6]. The mastery of prerequisite material for the success of students is important, that is why the teacher always have to direct and improve the concepts that relate to students in order to follow the new lesson.

Teaching-Learning process is one complicated process because students does not merely absorb information from the teacher but also involves various activities and actions that must be done, so that the teaching-learning process should be able to emphasize the various activities and actions by using certain methods and approaches that can develop the active learning, for both teachers and students [6]. Furthermore, Knowledge is built into the mind of the child through assimilation and accommodation [4]. Assimilation is the absorption of new information in the mind. While accommodation is rearranging the structure of the mind because of new information, so that the information has a place in the brain. Another definition of accommodation is that accommodation is the mental process that involves the creation of a new scheme that matches the new stimulation or modifies the existing scheme to fit the stimulus [6]. Constructivism as a cognitive psychological flow argues that knowledge is the meaning of a reality and man must build the meaning to the reality. The implication of the constructivism theory in teaching-learning process is that knowledge can not be transferred entirely from the teacher's mind to the mind of the student. Students themselves who should be mentally active constructing their knowledge, especially related to the physical knowledge and logic.

Plant Anatomy is one of the compulsory materials in Biology Education Studies Program. This Plant Anatomy Material is usually packed in a course of Plants Anatomy, in some universities this subject is broken down into two different courses which is Plant Anatomy Course and Plant Anatomy Practicum. In the curriculum structure of Biology Education Program of University of Muhammadiyah Sukabumi (UMMI), the material of plant anatomy is taught on the subject of Plant Anatomy and Plant Anatomy Practicum. This Plant Anatomy Practicum program requires students to:

1. Able to master the concepts, principles, laws and theories about the structure of plant anatomy; 2. Students are able to identify the complexity of network structures that make up plant organs; 3. Students are able to analyze the relationship between the anatomical structure of the plant and its function; 4. Students are able to analyze the relationship between plant anatomy structure and form of adaptation done by plants; 5. Students are able to apply knowledge about plant anatomy structure; 6. Students are able to communicate the results of scientific inquiry in the form of scientific papers; 7. Students are able to do scientific inquiry to develop knowledge about the structure of plant anatomy. Students are also required to be able to master the procedural knowledge in terms of making the preparation, perform observations under the microscope, and able to study microscopic images of observations under a microscope [7]. In the plant anatomy practicum, the students are required to be able to relate the knowledge acquired through the theory from the practical work and have spatial ability to explain the observed images under a microscope[8]. The demands of skills in learning outcome of the course and demands in doing the practical work of Plant Anatomy requires students to think complex, the demands are not only to memorize and understand the material but students are required to be able to apply knowledge, analyze, evaluate, and create.

The purpose of this research is to obtain a picture of the cognitive abilities of students based on the cognitive process dimension from the new bloom taxonomy, and to know the obstacles and problems facing students in the process of acquiring knowledge, especially in Plant Anatomy Practicum. A learning experience that enables students to be physically and mentally involved and facilitates the construction of knowledge processes becomes an important position. Learning experiences organized by teachers or lecturers should provide an opportunity for students to construct knowledge. Learning
experience that has to be held in the teaching-learning process of science is inquiry [9]. Inquiry learning can improve the mastery of concepts [10]; [11]; [12]; [13] & [14]. Inquiry-based learning allows students to gain a learning experience like when a scientists construct scientific knowledge. Inquiry-based learning involves students hands on and minds on in the process of constructing knowledge, thus creating meaningful learning. The significance of this process will positively affect the achievement of student competence.

2. Method
This research is a qualitative research that aims to explain the phenomenon of students' cognitive abilities in the context of Plant Anatomy Practicum. This research was conducted in Biology Education Study Program. Its implementation time is in the odd semester of the 2015/2016 school year. The subjects of this research are 42 students who take the course of the Plant Anatomy Practicum. Research data is in the form of cognitive ability test results that are analyzed descriptively and qualitatively.

The implemented activity of plant anatomy practicum in this research is learning experience which is proving or verifying knowledge obtained from theory. Practicum is carried out starting from cell material and its parts, basic tissue system, vascular and organology. Data collection was performed through cognitive ability tests based on cognitive ability level in revised bloom taxonomy [1] from C2, C3, C4, C5 and C6 levels and interviews with students. The data of the research were then analyzed and compared with predetermined success indicators. Parameters used to measure the achievement of cognitive ability is a score-based parameter of achievement of learning mastery in the course of Plant Anatomy, which is 75.

3. Result and Discussion
The results obtained are quantitative data of students' cognitive ability and qualitative data of the interview result. Data is presented in the form of graphic drawings and descriptions. Figure 1 shows students' cognitive abilities based on cognitive process dimensions and Figure 2 shows students' cognitive abilities based on the knowledge dimension.

![Figure 1](image-url)

**Figure 1. Student cognitive ability based on the cognitive process dimension**

Figure 1 above illustrates the mastery of the cognitive abilities of pre-service biology teacher. Of the four levels of cognitive process dimension measured, mastery at the C2 level attainment is the highest, followed by ability at C4, C5 and last level at C6 level. The data in Figure 1 shows that students still have difficulty in mastering the level of cognitive process dimension at C3, C4, C5 and C6 levels.
Figure 2 shows the mastery of cognitive abilities based on the dimensions of factual, conceptual and procedural knowledge. Figure 2 shows that the mastery of the students' procedural knowledge has the lowest attainment compared with the mastery of the conceptual and factual dimensions. The dimension of factual, conceptual, procedural and metacognitive knowledge is a gap that describes the ability of concrete thinking to abstract thinking [1]; [15]. The results of the study illustrate that students have difficulty in abstract thinking. This is due to the mastery of procedural dimensions that are lower than the conceptual and factual dimensions. The achievement of this knowledge dimension shows that the tendency of students to have difficulty in abstract thinking. This will affect the students' complex thinking ability. In addition, the low acquisition of the factual knowledge dimensions is caused by students who do not fully understand several procedures in the plant anatomy practicum. Results of interviews with students show that students do not know some procedures in making the preparation, for example students do not know what reagents should be used when they will observe the berlignin cell wall. Some students also do not know the procedure of making fresh preparation properly.

Achievement on the cognitive process dimension of C2 level is higher than the other level, but the achievement is still below the passing grade which is 75. At the C2 level, students are required to be able to understand the material content of plant anatomy. Students are considered to be understood if they can construct the meaning of the learning messages, whether they are spoken, written or graphically conveyed through the teaching process [1]. Students can understand something well if their conceptual understanding is also good. Conceptual understanding underlies the students in understanding something. The results of the study showed that at level C2, student is facing difficulties to understand the knowledge on conceptual dimensions, student is facing difficulties on reconstructing the meaning of descriptive messages, and student is facing difficulties to describe the characteristics of plant tissue using words.

Achievements at C3 level are lower than C2 and C4 levels. Apply with regard to procedural knowledge [1]. Thus, students' procedural knowledge influences the achievement of the cognitive process dimension at C3 level. The results showed that the students' procedural knowledge is lower than the factual and conceptual knowledge, so it is reasonable that the achievement of C3 level is still low. In the above explanation mentioned that the low achievement of this low level of C3 is the ability of students to think abstract is low and students do not understand some procedures in learning practicum plant anatomy. Achievements at the C4, C5 and C6 levels show that students still have difficulty mastering the cognitive processes dimensions at the level of analyzing, synthesis and creating. Thinking occurs when someone takes new information to be then is stored in the memory and interconnects or rearranges and extends this information to reach the goal or find possible answers in confusing situations [3]. The process of thinking will be more complex if it requires students to connect information, analyze information, and create inferences from observed phenomena. Cognitive processes at a high level
require abstract thinking skills [1], so if the student is facing difficulties in solving the problem of

cognitive processes at this high level, it indicates that students' abstract thinking ability is still low.

The picture on the side is the image of the transverse section of the dicotyl plant stem on the primary growth. Here is a schematic drawing of the stem that you think best fits the image of the observation on the side.

Figure 3. Sample item for cognitive abilities at level C6 (factual)

The process of thinking from C4 to C6 levels is included in complex thinking or better known as "High-Level Thinking", the three aspects are aspects of analysis, evaluation aspects, and aspects of creation [1]. Analyzing includes the ability to parse an issue or object into its elements, cognitive processes in analyzing include: differentiating, organizing, and finding the implied message [15]. Creating is the ability to combine several elements into a unified form and the ability to produce something new by organizing some elements or parts into previously invisible patterns and structures, these capabilities can include: making, planning and producing [15]. The other three aspects of the same realm, namely the aspect of remembering, the aspect of comprehension, and the aspect of the application, fall into the intellectual part of the lower-order thinking. At the C4 level, students are still struggling to organize information. Students struggle when told to determine the relationship between the anatomical structures of the tissue or plants' organ with its function and make the relationship between the anatomical structures observed with the new situation presented. Meanwhile, at the C6 level students are still struggling in formulating hypotheses that meet certain criteria.

The results of interviews with students, shows that students have difficulty in solving problems at high cognitive process level because the students have not been accustomed to work on these questions, so students find it difficult to solve these problems. Learning experience that is experienced by students, especially on practicum learning also affects the ability to think students. The practical learning experience that the students get during this time is still a verificative experiential learning experience (practicum to proof), the students are not familiar with the investigative practicum. This is a factor causing the complex thinking ability of students still low. Verificative learning practicum experience only train the ability of cognitive processes in terms of understanding the contents of material that is constructed through the activities lab.

The plant anatomy practicum requires students to think complexly, students are required to analyze the observed images under a microscope, then analyze the linkage between the structure of the tissue or organ with the function of the tissue or organ [7]; [8]. Ability to analyze not only requires students to combine a lot of information but also requires students to think abstract. If the abstract thinking ability is still low, students will find it difficult to analyze and cognitive processing higher than that, such as to create.

The ability to think complex requires students to connect information, describe the information obtained, make consideration of the obtained information, and produce something new based on the information obtained through the learning process. Incomplete information will make it difficult for students to make connections between information. The results of interviews with some students shows that in the process of learning in the course of Plant Anatomy Practicum students are not
required to obtain extensive and in-depth information, students only get information from the explanation of lecturers during the lecture activities carried out. Information that is partially understood will cause students to engage in high-level thinking processes. The practical learning experience that only verificative also does not provide the learning experience to the students to have complex thinking skills.

The acquisition of knowledge is also influenced by the learning experience that is experienced by the students. Principally, the learning experience should enable student involvement in the learning process. Knowledge must be constructed by students themselves through the learning experience experienced by students, so it is very important to involve students in the learning process [8]. Less meaningful learning experiences will make it difficult for students to understand the concept or concept construction. [9] States that one of the standards in teaching science is inquiry. Inquiry is a learning experience that can be held by lecturers in order to build student knowledge. Inquired earning experience will help students construct the knowledge that is required in the learning process. Inquiry learning can strengthen students’ abilities in carrying out various cognitive processes [16]. Experience through observing, identifying problems, designing experiments, collecting data, and analyzing data enables students to gain experience and constructed knowledge naturally, like a scientists discover and gain knowledge. Inquiry-based learning can also develop students’ ability to develop a number of important basic skills possessed by students such as problem-solving skills, critical thinking skills, and creative thinking skills.

4. Conclusion

The results of this study showed that students' cognitive abilities in Plant Anatomy materials are still low, especially in the high-level cognitive process dimension. Students are still struggling in performing the process of thinking, especially at the level of the ability to think complex such as analyzing, and creating. These three levels of thinking processes require students to connect a lot of information, and it becomes an obstacle for students. The learning experience that is experienced by students during the formation of such knowledge becomes an important factor of student's success in shaping their knowledge. Lecturers must design a learning experience that can assist students in reconstructing their knowledge, especially at the level of high-level cognitive process dimension. It is necessary to design lecture programs both in the class and laboratory to develop students’ cognitive abilities.

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