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Guided Inquiry Based Learning on the Concept of Ecosystem Toward Learning Outcomes and Critical Thinking Skills of High School Students

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Abstract: *Survey result by Trends in International Mathematics and Science Study (TIMSS) 2007 reported that Indonesian students achievement in mathematics was ranked 36th of 49 countries, while in science lessons was ranked 35th of 49 countries. Survey result by PISA on 2009 in mathematics and science reported that Indonesia achievement left behind from Singapore, Thailand, and Korea. The important things that need to be done are how to design learning and do assessment that able to stimulate the increasing of science literacy. Quasi experimental research aims to examine the effects of guided-inquiry based learning on the concept of ecosystem towards learning outcomes and critical thinking skill of high school students. This study population is students from grade X SMA Negeri 1 Sungai Tabuk. Samples were determined purposively as many as four out of seven classes. The learning result of cognitive products and cognitive process are collected using tests and analyzed with anacova. Critical thinking skills collected from students' worksheets and analyzed descriptively using categories: good (76-100%), fairly good (51-75%), less (26-50%), and bad (<25%). The results show 1) guided-inquiry based learning has effect towards learning outcome of cognitive products (F= 10,06; P= 0,0001), 2) guided-inquiry based learning has effect towards learning outcome of cognitive process (F= 20,63; P= 0,0001), 3) students' critical thinking skills include formulate problems, formulate hypothesis, collect data, analyzed data, and make conclusion on average categorized as good enough.*

Keywords*: constructivist, critical thinking, ecosystem, guided-inquiry, learning outcome,*

I. Preface

One of the problems that Indonesia education world facing is the weakness of learning process, students are less encouraged to develop their thinking skills, and learning in classroom only directed to memorize informations without being required to undestand what they remembered (Sanjaya, 2007). This condition also happens in biology lesson in high school. TIMSS 2007 reported that Indonesian students achievement in mathematics was ranked 36th of 49 countries, while in science lessons was ranked 35th of 49 countries. It's also obtained from PISA survey on 2009 on the same subjects. Indonesian student achievement left behind from Singapore, Thailand, and Korea (Kemendikbud, 2011). Based on this study result, Indonesian students science ability are low, moreover the implementation in science literacy are lower and not showing any trend of increasing. The important things that need to be done immediately are how to design learning and do assessment that able to stimulate the increasing of science literacy (Wasis, 2015).

Center of School Science and Mathematics (PSMS) Unesa Surabaya has produced many lesson plans which can be used by teachers. At least, through this institution can be used as guidelines for teachers to developing in biology lesson. This effort is worth to follow because it's an innovation in education field.The competencies of graduate from education program are cover three competencies i.e attitude, knowledge, and skill, so that can be produced a fully human-being. Attitude is obtained by activities "accept, execute, respect, appreciate, and practice". Knowledge is obtained by activites "remember, understand, apply, analyze, evaluate, create". Skill is obtained by activities "observe, ask, try, reasoning, and create". Guidance in scientific work includes 1) purpose, 2) theoretical basis, 3) materials (equipments and materials), 4) procedure, 5) observation and result, and 6) questions (Cappuccino & Sherman, 1983).

Education purpose is combination of educational goals that are developing the personal skills optimally with social goals that are fully human-being that able to play its role as citizen in variety environments and social groups (Mudyaharjo, 2002). Teachers are required to motivate students, use variety models, and learning media to help students to construct lesson materials. This is reasonable because education is directed to the process of finding concepts, not only remembering concepts.

Thinking skills can be accommodated through learning that designed using constructivist models. Either the critical thinking skill, creative thinking, or higher level thinking. Singh & Rahman (2012) explained a environment education program should have purpose relating to awareness creation, knowledge accumulation, positive attitude, problem solving skill, and community participation.

Inquiry based learning has often been reported. Use of this model has improved students' learning outcome (Belawati, 2009; Khairunnisa, 2010; Ariyani, 2011; Wati, 2012). On the other side, it's also increasing thinking skill (Wati, 2012). Inquiry based learning need to be implemented in high school, considering this model can digging critical thinking skill. Through critical thinking skills practice, become a basic asset to improve students' critical thinking skills. Based on it, research about implementation of inquiry based learning on biology towards learning outcome and high school students' critical thinking skill was conducted.An effective way to develop critical thinking skills is with insert it into a part of each lesson. Teaching critical thinking is a continuous process. It can't be confined to the classroom sessions, but must be put through a variety questions, lessons, and activities that focus on the level of higher thinking skills (Reddington, 2012). High-level thinking skills include critical thinking, logical, reflection, metacognitive and creative thinking (King, 1997). Active learning involves students typically comprises components of this skill. So, critical thinking skills are expected to be managed by the student in the learning process.

Arends (2012) stated critical thinking skills require skills that will help determine the accuracy of information and recognize the illogical argument. According Facione (1998) there are some skills that are categorized as critical thinking skills, the experts do the interpretation, analysis, inference, evaluation, explain, and self-assessment. If the student has mastered one skill, he has been led to critical thinking ability even though they hadn't fulfilled all the expertise that has been mentioned. Facione (1998) explain interpretation is the ability to understand and express the meaning of the various experiences, circumstances, data, events, considerations, conventions, beliefs, rules, procedures or criteria. Inference is like concluding a picture of some of supporting data that presented. Explaining/ describing is the ability to declare and to justify the reasoning in relation to the conceptual, methodological, criteria and considerations based on the underlying context.

Schafersman (1991) put forward an effort to improve the ability of critical thinking through 1) the ability to read, 2) the ability to listen, 3) the ability to observe, 4) the ability to analyze. Improving the ability to read critically carried out by a) underline the key ideas, b) learn together and compare the main ideas are made with the other group members, c) write what the main idea of a passage in their own words. The ability to listen critically, carried out by a) making-points that are important, b) focus on what the speaker is saying and hearing the main points or key.The ecosystem concept in biology learning should be emphasize to the learning process in students so it will formed the national character and love of the homeland (Ridwan, 2010). A learning source i.e natural environment as a source of learning lessons for students to find the concept is still underutilized. Volk & CHEAK (2003) describes the environmental education is used to measure critical thinking skills that make conclusions, make inferences and identify bias.Ertekin & Yuksel (2014) explained that environmental education could help someone to improve perception, understanding, and attitude in human interaction, culture, and biophysics environment. Through the environment based learning could improve students' critical thinking skill (Listyawati, 2012).The basic thing that needs to be introduced to the students are the damage or loss of ecosystems such as wetlands around the school can impact the loss of function of wetlands, such as prevent flood, prevent fires (forest), prevent the intrusion of sea water, the source of water providers, prevent global warming, livelihoods, and education (Zaini, 2014). The lives of the present and future generations are determined by the community's concern in preserving the wetlands in the vicinity. One way to conserve wetlands is through environmental education.

II. Methods

Research about effect of guided inquiry-based learning on the ecosystem concept to the high school students learning outcomes using a quasi-experimental, while the students' critical thinking skills obtained through descriptive study. Quasi-experimental design is using the non-equivalent control group design, like picture 1.

Class A	O_1	X	O_2

Class B	O_1		O_2

Picture 1. Research Design Model of *The Nonequivalent Control Group Desig* Information: O_1pre-test; O_2: post-test; X: Learning with guided-inquiry

Research conducted at the SMA Negeri 1 Sungai Tabuk Banjar district academic year 2013/2014. These study populations are students of class X with seven parallel classes. Samples consist of four classes; consist of two experimental classes and two control classes, which determined purposively. The learning results of cognitive product and cognitive process using the test, critical thinking skills using students' activity sheet.

The analysis of learning outcomes data using covariance techniques were processed using Statistical Analysis System application release 9.1.3. Data of critical thinking skills are described using categories; good (76-100%), fairly good (51-75%), less (26-50%), and bad (<25%).

III. Results

a. Cognitive Product Learning Outcome

The cognitive product learning outcome presented in Table 1.

Table 1. Summary of Cognitive Product Learning Outcome

	Control Classes		Experimental Classes	
	Pre-test	Post-test	Pre-test	Post-test
Average	35,73	58,96	35,73	62,29

Table 1 shows the difference between the control group and the experimental classes. Furthermore, the significant test is presented in Table 2.

Table 2. Summary of Covariance Analysis of the Cognitive Product Learning Outcome.

Source	DF	Sum of Squares	Mean Squares	F-Value	Pr > F	Information
Model	2	0,102	0,051	10,06	0,0001	Significant
Error	93	0,469	0,005			
Corrected Total	95	0,571				

Information: R-square = 0,17 C.V = 3,99

Table 2 shows a significant effect of guided inquiry-based learning on the cognitive products learning outcome (F = 10.06; P = 0.0001).

b. Cognitive Process Learning Outcome

The cognitive process learning outcome presented in Table 3.

Table 3. Summary of Cognitive Process Learning Outcome

	Control Classes		Experimental Classes	
	Pre-test	Post-test	Pre-test	Post-test
Average	39,36	57,34	38,51	60,64

Table 3, also shows the difference between the control group and the experimental classes. Furthermore, the significant test is presented in Table 4.

Table 4. Summary of Covariance Analysis of the Cognitive Process Learning Outcome.

Source	DF	Sum of Squares	Mean Squares	F-Value	Pr > F	Information
Model	2	0,17	0,083	20,63	0,0001	Significant
Error	93	0,37	0,004			
Corrected Total	95	0,54				

Information: R-square = 0,31 C.V = 3,57

Table 4 also shows a significant effect of guided inquiry-based learning on the cognitive process learning outcome (F = 20,63; *P* = 0,0001).

c. Critical Thinking Skills

The result of students' critical thinking skills during the learning process are presented in Table 5.

Table 5. Summary of the Average of Critical Thinking Skills

No.	Observed Aspects	Average (%)	Category
1	Formulate problems	71.22	Fairly Good
2	Formulate hypothesis	70.5	Fairly Good
3	Collect data	74.77	Fairly Good
4	Analyze data	73.43	Fairly Good
5	Mak conclusion	72.81	Fairly Good

Information: Good (76-100%), Fairly Good (51-75%), Less (26-50%), Bad (< 25%).

Table 5 shows the average of students' critical thinking skills in all aspect are fairly good.

IV. Discussion

a. Cognitive Product Learning Outcome

There is a significant effect that given by the using of guided-inquiry based learning with the result of cognitive learning product. This result similar to the previous research (Bilgin, 2009; Tangkas, 2012; Ni'amah, 2013; Nurochmah, 2007; Hermawati, 2012; Suwondo & Wulandari, 2013; Marhaeni, et al., 2013; Ristanto, 2009; Belawati, 2009; Rosmalina, 2010; Zannah, 2012; Prasiska, 2013). These researchers were merely using

guided-inquiry based learning in teaching and learning process (Bilgin, 2009; Marhaeni, et al., 2013; Ni'amah, 2013), or combined it with environmental approach (Belawati, 2009; Ristanto, 2009; Prasiska, 2013). The combination of guided-inquiry based learning with cooperative learning could increase students' activeness in the classroom and improves their learning environment (Bilgin, 2009; Zannah, 2012; Prasiska, 2013). The using of guided-inquiry based learning could optimizing students' average scores (Tangkas, 2012; Ni'amah, 2013; Marhaeni et al., 2013; Rosmalina, 2010) and students' comprehension (Belawati, 2009). It also could increase students' achievement consistently (Suwondo & Wulandari, 2013).Most of effective contribution (*R-square* = 0,17) (83%) are found to be unidentified factors or some external factors that effect students' cognitive product. This external factor is the fact that students are not familiar with the guided-inquiry based learning itself. This obstacle is admitted by a biology teacher in SMA Negeri 1 Sungai Tabuk, who said that the teaching and learning process in his school is still teacher centered in which students are less active in the classroom. Environment as a source of learning is also still underutilized. Guided-inquiry based learning emphasis the maximizing of students' activity in exploring and finding which means it places students as the subject of learning (Jauhar, 2011). Students face some difficulties in using this model, since they are still accustomed with the system where they get everything directly from the teacher. This learning model need a quite long time, which makes teacher faces difficulties in adjusting the material with the given time. Students who are still unfamiliar with this kind of model would need some times to adapt.

The questions in cognitive area are already heading to the C4 (analyzing) in Bloom's taxonomy. These questions are considered as difficult by students, since previously they used to deal with questions in the C1 (remembering) and C2 (understanding). They haven't ready or trained yet to think in higher cognitive level. Students' success is also affected by the completeness of learning facilities. Since the biology textbook for the tenth grade students is insufficient, students have limited opportunities in learning the material. The time management in a test is also has some effect in students' achievement. The environment of the evaluation is also one of the factors that affect the success of teaching and learning process (Djamarah & Zain, 2010).The use of technology in learning act ivies hasn't conducted yet, due to the limited facilities; such as a slow internet access, even though the implementation of Kurikulum 2013 emphasizes a technology based and communicative learning. Those reasons are causing the effect that is resulted by guided-inquiry based learning to cognitive learnig product is not optimal.Even though, the effective contribution of guided-inquiry based learning to the cognitive product learning outcome is only 17%, this shows an increase in students' achievement in cognitive product learning outcome. It is shown from the different result of students' cognitive product in the experimental group and control group. Students start to build a constructivism concept in their learning activities; they try to be active in finding the answer of their curiosities related with the material.

b. Cognitive Process Learning Outcome

There is a significant effect that given by the using of guided-inquiry based learning with the cognitive process learning outcome. This result similar to the previous research (Bilgin, 2009; Tangkas, 2012; Ni'amah, 2013; Nurochmah, 2007; Hermawati, 2012; Suwondo & Wulandari, 2013; Marhaeni, et al., 2013; Ristanto, 2009; Belawati, 2009; Rosmalina, 2010; Zannah, 2012; Prasiska, 2013).Guided-inquiry based learning could develop scientific process skills (Brickman, et al., 2009; Ambarsari, 2012; Tangkas, 2012). Trained scientific process skills would create students' scientific process skills (Nurochmah, 2007). Teaching and learning that is conducted in real life environment is influencing more positive achievements (Ristanto, 2009; Prasiska, 2013).
Most of effective contribution (*R-square* = 0,31) (69%) are external factors that affect students' result of cognitive learning process. The cognitive process effective contribution bigger than the cognitive product. Ridwan (2010) states that learning biology through observing and experimenting give students more real life experience.The effective contribution is still low due the students' unfamiliarity with the activities conducted in guided-inquiry based learning. Students rarely do an observation or experiments in biology learning. Thus, when they are asked to do so, students are not as active as expected. Gulo (2004) proposes some requirements in conducting inquiry activities: 1) social aspect in the classroom and open-free atmosphere that poke students' interest and curiosity, 2) focus on the hypotheses that is going to be tested, 3) using facts as evidences. The described condition above has not met these requirements yet. Uno and Nurdin (2012) explains the advantages of learning using natural environment which are 1) students could get a concrete experience related with the material, 2) it is easy to be understood, 3) it gives students limitless area of thinking because the material is real/concrete. These requirements hasn't fulfilled yet either.Even though the effective contribution of this teaching and learning model is only 31%, the practice of this model shows some positive effects in students' achievement in cognitive learning process. According to Amri and Ahmadi (2012) the inquiry process during the teaching and learning process results constructive impact that gives many chances and energy in increasing the effectiveness of teaching and learning. Roestiyah (2012) states this model encourages to think and work based on their desire, objective, honest, and open minded. It also encourages students to think intuitively in formulate a hypotheses.

c. Critical Thinking Skills

Students' critical thinking skill in stating the problem, formulating the hypotheses, collecting the data, analyzing it and make a conclusion based on it is considered as good. The result of this research is similar with the previous ones (Brickman et al., 2009; Kitot et al., 2010; Metz, 2008). Teaching and learning using inquiry model could increase students' critical thinking skill (Brickman et al., 2009; Kitot et al., 2010) and comprehending in data analysis (Metz, 2008).Students' critical thinking skill haven't categorized as good yet, since students are still not familiar in conducting the steps in inquiry learning. They still need times to practice. Some students found problem stating skill is difficult. They face some difficulties in connecting the statement of problem with the hypotheses as well. The ability in collecting data could be categorized as fair; this is caused by the way students learn before and the limited source of learning from natural environment. One of the difficulties in applying guided-inquiry based learning is the assumption that in learning, the only source of knowledge is the teacher. Teacher explains everything; thus, students do not have to go outside to find it by themselves. If this learning habit continuously conducted, students would find difficulties when they are asked to solve a problem. They would find it difficult in asking and answering questions from teacher as well. This thing could be overcome if students are given a quite long time to find the answer of a question (Sanjaya, 2013). According to Piaget guided-inquiry based learning is a means to develop students' critical thinking skill. Students' critical thinking skill is considered as fair since students are used to be given a conceptual material, instead of the real ones. If the students have zero interest, then the thinking process would not be conducted. Guided-inquiry based learning teaches students how to understand and explore the material, besides develop their thinking skill (Hartono, 2013). Gulo (2004) states that the learning activities of this model involving the maximal participation of students' skill in observing and exploring systematically, critically, logical, and analytical, so they could formulate their own findings confidently. Guided-inquiry based learning could help student to develop a discipline behavior and intellectual skill in finding the problem and its answer by themselves, so they could be an independent problem solver (Ngalimun, 2012).

V. Conclusions

1. Guided-inquiry based learning gives a significant effect to the cognitive product learning outcome.
2. Guided-inquiry based learning also gives a significant effect to the cognitive process learning outcome.
3. Students' critical thinking skill, involving formulate problems, formulate hypotheses, collect and analyze data, and make conclusions is categorized as fairly good.

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