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Original Research Article

Scientific Literacy of Students Learned Through Guided Inquiry

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ABSTRACT

The research aimed to find out the impact of guided inquiry instruction on scientific literacy in Basic Concept of Biology for Elementary School Course. Participants of the research were 59 students of Primary School Teacher Education program in Pakuan University, Indonesia. The research was conducted for one semester. Type of research was quasi-experiment with randomize factor. Indicator used for scientific literacy referred to PSIA, are identifying scientific issues, explaining scientific phenomenon, and using scientific evidences. Data used was the result of pre- and post-tests of scientific literacy. Ancova was used continued with LSD (*Least Significance Different*) test. Research result indicated that guided inquiry instruction gave better impact on scientific literacy of students than conventional learning.

Keywords: Guided inquiry, Scientific literacy, Biology learning

1. INTRODUCTION

In 21st century, there is a demand for individual to be able to keep up with the development in science and technology (Ozdem et al., 2010). Science has significant influence on the personal life of a society and global economy. In order to succeed in this century, students should have good scientific literacy and lifelong learning principle (Glynn & Muth, 1994). Good literacy ability will familiarize students to not only learning to read but reading to learn and have the ability to understand the reading (Kuhlthau, 2010).Scientific literacy is a must for every individual in order to have bigger opportunity to adapt with the dynamics of life and to increase development of a nation (Genc, 2015; Jurecki& Wander, 2012; Turgut, 2007).

Scientific literacy concept is initially introduced by Hurd (1958) and McCurdy (1958) in education world (Bacanak and Gokdere, 2009). Scientific literacy is defined as the ability of an individual to understand and use knowledge in science field (Dani, 2009; Cansiz et al, 2011; Cavas et al., 2013). Other definition stated that scientific literacy is an understanding attitude of a person on science and the ability to apply it in the daily life (Eisenhartet al, 1996; Hurd, 1998; De Boer, 2000). Components of scientific literacy consist of the ability to identify questions and draw conclusion based on facts to understand the nature, to communicate orally or in writing and to make a decision from changes occurred due to human activities thus having attitude and high

sensitivity toward self and environment (Toharudin et al., 2011).

In sciences learning process, students should be provided with good scientific literacy (Hoolbroke& Rannikmae, 2009), including those students who enroll in teacher program. Prospective teacherswho play role as change agents have important role in giving science lesson to students to achieve the goals of learning science (Ozdem et al, 2010). Therefore, it is expected that teachers also have good scientific literacy (Cavas et al., 2013). Some result, however, indicates that scientific literacy is not as expected. For example, the mastery of teachers on science ability and its application in learning is very low (Budiastra, 2011). In learning process, teachers have not linked learning material to the daily life (Ayas et al., 2001). On the other hand, elementary school teachers and pre service teachers do not have good scientific literacy(Çepni, 1997; Çepni & Bacanak, 2012; Sujana, 2014). Scientific literacy of students in Indonesia is within low category and learning process hasn't been optimal yet in increasing scientific literacy(Dahtiar, 2015). Scientific literacy of students in Indonesia in the aspect of content, process and context were low category (Odja & Payu, 2014; Suciatiet al, 2013).

Effort that could be conducted by teacher in increasing scientific literacy is by increasing the quality of learning (Sujana, 2014). A learning model is neededto develop the ability and skill to be creative in appropriately using knowledge based on scientific evidences, especially in daily life, and self-ability in solving problems and makingjoint and accountable scientific decisions (Holbrook & Rannikmae, 2009). Through enquiry process, scientific literacy can be increased (Carlson, 2008; Gormally et al, 2009, Adolphus; et al, 2012). Some studies indicate that guided inquiry learning could increase scientific literacy of students (El Islami, 2013; Ngertini, et al, 2013).

Guided inquiry instruction is a learning model potential to be developed in biological learning (Bialangi et al., 2016; Ristanto, 2011). The learning model gives emphasize on students to learn through stages to gain knowledge through scientific method processes, which are formulating problems, proposing hypotheses, collecting data, verifying result, and generalizing by drawing conclusion. In guided inquiry process, the role of teacher is as a mentor in decision making process (Matthew& Keneth, 2013; Obomanu et al, 2014, Oghenevwede, 2010). In the process, students and teachers work together to formulate problems and develop answers. The activities could train students to develop attitude of responsibility and cognitive ability (Bilgin, 2009). In addition, inquiry activity also trains student to involve actively in finding a concept and principle of the material learned (Kubicek, 2005). The use of articles in inquiry learning process could help students to increase the ability in understanding text. In addition, reading could also develop their own knowledge (Baer et al, 2008; Maulis et al, 2011).

Based on study of learning model characteristics and courses, guided inquiry learning is an appropriate learning model for Basic Concept of Biology for Elementary School. Since a learning process would need an activity that could change students to find a concept through direct creativity, guided inquiry instruction is expected to increase scientific literacy. This research aimed to find out the impact of guided inquiry learning on scientific literacy of students in Pakuan University, Indonesia. Hypothesis used in the research was that guided inquiry instruction influences students' scientific literacy.

2. METHODOLOGY

The research used quasi experiment research design with pretest-post-test non-equivalent control group design. Independent variables in the research were guided inquiry instruction and conventional model, whereas the dependent variable was scientific literacy.

Table 1. Experimental Design of the Randomized Pretest – Post-test Control Group

Pretest	Treatments	Posttest
T_1	X_1	T_2
T_3	X_2	T_4

Note: $T_{1,3}$ = Pretest
$T_{2,4}$= Post-test
X_1 = Guided inquiry instruction
X_2 = Conventional learning

3. Research Population and Sample

Research population was all students in the first semester of Primary School Teacher Education program, Faculty of Teacher Training and Education, Pakuan University, Indonesia in total of 300 students. Sampling was conducted randomly where statistical test of grouping test was conducted previously based on data of college admission score. It was conducted to ensure grade equality level. Further, random selection was conducted to determine 1 experiment group and 1 control group. The number of sample involved in the research was 59 students.

4. Research Instruments

Instruments used in the research, was literacy science test questionnaire. The test questions used consisted of 40 questions in form of multiple choices referring to the type of questions from PISA. The questions covered content, context and process aspects. In the implementation, students were given one set of scientific literacy questions to be completed in 90 minutes.

5. Data Collection

Research process was conducted in the first meeting. Previously, students had been given explanation related to study contract and lecturing process to be conducted. In preparation stage, discussion activity was conducted to discuss on lecturing tools and instruments used and steps in guided inquiry learning. The activity was conducted so that students and lecturers understand and have good understanding. The research was done for one semester with 8 (eight) subjects and every lecture was observed regarding the implementation of lecturing plan. The eight subjects are described in Table 2.

Table 2: Material of Basic Concept of Biology for Elementary School Course

No	Basic Competence	Course Material
1.	Describe cell as structural and functional unit of organism and apply it in the daily life	▪ Cell ▪ The history of cell ▪ Cell organell (cytoplasm, nucleus, ribosome, RE, golgi body, vacuole, coated vesicle, lysosome, peroxisome, mitochondria, plastid, cytoskeleton, centriole, cilia, and flagella), cell membrane and cell wall ▪ The difference between animal cells and plant cells
2.	Describe cell reproduction and apply it in the daily life	▪ Direct cell division (binary) ▪ Mitosis ▪ Meiosis
3.	Describe the basics of classification and diversity of organism and apply it in the daily life	▪ Basics of classification ▪ Virus ▪ Monera ▪ Bryophyta and pterydophyta ▪ Flowering plant (*Angiosperm*and *gymnosperm*)
4.	Describe the classification of vertebrate and invertebrate animals and apply it in the daily life	▪ Invertebrate animals (*Phylum Protozoa, Porifera, Coelenterata, Platyhelminthes, Nematelminthes, Anelidae, Arthropdha, Echinodermata, Moluska*) ▪ Vertebrate animals (*Pisces, Amphibia, Reptile, Aves, Mammalia*)
5.	Describe various functions of animals I	▪ Digestive system ▪ Respiratory system ▪ Circulation system
6.	Describe various functions of animals II and apply it in the daily life	▪ Reproduction system ▪ Nervous system ▪ Movement system
7.	Describe various functions of plant I and apply it in the daily life	▪ Tissue system and organ in flowering plant ▪ Reproduction of flowering plant (vegetative and generative)
8.	Describe various functions in plant II and apply it in the daily life	▪ Growth and development ▪ Photosynthesis

6. Data Analysis

Research data was analyzed using descriptive statistic. Before data analysis was conducted, data was previously tested for Ancova assumption consisted of data normality test and variance homogeneity

test. Normality test used *One-Sample Kolmogorov-Smirnov* test, whereas homogeneity test used *Levene's Test of Equality of Error Variances*. The tests were conducted using statistical analysis program of SPSS 18.0 for Windows, with significance level of 0.5%.

7. Findings

The summary of Ancova test result of the influence of guided inquiry instruction on scientific literacy of students is presented in Table 3.

Table 3: Result of Ancova test of the influence of guided inquiry instruction on scientific literacy of students

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	6853,955[a]	2	3426,978	55,073	,000
Intercept	2721,022	1	2721,022	43,728	,000
Pretest	1147,542	1	1147,542	18,442	,000
Learning_Model	4470,016	1	4470,016	71,835	,000
Error	3484,643	56	62,226		
Total	280460,323	59			
Corrected Total	10338,598	58			
a. R Squared = ,663 (Adjusted R Squared = ,651)					

As indicated in Table 3, result of Ancova test showed that learning model had influence on scientific literacy with sig. value of 0.000, which is less than alpha of 0.05. Research hypotheses stated that there is influence of the difference in scientific literacy between guided inquiry instruction and conventional learning is accepted; thus, it can be concluded that learning model had influence on scientific literacy. Further, a follow up test was conducted using LSD test as presented in Table 4.

Table 4 Result of LSD test of the influence of learning model implementation on scientific literacy of students

Class	Average		Average	Increase
	Pretest	Post-test	Corrected	
Conventional	54	58	57,66	6,78%
Guided inquiry model	58	77	77,37	33,40%
The difference in the increase of scientific literacy				26,62%

Based on the result of LSD test in Table 4, it can be seen that the achievement of scientific literacy of students in experiment class was significantly higher than those of control class. Class taught with guided inquiry instruction had a difference in the increase of scientific literacy of 26.62% higher than those in conventional class.

8. DISCUSSION

The implementation of different learning models in the course of Basic Concept of Biology for Elementary School was the basic of the research. In experiment group of students, guided inquiry instruction was implemented, whereas conventional learning was implemented in control group of students who learn biology. Conventional learning is a learning commonly applied in the course of Basic Concept of Biology for Elementary School. Conventional learning process is applied through presentation by lecturer and students as the audiences pay attention to the lecture and usually, they are given a chance to ask or submit issue for discussion.

Research result showed that the implementation of guided inquiry learning was more effective in increasing the ability of scientific literacy among students. The result confirmed some relevant research results that there was a strong connection between guided inquiry learning and scientific literacy. Guided inquiry learning has proven to be able to increase scientific literacy effectively (Gormally et al, 2009, Adolphus et al, 2012, El Islami, 2013; Ngertini, et al, 2013, Carlson, 2008). The learning model was able to increase scientific literacy of 33.40%, whereas conventional learning gave increase of 6.78%. One of factors influencing scientific literacy was learning model used and time needed to learn science (Hariadi, 2009). The potential increase in scientific literacy was explained in the syntax of guided inquiry instruction.

The research implemented guided inquiry instruction by forming heterogeneous group. The grouping was conducted according to cooperative learning principle. The grouping was based on pretest result of the students that conducted before the learning of Basic Concept of Biology for Elementary School. In one group there were students with high, medium, and low pretest results.

Inquiry learning is started with questioning. Problem is conducted by asking questions related to material being studied. Next, students write the hypotheses. Lecturer plays role as facilitator by reviewing open-ended questions and hypotheses. Problems and hypotheses formulation process are activities included in scientific competition in scientific literacy, which is identifying scientific issues. The competence consists of ability to recognize scientifically-explained issues, identify keywords to look for scientific information, recognize the key form of scientific inquiry (PISA, 2006). Students are trained to be sensitive toward issues related to the material studied. In addition, they also learn to determine problems that can be solved through inquiry process. Hypotheses proposed give opportunity for them to give answer based on previously-owned knowledge.

An important step in guided inquiry is the inquiry process. Inquiry process is included in scientific literacy competence, which is explaining scientific phenomenon. Learning process through inquiry activity could increase scientific literacy of students (Wening, 2006). Inquiry activity is conducted by students in a group to dig deeply to explore answer of problem formulation. In addition, inquiry activity is conducted to proof the truth of the hypotheses. Inquiry is directed by looking and studying from relevant article sources. Articles sources-based inquiry can help students to increase their ability in understanding the reading. In the inquiry process through reading study, students could develop their own knowledge from the meaning in texts (Baer et al., 2008; Maulis, et al., 2012). If possible, students are also given a chance to explore by involving the object studied directly. Guided inquiry instruction implemented in science trains students to study directly from the environment. The activity of direct interaction with the learning sources conducted through inquiry process could reinforce the ability of scientific literacy of students (Khasnabis, 2008, Soepudin, 2014).

The next step after inquiry is drawing conclusion and is followed with writing report and consultation with lecturer for pre-presentation review. Presentation is conducted so that students could discuss it through question and answer and compare their research result. The activity is a scientific competence in scientific literacy, which is using scientific evidences (PISA, 2006). Activities in inquiry learning in the research could not be separated from language element started from problem formulation process to the presentation of enquiry result. Language aspect is considered as the key to success of scientific literacy. Language aspect consists of reading, writing and communicating (Norris & Phillips, 2002). Inquiry activity in the research was conducted by studying from reading sources that support problem solving process or in order to look and process information from other learning sources.

The implementation of learning model and time quality used in studying biology are factors influencing one's scientific literacy (Hariadi, 2009). The implementation of guided inquiry instruction gave opportunity to students to learn more about Biology compare to those with conventional learning. Therefore, the implementation of guided inquiry instruction gave batter result in increasing scientific literacy compare to those with conventional learning. Guided inquiry is a learning model that includes three scientific competences in scientific literacy. The implementation of inquiry instruction could put student into a scientist who try to

understand the nature as a science application and give explanation on what they have learned (Rakhmawan *et al*, 2015).

9. CONCLUSION

Conclusion of the research is that guided inquiry instruction gave significant influence on scientific literacy of students.

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