IMPLEMENTATION OF INQUIRY LEARNING STRATEGY IN PLANT ANATOMY LECTURE TO EQUIP THE UNDERSTANDING ABILITY AND CONCEPT RECONSTRUCTION FOR BIOLOGY TEACHER CANDIDATES

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Abstract

The purpose of this research is to understand the effect of inquiry learning strategy toward the understanding ability and concept reconstruction of plant anatomy to the students. The subject of the analysis is students of biology education at 3rd semester Faculty of Education and Teaching, Syiah Kuala University. The method used in the research is experiment design of Pretest-Post test Contorl-Group. Inquiry learning strategy is done by giving students structured task, question answers and discussion. Understanding of the concept is measured by a written test, an objective test which has been validated. Concept reconstruction ability of students are measured by comparing the ability of understanding ability concept before and after lecture. Understanding ability data obtained is then analyzed using normalization of gain calculation method. To compare understanding ability and concept reconstruction between groups of student which are equipped with inquiry learning and control groups, they are tested with Independent Sample t-Test. The result of the research shown that there is significant improvement toward concept understanding of students equipped with inquiry learning compare to students not equipped with inquiry learning. Concept reconstruction ability of students' equipped with inquiry learning is higher (62%) compare to students not equipped with inquiry learning. Therefore, inquiry learning strategy is effective to improve understanding ability and reconstruction concepts of plant anatomy.

Key Words: Learning strategy, inquiry, plant anatomy, concept reconstruction

1. INTRODUCTION

In general, the target of education system especially Biology is to produce a good quality graduates, able to master various concepts, have an ability to inquiry and also able to implement science principles in daily life. Main component in education system that determines the quality of the graduates is the quality of the teacher. Therefore, to keep and improve education quality, it is required to prepare the Biology/Science teacher to have a good quality at In-service level in educations institute. Quality control of teacher candidates at In-service level requires standardization that related with input, process, and output. Input

standard related to students selection, facilities and curriculum. Process standard related to learning process in preparing Science/Biology teacher candidates that fits Science learning standard that include process and products. Process standard includes process evaluation standard and learning result that's coherent with evaluation values. Output standard is related to graduates control that coherent toward agreed graduation standard. Criteria of professional and good quality Science/Biology lecturer are the ones with (a) master in learning strategy through inquiry, (b) master in concept, (c) designing and implementing evaluation through assessment, (d) understanding the nature of science as a process and product, (e) understanding and mastering Science curriculum, and (f) master in social context in Science learning (Duggan-Hass, 2000). Inquiry is a learning strategy which has Science characteristic, including process acquiring information through empirical method, acquiring information through investigation and has critical thinking process combination that produce valid and reliable information. In preparing an excellent and proffessional Science/Biology teacher candidates at level In-service, inquiry learning strategy implementation in university system is really relevant.

In preparing Science/Biolgy teacher at In-service level, the most important element that need special attention is learning strategy. Teachers will teach material with the same method the lecturer taught them during their study time (McDermott, 1998, pp.734-742). In NSTA & AETS/National Science Teachers Association & Association for the Education of Teacher in Science (2003, 1-9) explain teacher that learn Science through didactic and abstract could not be expected able to teach their students constructively and concrete. Teachers that have never investigated will not like investigation design in learning process for their students. Same goes to Shulman (Gabel, 2004, p.204) stated that material knowledge that teacher candidates obtained during classes are not enough to be used as teaching modal.

According to NSTA & AETS (2003, pp.1-9), if learning process is tend to rely on abstract learning strategy with laboratorium activities that are more demonstrative, then students will only learn Science at the surface level. If this condition remains for long, then teacher candidates will received a minimum modal that will be used to teach in the future. Learning activity should be more to expanding inquiry ability in understanding concepts naturally. A change from teaching paradigm into learning paradigm fits the concept of inquiry learning that need to be implemented at every learning process toward students that are Biology teacher candidates.

Plant anatomy is one of the subjects that students must take upon completing study as Biology teacher candidates. The main target that is expected from the lecture of plant anatomy is to make sure students understand the concepts of plant anatomy also the connection between one concept with anothers that are compiled to understand the plant body. That ability is the basic that bridging basic Biology concepts with advance Biology concepts (fisiology, taxonomy, genetics, ecology) or even for other discipline studies that are relevant (agriculture and forestry). Besides, plant anatomy provides students to master plant anatomy concepts in deep at basic and medium education level.

Besides the main target that have been mentioned above, plant anatomy also can be a tool that is used to provide students with ability of Science process including analyze, clarification, measure, using tools, communication, interpret, predict, plan, and conduct a test. Those abilities are a must of professionalism for Science/Biology teacher and a must of curriculum for Science school (Depdiknas, 2003, pp.1-102).

Despite the the importance of plant anatomy subject for education and teaching department students, the learning result is not satisfy yet. This is proven from the test result of pra-learning plant anatomy from the last four years (2012 to 2016) in Biology department of Education and Teaching Faculty of Syiah Kuala University, Aceh. It is shown that the most of the students are having alternative conception toward subjects that are tested. Reproduction concept of cells, networks and organ is top of the list (78%) where the students understand the concepts through alternative concept (Muhibbuddin, 2016, pp.1-26).

Data mentioned earlier indicates that the high percentage application of alternative conception is the impact of learning result obtained at the past. The occurance of alternative conception is also expected related with learning process that is used by Science/biology teachers at basic and medium learning level. One of the indicators that strengthened the conjecture is shown from the result of a research by Muhibbuddin (2015, pp.33-46) which mention that major part (more than 50%) of teachers are embedded with alternative conception in understanding plant anatomy concepts including concept of cells, networks and organ.

Alternative conception cannot exist for a longer period of time as it will mislead the students or teacher candidates which then will mislead their students. Therefore, it is necessary to improve the concept understanding, eliminate alternative conception and provide students with ability of reconstruction concepts of plant anatomy.

Several research related to inquiry learning strategy has been done by (Capps & Crawford, 2017, pp. 497-526; Sahyar & Hastini, 2017, pp. 120-126; Hannasari at al., 2017, pp. 48-52; Philip & Taber, 2016, pp. 207-226; Hairida, 2016,pp. 209-215; Kuhn, M.A.,2015, pp. 37-50; Siew Li & Arshad, 2015, pp. 151-175; Basey at al., 2010, pp. 80-86; Baseya & Francis, 2011,pp. 241-255; Campo & Garcia-Vazquez, 2010, pp. 15-20; Crawford, 2007, pp. 613-642; Schwartz at al., 2004, pp. 610-645; Buxeda & Moore, 1999, pp. 159-164; Switzer & Shriner, 2000, pp. 157-162; Jones et al., 2000, pp. 37-50; Windschitl & Buttemer, 2000, pp. 346-350; Marbach-Ad & Claassen, 2001, pp. 410-419; Marbach-Ad et al., 2001, pp. 434-438; Anderson, 2002, pp. 1-12). However, those research tend to discuss the Science/Biology understanding concepts for middle and higher school and efforts that have been done to repair learning strategy. Research that related to ability improvement to increase understanding concept, decrease alternative understanding conception and provides reconstruction concepts of plant anatomy for students for In-service level is very limited. Therefore, it is necessary to analyze the implementation of inquiry learning strategy in plant anatomy subject to provide understanding ability and concept reconstruction for Biology teacher candidates.

2. RESEARCH METHOD

Method used in this research is experiment method with Pretes-Post Tess Control Group Design (Gall et al., 2003). Research design is shown in Table-1 below.

Table 1. Pretes-Post Test Control Group Design

Sample	Group	Pretest	Treatment	Post Test
Random	experimental class	O1	X1	O2
Random	control class	O1	X2	O2

X1 = Learning with strategy inquiry

X2 = Learning non-inquiry (conventional)

O1 = Pretest (before treatment)

O2 = Post Test (after treatment)

Research is done toward Biology students at 3rd semester, Faculty of Eduction and teaching, Syiah Kuala University, Banda Aceh, Indonesia. Research duration is three months, from September to November 2017. Total of students involved in this research is 60 students. The students is separated into two groups, experimental class and contorl class with 30 students in each group. Grouping is done based on basic ability and understanding of the same concept (data of pretest) and conducted randomly.

Experimental class is equiped with inquiry learning strategy, while control class is equiped with non-inquiry (conventional) strategy. Inquiry learning strategy is done through structured task toward students to study palnt anatomy concepts independently from vairous sources, with guidance of College Student Worksheet, then continue with discussion within the class. Discussion activity is throughoutly conducted by students, lecturers are only facilitator and lead the discussion. Discussion is lead toward each sub-subjects (i.e. cell wall). At the end of discussion, each student has to deliver conclussion toward the concept that has been discussed. This method of learning is repeated for each and every sub-subjcest included in plant anatom subject. During the learning activity, students reconstruction and independent concept understanding abilityies are being trained. This process is assisted by lecturer. At the of the learning process, postes is conducted to get to know the result of different learning method applied. Figure-1 below concluded inquiry learning strategy concept.

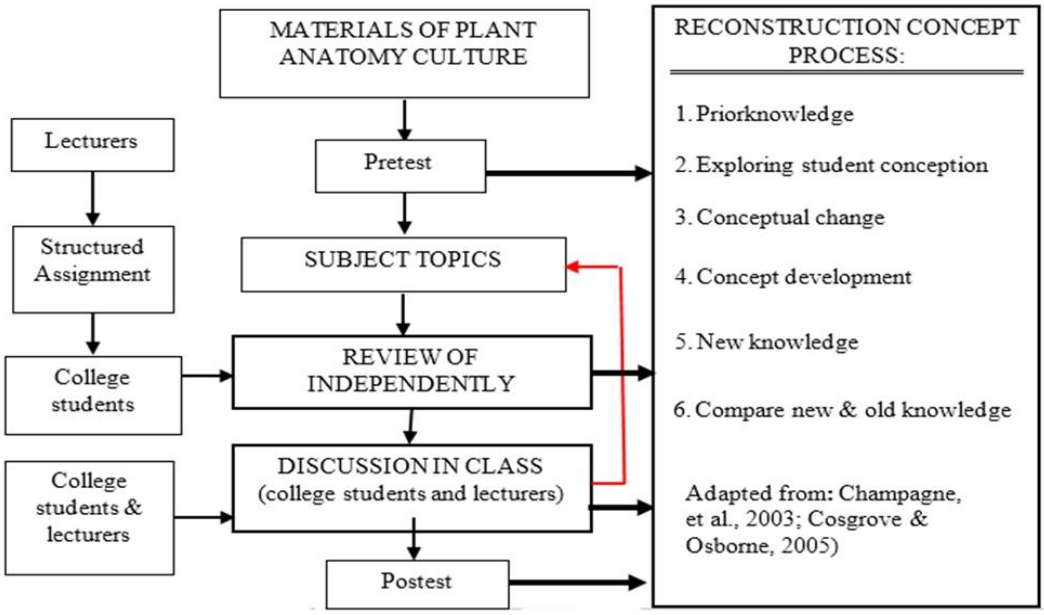

Fig. 1. Summary Stages of Inquiry Learning Strategy

3. DATA AND ANALYSIS

Data obtained from research result is score of pretest and post-test for both classes (experimental and control classes). Pretest and post-test scores are tabulated and gain is calculated by seeking the gap between test score and pretest scores. Obtained gain is then normalized using a formula from Meltezer (2002) by finding the gap between post-test and pretest scores.

$$g = \frac{\text{post-test score} - \text{pretes score}}{\text{maximum possible score} - \text{pretest score}}$$

Reconstruction ability concept data is conducted by analyzing pretest and post test scores for each test item. Criteria used in analyze ability concept reconstruction is: First. Pretest-post test scores = 0-1 (reconstruction occurred). Second, pretest and post test = 1-0 (do not understand). Third, pretes-post test = 0-0 (alternative conveptions).

To understand the effectiveness of inquiry learning implementation toward learning activity result of the students between experimental and control class, average gain data is used, and reconstruction concept data. Effectiveness test is conducted by comparing average gain scores and reconstruction concepts between experimental class and control class through t-test, Independent Sample t-test.

4. RESEARCH RESULT

4.1 Students Early Effect

Students initial knowledge about concept understanding of plant anatomy has no significant difference between experimental and control class (Table-2). This result shows that students understanding toward plant anatomy concepts before implementation of learning process for both experimental and control class are having the same level of understanding.

Table 2. Pretest Average Difference Test Results Between Experimental and Control Class

Average Score	Group		Normality*		Homogeneity** (Exp-Control)	Significant
	Exp.	Control	Exp.	Control		
Pretest	28.13	28.03	Normal	Normal	homogeneous	Not significant

			Sig.:0.200	Sig.:0.200	Sig.:0.718	$t_{count.}$ = 0.074; Sig.:0.470 > 0.025

*)Kolmogorov – Smirnov Test (Normal, Sig. > 0.05)

**)Levene Test (Homogeneous, Sig. > 0,05)

4.2 Learning Process

4.2.1 Concept Understanding

Students understanding concept after learning between experimental and control class shows there is improvement compare to before learning. Experimental class students achieve an average gain of 91.27 and control class 45.37. Increase in learning result of experimental class is higher compare to control class with an average gain gap of 45.90 (49.71%).

Increase in concept understanding of plant anatomy shows a significant difference between experimental and control class (Table-3). A result of average gain shows a significant difference between experimental and control class. Therefore, it has shown that the implementation of inquiry laerning strategy is effective and contributes a a lot toward an improvement of plant anatomy concept for students.

4.2.2 Concept Reconstruction

Analysis result of pretest and post test scores shows that reconstruction concept ability of experimental class achieve an average of 58.68%, higher than control class with only 34.61%. The result of analysis also shows there is alternative concepts that are not well understood by both experimental and control class.

Table 3. Gain(g) Average Difference Test Results Between Experimental and Control Class

Average Score	Group		Normality*		Homogeneity** (Exp-Control)	Significant
	Exp.	Control	Exp.	Control		
Gain(g)	91.27	45.37	Normal Sig.:0.200	Normal Sig.:0.200	Homogeneous Sig.:0.680	Significant $t_{count.}$ = 37.978; Sig.:0.000 < 0.025

*)Kolmogorov – Smirnov Test (Normal, Sig. > 0.05)

**)Levene Test (Homogeneous, Sig. > 0,05)

However, alternative concepts are felt at higher rate at control class (an average of 34.71%) compare to experimental class (an average of 10.32%). Control class has a higher percentage of concepts that are not understood compare to experimental class with an average of 6.78% and 2.94% respectively. A significant test result (Table-4) of average of reconstruction ability concept, alternative conceptions and concepts that are not understood between experimental and control class shows a significant difference. Based on significant test result, it is believed that reconstruction ability concept of experimental class is better than control class. Meanwhile alternative conceptions and do not understand concepts are lower in experimental class compared with control class. Therefore, the implementation of inquiry learning strategy is really effective and contributes toward the improvement of reconstruction ability concepts of plant anatomy which able to reduce the implementation of alternative conceptions and do not understand concepts for students.

Table 4. Reconstruction, Alternative Conceptions, and Do Not Understand Average Difference Test Results Between Experimental and Control Class.

Average	Group		Normality*		Homogeneity** (Exp-Control)	Significant
	Exp.	Control	Exp.	Control		
reconstruction	52.81	31.15	Normal Sig.:0.200	Normal Sig.:0.034	Homogeneous Sig.:0.002	Significant $t_{count.}$ = 21.41;

						Sig.:0.001 < 0.025
alternative conceptions	9.29	31.23	Normal Sig.:0.200	Normal Sig.:0.200	Homogeneous Sig.:0.009	Significant $t_{count.}$ = 25.16; Sig.:0.000 < 0.025
do not understand	2.65	6.08	Normal Sig.:0.200	Normal Sig.:0.021	Homogeneous Sig.:0.006	Significant $t_{count.}$ = 16.13; Sig.:0.000 < 0.025

*)Kolmogorov – Smirnov Test (Normal, Sig. > 0.05)

**)Levene Test (Homogeneous, Sig. > 0,05)

5. DISCUSSION

A good understanding and concept reconstruction in experimental class is related toward the character of inquiry learning that put learning strategy through discussion as priority. Students is led to construct their knowledge independently, lecturer is acting as facilitators to lead the discussion.

Inquiry learnig characteristic is based on positioning the students as a person that is studying, not as a person that is taught and conditioning a happy studying feeling. That condition can be achieved thorugh the lecturer efforts in designing learning strategy by organizing several elements including time, method and environment or a happy class feeling (Costa, 2005, p.127). From a significant result obtained, it is believed that plant anatomy learning with inquiry laerning strategy is effective to improve concept reconstruction ability independently. Inquiry learning strategy is effective to improve students' ability in learning process. A meaningful study is a process where new concepts are attached inside a person cognitif sturucture. Learning process is not only remembering concepts or facts (root leaerning) but also strugling to connect those concepts to produce a solid understanding (meaningful learning). Hence, concepts being learnt can be well understood and not easily forgotten (Dahar, 1985,p.128; Novak & Gowin, 1984,p.345; Novak, 1990, pp. 937-949; Odom & Kelly, 2001,pp. 615-635)

Knowledge provision of teacher candidates should be more toward good learning process such as how to get the knowledge, seek for information, read literature, do experiment correctly, how to do inference, interpretation, extrapolation or intrapolation and communication so that receiving the knowledge become a happy sensassion, a need and the way living and forced during their intellectual provision. One of the ways that can be chosen is through inquiry learning strategy (NRC, 2003. P.300). Inquiry has become an important standard in provisioning Science/Biology teacher candidates (NSTA & AETS, 2003,pp.1-9). Experience of experiment, analyzing and data interpretation, communication and discussion while building the concepts, maintain of criticize friends opinion and suggestion is an example of intellectual skill that can be developed through inquiry (NRC, 2003, p.300).

Understanding about science and knowledge of how to learn science is important for teacher candidates to know. However, if the students only received basic science knowledge as a provision for their future will never be enough. Semiawan et al. (2003,p.286) suggested that a fast development of knowledge nowadays, impossible for the teacher to teach all the facts and concepts toward the students.

McDermott (1998, pp.734-742) stated that learning activity that provide teacher candidates must show several learning criteria which relevant for Science teacher, which are (1) teacher candidates are needed to be prepared to teach with correct method and strategy, (2) science learning is more effective if a concrete experience is used as a guideline of specific learning concepts, (3) in a process of learning a new concepts, it is necessary to give a chance to fo an open-ended experiment in laboraturium, hence, teacher candidates are well aware with phenomenon that might appear during learning activity, (4) lecturer need to improve questioning skills of students that is expected to increase the critical thinking of the students as well as improve the ability of the students to ask question, (5) learning strategy for teacher candidates need to be led into a situation where they are well aware toward conception difficulties that might be appeared among the students. Those statements show that in preparing a Science teacher, it is not only by improving their knowledge element of the subjects only, but also others elements such as skills of using laboraturium tools (accuracy) and science process skills (observing, clarifying, interpreting, predicting and asking questions) that need to be deeply improved.

A Biology teacher candidate should be prepared through involvement in research and laboraturium activities that are substantive and significant which inlcude active inquiry learning experience such as formulating questions, collecting and analyzing data, reporting and maintaining the result (NSTA & AETS, 2003, pp.1-9). Besides, if the teacher candidates learning science through a good process, then they already provided with a life-time learning skills (Carin, 2007, p.231).

In planning learning program, according to Uno (1999,p.320), several things need to be considered, first, the purpose of the learning program, both for lecturer and students, second, what kind of learning strategy will be used to help students to achieve those target, third, how to know that lecturer or students have achieved those target and the last is what is the assessment,

Learning target that is formulated should always related with cognitive process dimension which include various process; remembering, understanding, the application, analyzing, evaluating and planning. Remembering process is recalling back knowledge that is relevant from long memories. Completed by identification or mentioned. Understanding process is creating meaning from learning process that includes verbal communication, writing and figures through clarifying, recalling back, translating, imaging, categorizing, or restating with students own way and sentences, abstracting, generalizing, extrapolating, interpolating, predicting, mapping, contrasting, fitting and building a model. Learning application process is using procedure or guideline in certain condition. Analyzing process is a process of elaborating certain product become pieces that explained how each of those pieces are related to each other and have the same core. Evaluating process is a marking process that is based on certain criteria and standard. Planning process is a compiling back process certain parts into a expected or new patters (Anderson & Krathwohl, 2001,p.37).

In inquiry learning process, students actively improving their understanding about science and combining their knowledge with thinking skills. Students will add their knowledge as a result of experience and students will be effectively seek for a good growth of their knowledge. From pedagogy point of view, Science learning which is inquiry oriented tend to have a constructive learning model as an active students that is solidly applied nowadays by lecturers and teachers. In constructive learning model, learning is a mental change that occurred continuously toward students.

Constructive model can be achieved through cognitive conflict that is defined as imbalance situation of the students when they are faced with unexplainable situation through application of framework concept laid within the students (Shayer & Adey, 1992,pp. 81-92). This imbalance will produce conflict so that students become unsure with the concept that is attached in their cognitive structure. If the students can find a new concept, the a changing concept phenomena occurred (Carey, 2008). If the new concept tends to be a better solution, then it will fix the misconception that exists within the students or it will make students having a stronger concept understanding. For example, if the result of inquiry activity that is done by the students is not the same as the theory or concept that already exist, then a conflict will occur within the students that can trigger the students to seek the answer that satisfy them.

For instance, students understanding about water movement in osmosis phenomena is from high concentration to low concentration, while the result of the experiment is vice versa, so that students will ask think and ask questions to seek for balance so that a satisfy answer obtained will be a new concept. Another example is when the students are asked to report their findings in searching of a connection between several variables involved in experiment and show it to the teacher. If the the method of student achieving the result is rejected by the teacher because of several variables are changed, then students will be motivated to rethink about the basic of their experiment. This condition produce conflict among the students, hence students tend to be more sure with the procedure that need to be followed in Science process (Hodson, 2008,pp. 85-142).

The heart of inquiry learning is the ability to ask questions. Considering the importance of questions in inquiry learning, teacher should be sensitive enough toward students question pattern. Teacher should analyze question from students in order to determine the strength and weakness of their questions (NSTA & AETS, 2003, pp.1-9). Inquiry learning needs skills in collecting and analyzing data and also giving value toward the result to get a solid conclusion. Students should be given a chance to analyze data toward their preparation. They should obtain an acceptable level of proficiency in collecting and analyzing data from different format and can use those criteria to differentiate a valid and not valid conclusion. In planning laboraturium activity, teacher use a small group to stimulate the discussion, increase student skills in using lab tools, distributing responsibilities, spreading skills within the class. From social point of view, inquiry collaboration is essential. Students whom teacher candidates must be given a chance to work in a team. Group work strategy that include working rules within a team must be part of the learning (NSTA & AETS,

2003, pp.1-9).

Inquiry learning strategy can be done through two orientations, deductive inquiry and inductive inquiry. Dahar (1985 p.128) stated that both of the orientation are difference at the finding the concept stage. Deductive inquiry tends to inquiry activity after the teacher deliver the concept or principles of the subject, while concept and principles findings in inductive inquiry are done by the students after they conducted inquiry activity.

Based on several philosophy and experiment result, inquiry learning includes; (1) inquiry learning facilitate students toward science understanding as a process and products, (2) students learn to construct the knowledge that is accurate based on communication and dialog, (3) students learn science through critical understanding, (4) students learn science as thing that is dynamic, cooperative and accumulative, (5) students learn material and science values as scientist work, (6) students learn the nature of science and knowledge of science integratively (NRC, 2003, p.300).

6. CONCLUSION

The result of the research are; (1) inquiry learning strategy is effective to provide concept understanding ability of plant anatomy toward biology student, (2) implementation of inquiry laerning strategy gives a huge contribution toward the improvement quality of concept reconstruction ability of plant anatomy and can minimize the alternative conceptions and do not understand concept of the students, (3) inqury learning strategy able to deeply push students in learning the plant anatomy concept, to seek the concept that need to be found, and able to reconstruct concepts that they already have to create a solid and valid concept understanding as well as related back those concepts to the other existing concepts.

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