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THE STUDY OF INQUIRY ABILITY IN THE PHOTOSYNTHESIS CONCEPT

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ABSTRACT

The learning process has characteristics that reflect scientific, thematic, collaborative, and student-centered. This type of learning usually uses constructivist learning, and one of them is Inquiry. The inquiry is a process to get information by conducting observations or experiments to find answers or solve problems for questions or formulation a problem by using logical and critical thinking skills. This preliminary study focused on investigating new prospective teachers' inquiry ability. The respondents were new prospective teachers of Hamzanwadi University. The research instrument was a student worksheet with the topic "photosynthesis." Data analysis used descriptive statistical methods by calculating the score of each indicator of Inquiry after three assessments. Using of amount score to shows that for each indicator: (1) problem formulation (66), (2) Hypothesis (50), (3) Design (40), (4) Findings (12), and (5) Conclusions (10). It can be concluded that the new prospective teachers' in their involvement still needed to be trained, guidance, and continues to be developed. Therefore, Inquiry-based learning needs an extension for their next learning.

Keywords: student-centered; constructivist; inquiry; photosynthesis

INTRODUCTION

The ideal concept of learning is a two-way interaction between teachers and students by using learning strategies because it can stimulate their way of thinking. The teacher gives an apperception that leads their thoughts in a constructivist direction, and then students look for and find their answers through an experiment. The regulation of the minister of research, technology and higher education of the Republic of Indonesia, number 44 of 2015 concerning national standards for higher education in Part Four concerning Standards for Learning Processes, Article 11 paragraph 10 concerning Higher Education states that "Learning is the interaction between educators, students, and learning resources, within the environment certain learning" (Dikti, 2015). Learning is s a system that consists of various components that are interconnected with another, such as objectives, materials, methods, and evaluation. It must be considered by the teacher in choosing and determining what learning models will be used in learning activities to achieve the learning objectives.

Science teaching can be planned activities strategy by involving students to ask the scientifically oriented questions, giving priority to prove in responding to the questions, formulating the explanations of evidence, relating the explanations to the scientific knowledge, and communicate and justify explanations (Lee & Shea, 2016). Biology subject as a part of science prioritizes observation in the learning process to practice accuracy, truth, curiosity, and minds-on and hands-on equivalences. According to Nuangchalerm (2014), observation is a skill that must be possessed by students and as a way to prove

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the truth if you want to learn science. However, the biology subject is still deductive. It is still on the teacher-centered where students receive information passively, and practical implementation is verification.

Considering in biology subject contains many concepts and practical material that must be mastered by students, a strategy is needed to understand each of the concepts and practical material correctly. For example, by applying fun and challenging interactive learning models, it can directly involve students and can make the students enthusiastic in learning. According to karami et al. (2012) in researching teaching methods is important to do because it affects all types of learning in the schools among the cognitive, affective, and psychomotor domains.

Regulation of the Research Minister, Technology and Higher Education of the Republic of Indonesia, number 44 of 2015 concerning national standards of higher education in Part Four concerning Learning Process Standards, case 11 line 10 regards the student-centered learning. It states that "student-centered, as referred to in the learning achievements of graduates, is achieved through a learning process that prioritizes the development of creativity, capacity, personality, and needs of students, as well as developing independence in seeking and finding knowledge. "

New students of biology education came from various majors when they were still in high schools such as Sciences Program, Social Program, and Technology Program. Based on their experiences, learning methods were still less attractive because the teachers tended to be monotonous in delivering material, such as assignments and group discussions that had an impact on lack of interest, learning motivation, and high-level thinking habits of the students. Therefore, through general biology courses, researchers want to apply enjoyable learning so that students do not feel bored with the learning methods previously obtained. As suggested by Murray et al. (2015) suggests that the literature is crucially needed that focuses on learning services in tertiary institutions, significantly how students are affected in learning.

One of innovation in learning is to involve students in thinking related to curiosity and interest. Therefore the teacher needs to also change his mindset from the didactic paradigm to the holistic paradigm (Spector et al., 2020). The Inquiry is one of the teaching strategies that are suitable to be applied in biology courses, especially in photosynthesis material, because Inquiry is constructivist learning. Therefore, the teacher needs a learning strategy to familiarize or to practice their higher-order thinking in college, one of them is by applying inquiry learning because it allows students to have the real and active experience, and trains them on how to solve problems while making decisions. Ghumdia (2016) stated that Inquiry is more effective than conventional methods because it is more systematic, using thinking skills to plan, implement, evaluate, and report.

The inquiry-based teaching has been the most recommended approach in science education for decades (Zhou & Xu, 2017) because its teaching strategies are student-centered, independent, conducting investigations to find answers to the questions offered, experimenting to prove answers, and concluding the results of the experiment. The inquiry learning requires the students to solve the problems through investigation activities that increase skills and knowledge independently (Trna et al., 2012). The Inquiry provides an opportunity to practice hands-on skills, experiment, make questions and develop responses based on reason by the aim at helping the students to develop intellectual thinking skills and discipline by giving questions and getting answers based on curiosity (Andrini, 2016), and satisfy curiosity and to develop theoretical ideas (Nurhadi et al., 2016). Although it is inquiry-based learning, the teacher still pays attention to the domain of scientific knowledge in each phase of Inquiry (Van Uum et al., 2016).

Based on the description, researchers want to apply learning by using Inquiry because, from the results of interviews, the students do not yet know the type of learning. This research is limited to new students in first class, and tried only one material. Therefore, the question of this study is whether prospective teachers able to Inquiry about the photosynthesis concept? This study aims to find out the ability of new students to Inquiry on the photosynthesis concept.

METHODS

This study used was experimental research to know the effect of inquiry ability on the photosynthesis concept. Data analysis used was descriptive statistics because it only described the research results on the research object without making conclusions applied to the public (Sugiyono, 2015). There are 23 respondents. The research instrument used was a student's worksheet activity (sees figure 1), discussing photosynthesis by assessing inquiry indicators, namely: 1) prob-

lem formulation, 2) hypothesis, 3) design, 4) experiment, and 5) concluding and each answer of the indicator was given a score; 3 (the answer is correct and complete)., 2 (the answer is correct but not complete., and 1 (the answer is not suitable). The assessment process was conducted three times for indicator; 1) problem formulation, 2) hypothesis and 3) design; it was done during the process of guidance because the first time students got a learning strategy implemented.

Photosynthesis

Almost all living things depend on the energy produced in photosynthesis. Photosynthesis also works to produce most of the oxygen contained in the Earth's atmosphere. Organisms that produce energy through photosynthesis are called phototrophs. Photosynthesis is a biochemical process of the formation of food or energy substances, namely glucose, which is conducted by plants, algae, and several types of bacteria using nutrients, carbon dioxide, water and the help of sunlight energy. The process of photosynthesis occurs in the leaf part, and there is a green leaf substance (chlorophyll) which functions to absorb light energy. The root functions to absorb water, from plant roots channeled through stem vessels to the leaves. CO_2 is absorbed through the leaf mouth (stomata). Then, CO_2 and water react with the help of light energy. The reaction produces starch or carbohydrates (food). This process of making food with the help of light is called photosynthesis. Chemically, photosynthesis events can be written as follows: $6H_2O + 6CO_2 + \text{light} \rightarrow C_6H_{12}O_6$ (glucose) + $6O_2$

Questions

1. Based on the picture, ask the question!
2. Based on the questions you ask, state your hypothesis!
3. Make a design to prove your hypothesis which consists of: a) tools and materials, b) how to work!
4. Do proof of your hypothesis based on the design made!
5. Make the results of his observations and conclude!

Figure 1. Student's Worksheet Activity

RESULTS AND DISCUSSION

Inquiry as one of the learning strategies prioritizes the process of discovery in learning activities to gain knowledge. In inquiry learning, the lecturer designs learning that allows students to do discovery activities on the subject. Faulconer (2016), states that investigation in the classroom is better considered in academia as the best practice that is very important for scientific literacy. By conducting scientific investigations, students can determine their problems, find information, propose alternative solutions, and evaluate the information obtained (Wall et al., 2015). Arnold et al. (2014) stated that learning scientific facts and principles need to develop scientific investigation skills. Other findings suggest that inquiry learning is more significant than conventional strategies for understanding biological concepts. Katsampoxaki-Hodgetts et al. (2015) stated that scientific investigation; students determine problems, develop alternative solutions, find information, evaluate information, and communicate with their friends.

The implementation of inquiry learning in the classroom requires more time to get the students accustomed to the process, requires patience when asking students to teach how to ask the questions based on the problem, hypothesized, formulate plans, experiment, and how to make conclusions. Students are asked to find information or data through library research in order to find the right solution to prove the proposed hypothesis. It takes two days to get answers that are considered absolute by students. Therefore the students draw up plans to conduct experiments that require approximately two weeks so that the correct data is obtained dealing with the hypothesis. When searching for information and conducting experiments, a curiosity sense and high curiosity can be seen from the students' attitude and many of them asking the lecturers. According

to Ural (2016), the application of Inquiry requires enough time because it implements thinking skills development, and students will experience obstacles to give a short time can influence fewer results. Another, by giving enough time that students can generate ideas, do the planning, brainstorm the problems, propose the solutions, and its reasons (Michalopoulou, 2014).

In the inquiry learning process, the teacher must design activities to facilitate the learning and assess the process in the form of student worksheets, which enable students to conduct discovery activities. These activities are implied in the worksheet activity. Sund & Trowbridge (1973), the first expert to propose seven stages of Inquiry, which are (1) asking the questions,; (2) formulating the problems; (3) formulating a hypothesis; (4) designing an investigation; (5) conducting experiments; (6) synthesizing knowledge; and (7) have a scientific attitude. Besides, some researchers also developed the Inquiry in learning such as Shamsudin et al. (2013) with five steps: simulation, field study, and project, demonstration of discrepant and experimental events. Then Pedaste et al. (2015) conducted seven phases of the Inquiry: introduction, exploration, designing the investigation, conducting the investigation, conclusion, presentation/communication, and deepening/broadening. Based on these inquiry phases, the inquiry phases used in this study are: formulating a problem, making a hypothesis, designing, experimenting, and concluding.

The inquiry assessment process is conducted, so the answers are considered to be correct by the lecturer, and the assessment process from the result wasted three times were obtained (Inquiry formulates a problem, hypothesis, and design), the score of each the inquiry assessment step is presented in figures 2 and 3.

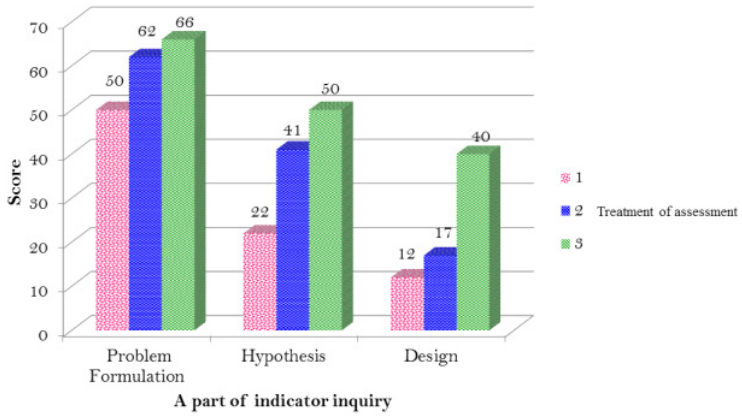

Figure 2. Students' Inquiry Ability Score Before Practicum

In being conducting the assessment, the lecturer acts as a facilitator neither as a dictator. As proposed by Gormally (2016), in the classroom, instructors are expected to act as facilitators of learning rather than information providers. There are the inquiry assessment processes of each step. (1) Formulating a problem, students ask questions based on the issues presented and the questions written correctly and given a score of three in the first, second, and third assessments. The inquiry process depends on the problems discussed at the beginning of learning so that students are more critical and correct in offering the questions based on problems. Llewellyn (2013) shows that Inquiry is more than asking questions. By the correct offering, problems will affect the next inquiry steps containing cognitive, affective, and psychomotor elements. As Pedrosa-de-Jesus et al. (2014) did in their research, they made critical questions into three domains: knowledge, skills, and attitudes. Furthermore, the teacher must ask open-ended questions that lead students to develop their questions and to design investigations that can answer their questions. (2) Hypothesis; when the process of proposing a hypothesis, students still look confused and hypotheses offered in the form of the questions both the first and the second assessment. After going through direction and guidance, in the third assessment, students were able to express how to propose a hypothesis. (3) Design; students make a plan to test hypotheses such as tools and materials that will be needed in the next experiments and a description of how it works. According to Faulconer (2016), students were asked to design their methods to be conducted for their investigation purposes. Based on the design results in three periods, the answers were still ambiguous to mention the tools and materials that will be needed. They were still incomplete included a description, and their wor-

king was still a less systematic sequence. During the designing process, it would be better if the lecturers give freedom of thought in designing to test their hypotheses, as suggested by Vácha & Rokos (2015) based on the results of their research to the teachers by providing opportunities to learn in designing their assignments which will be implemented in their teaching. (4) Experiments; students prove their experiment seven days and observe the process of the plant growth, record the results, and discover new things out of their hypotheses. Besides, scientific attitudes increasingly seem like critical thinking in finding new problems as the experiment progresses, curiosity was getting higher, and ways of making decisions. Sotiriou & Bogner (2015) also said that by experimenting, it could develop their understanding related to scientific content, problem-solving skills, science process skill, and understanding the nature of science and making students aware of the relationship between theories obtained and the results of experiments conducted. (5) Concluding, the student presents the conclusions of the whole experimental activities and answers the right hypothesis.

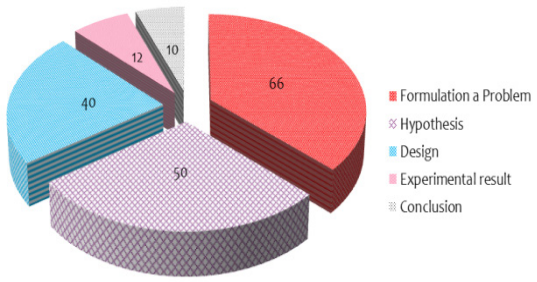

Figure 3. The Whole Students' Score of the Inquiry Process

Learning Inquiry provides opportunities for students to gain direct experiences such as curiosity, creativity, originality, perseverance, failure, and success in experimenting (Hugerat & Kortam, 2014).

The Inquiry was more effective than the conventional method because teaching was more systematic because it uses thinking skills to plan, implement, evaluate, and report. Rokos (2015) considers that inquiry-based learning does not lead to better knowledge acquisition, but it increases the level of inquiry skills (e.g., hypothesis formulation, planning of self-experiments, the conclusion of formulations, and others.). Although the teachers use scientific methods, the inquiry-based learning is a teaching method that must be considered in other disciplines because it supports the development of students who are responsible for their learning (Smallhorn et al., 2015). According to several researchers such as Potvin et al. (2017) in the technology engineering process to students answering problems, they also develop solutions to the problems by using inquiry-based learning. Then (Fast & Wild, 2018) applies Inquiry to blind students who are limited to the analysis of teaching concepts conducted by the teacher then applied to student routines. This student-centered approach, the teacher, and students played an equally active role in the learning process. The teacher's role was to train and facilitate the students' learning and understanding of the whole materials, and Magee & Flessner (2012) stated that the teacher as a facilitator, as a listener, as a guide when students explore their knowledge. Jiang & McComas (2015) state that in an inquiry-based learning environment, students are more active, and they guide their learning processes, and inquiry-based teaching has several types such as Guided Inquiry and Open Inquiry.

The Inquiry process allows students to have real and active experience; students are trained in how to solve problems while making decisions. Inquiry-based teaching has the advantage of deepening conceptual understanding into long-term memory (Marshall, 2013), fostering the character of effective learning and high-level thinking (Hugerat & Kortam, 2014), as well as students enjoying learning and getting the positive results (Saunders-Stewart et al., 2015). Therefore, in the learning process in the classroom, lecturers should reorient learning including: (1) using contextual problems at the beginning of learning; (2) develop problem-solving skills, train students in reasoning and critical thinking through exploration; and (3) construct concepts, formulate definitions and design procedures independently through investigation.

CONCLUSION

Based on the results of the inquiry data obtained, it can be concluded that students can receive an inquiry about the photosynthesis concept. Meanwhile, if viewed from the learning process, students need to be guided more intensely so that students are accustomed to expressing and writing scientifically and able to distinguish each inquiry indicator.

The lecturer must be reorient learning, which can stimulate student thinking, student-centered learning, and High Order Thinking

Skills (HOTS) training. One of them is using constructivist learning. The Inquiry is a scientific discovery that begins the questions, collects data by conducting investigations, proposes hypotheses, designs and conducts experiments to test hypotheses, and concludes the materials. In the implementation of Inquiry for the new students, especially in photosynthetic concept material, intense guidance is needed in each process, and by applying Inquiry into students' scientific thinking and attitudes such as curiosity, and critical thinking becomes increasingly apparent in the learning process.

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