Student’s inquiry skills and learning achievement in plant anatomy practical work using open-guided inquiry

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\textbf{Abstract}. The important of inquiry based learning (IBL) had been investigated, but not the inquiry skills as fundamental skills for students, especially prospective teachers. This descriptive study was carried out to get illustration about the inquiry skills and their knowledge from practical open-guided inquiry in plant anatomy practical works. A number of prospective biology teachers in second semester was involved as participants \((n=23)\). Data were collected through the use of certain instruments to detect inquiry skills and concept mastery got from IBL practical activities. Research results show that the prospective biology teachers can achieve score on inquiry skills as well as concept mastery above the minimum score determined previously \((75)\). IBL laboratory experienced by prospective biology teachers can debrief their inquiry skills and help them in constructing knowledge they need in science instruction.

1. Introduction

Inquiry skills become an important standard in the curriculum of preparing pre-service science teachers [1], [2], [3]. Inquiry skills are required by students to investigate the object being studied. Inquiry skills are also required by students to help construct scientific knowledge [3]. Inquiry skills are also important for students to perform activities in the laboratory or practical work that are essential activities and become an integral part of science learning [4], [5]. The demand in the university science teaching standard in America also enable the inquiry skills as essential capability for students [3]. Inquiry learning experience, which is the standard in science teaching will be held if students have good inquiry skills [5]. The success of students in the learning process is influenced by the mastery of knowledge. Knowledge becomes the basis for students to have various thinking skills such as: creative thinking, critical thinking and other thinking skills [6]. Learning experience becomes one of the determinants of the success of the knowledge construction process undertaken by students. Science learning experience needs to be designed so that students can be equipped with inquiry skills and in turn can be used to help students construct knowledge meaningfully and profoundly.

Learning strategies are needed to equip students to have inquiry skills, as well as extensive and in-depth knowledge. Open guided inquiry laboratory is a science-learning strategy that can be applied in practical learning [7]. Open guided inquiry laboratory can give students the opportunity to develop various competencies required by students. This strategy provides students opportunities to explore knowledge, practice skills, conduct investigations, train scientific reasoning abilities and other skills...
required by pre-service science teachers. Inquiry learning experience is an important learning experience in science learning [8], [9], [3]. Science learning can provide meaningful learning experiences for students. Inquiry-based learning can enable students to gain an in-depth knowledge of the nature of science (NOS), increase knowledge of scientific inquiry [10], improves process skills and science literacy [11]. Through inquiry-based learning, students have the opportunity to make direct observations, explore and understand the object of biological studies, so that this experience can equip students with hands-on abilities and thinking processes.

Plant anatomy is one of the basic courses that must be taken by students in Biology Education Study Program. In certain University the material of plant anatomy is taught as separate course (Plant Anatomy and Plant Anatomy Practicum). The focus of the study is in Plant Anatomy Practicum. This Plant Anatomy Practicum Program asks the students to: master deep anatomical knowledge, apply knowledge of plant anatomy, communicate the results of scientific inquiry in the form of papers, and conduct scientific inquiry. In addition, students are also required to be able to master the procedural knowledge and able to explain microscopic images of observations under a microscope [12]. In practicum of plant anatomy, students need to have sufficient spatial ability to explain the observed images under a microscope [13]. In order to be able to think complex and able to conduct inquiry, the students should have inquiry skills.

This study aims to investigate the inquiry skills and knowledge of students through practical learning with open guided inquiry laboratory strategy. This research was conducted on the plant anatomical practice. Open guided inquiry strategy implemented is expected to equip students with inquiry skills and help students construct knowledge optimally. This research is expected to be used as a basic reference to develop inquiry activities especially in laboratory.

2. Method
This descriptive research was carried out to obtain a description of inquiry skills and knowledge of students in one private university located in West Java through guided inquiry learning laboratory in the context of Plant Anatomy Practicum. The study was held in the odd semester of academic year 2017/2018 with the involvement of 23 students as research subjects. Research data in the form of concept mastery test and inquiry skills test, that was analyzed descriptively and qualitatively. The concept mastery test instrument was developed based on the inquiry skill indicators [9]. The concept mastery test instrument was developed based on the revised bloom taxonomy [14].

In this research, open guided inquiry model of laboratory on practicum was implemented in organology. The topic was divided into three practical activities: 1) Practicum of root organ, 2) Practicum of stem organ, and 3) Practicum of Leaf organ. Figure 1 below explains one of the steps of a practicum learning activity.

![Figure 1. Process plot of open-guided inquiry.](image-url)
The steps in Figure 1 above are repeated for other laboratory sub-topics. Each step of practicum activities is designed so that students gain experience by doing inquiry in order to train student inquiry skills and help students construct their knowledge. To assist students in doing the open-guided inquiry, the researcher develops Student Activity Sheet which guides and directs practicum activities conducted by students. The data of the study were then analyzed and compared with predetermined success indicators. Parameters used to see the acquisition of knowledge mastery and inquiry skills are used parameter of achievement based on the score of learning mastery in the course of Plant Anatomy.

3. Result and discussion
The results of measuring inquiry skills and concept mastery of student indicate that the ability of inquiry skill and concept mastery of student on each indicator or different aspects of different achievements. This can be seen from the improvement of the quality of students in both capabilities.

![Scoring graph of student skills scores](image)

The scoring of student inquiry skills score varies for each indicator of inquiry skills, of which six of them have all reached the criterion score of mastery. The highest achievement scores are on indicators: identifying problems, and also designing and executing experiments. While on the indicators: analysis and interpretation of data, generate arguments from some evidence, and communicate information acquisition score are not far from the established mastery criteria. This shows that the learning experience gained by students can equip student's inquiry skills, especially on the indicators of identifying problems, as well as designing and conducting experiments.

The achievement score of student knowledge on each learning indicator varies in achievement. 73% of learning indicators have reached the learning completeness criteria on Plant Anatomy Practicum. Indicators whose achievement is still below the criteria of completeness are: 1) Comparing the anatomical structure of dicots and monocots stems, 2) Explaining the anatomical structure of dicots stems on primary growth and secondary growth, 3) Analyzing stem dicots and monocots stem structure underwent anomaly, and 4) Examining the structure dicots and monocots stems (Figure 3). In general, the student's inquiry skills score shows that the open-guided inquiry learning experience provides students with inquiry skills. Inquiry skills include several aspects of which are: asking question, planning investigation, carrying out investigation, analyzing and interpreting data, constructing explanation, and engaging in arguments from evidence [9]. Inquiry skills are quite difficult skills taught to students.
Figure 3. Scores of student's knowledge.

The open-guided inquiry strategy of the laboratory provides an opportunity for students to be deeply involved in the learning process. Practical learning in the laboratory is a potential learning experience for developing high order learning skills such as: observation, planning observation, formulating relevant research questions, formulating hypotheses, and analyzing experimental or experimental data [1], [16]. To help students experience open-guided inquiry researchers develop Student Activity Sheets (LKM). LKM are developed based on inquiry steps [9] and open-guided inquiry strategies. LKM are created to ensure that each step of inquiry is done by the student during the practice activity. The LKM is equipped with a clear task and leads to what needs to be done. Tasks in the worksheet are an important part that must arise to guide practicum activities [17].

The implementation of open guided inquiry gives students more opportunity to identify problems, formulate hypotheses, and also design and conduct experiments. Prior to identifying students’ issues of observing the phenomenon to be investigated, the students discussed with their peers and elaborated related material content to identify problems and formulate research questions to investigate. After formulating the research question, the student then conducts library study from the related primary source as the basis for formulating the hypothesis, at this stage the student also conducts discussion with the peers to formulate the hypothesis of inquiry. This activity will also help students to construct broader and deeper knowledge [18], [19], [20]. In addition, the discussion with peers will help to minimize misconceptions that occur [7]. After formulating research questions and hypotheses, students then design experiments to answer research questions that have been formulated previously. This activity will train and develop procedural knowledge about the procedure of Plant Anatomy Practicum. This activity will help students understand the basic concepts needed to conduct investigations as well as develop the ability to identify problems, formulate hypotheses and the ability to design and conduct experiments.

Problems faced by students during the lab affect the score of students' knowledge, especially at the time of practicum about stem organs. This problem can result in the process of knowledge construction, because students get limited and incomplete information. The results of the analysis of field notes show
that the authors do as well as the observation of practicum activities, obtained information that students experience technical difficulties when carrying out practicum, cutting tools provided by students are not representative so that cause students difficulty getting a thin stem rod incision. This makes the students not get a clear picture of the anatomical structure of the stem. This difficulties causes the knowledge construction process to be inhibited.

Implementation of open guided inquiry on laboratory practicum, has several limitations and constraints. Practical learning should be accompanied by the readiness of students in doing practical work in the laboratory, so this will facilitate students in running procedures that must be done when doing lab. Procedural knowledge in carrying out the practicum is essential as the basis for running an experiment or investigation [15]. Providing adequate knowledge and skills is an important thing that must be done by lecturers so that the investigation activities undertaken by students can be optimal.

4. Conclusion

Inquiry skills and knowledge are important skills that must be mastered by students, especially for preservice biology teacher. Inquiry skills and knowledge possessed by students through open-guided inquiry laboratory study on practicum Anatomy of Plant has reached completeness criterion specified. The open-guided inquiry learning experience can equip students with a number of skills especially inquiry skills and help students construct knowledge. Open guided inquiry can be implemented by taking into account several aspects such as material characteristics, student characteristics, and basic practice skills of the students. This should be noted, so that the achievement of practical learning objectives can be achieved optimally.

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