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Science Literacy in Prospective Elementary School Teachers Through Science Technology Literacy Learning

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Abstract— The PISA report on science literacy skills in 2015 shows the position of Indonesian students in the 61st rank of 69 participating countries. Eventhough it has increased from its previous achievements in 2012, but Indonesian students are still lagging behind other students, especially in Southeast Asia. In catching up with this lag, the teacher has an important role to train students' literacy skills, therefore a prospective teacher must be able to literate science. This study aims to examine the application of STL (Science Technology Literacy) learning to science literacy skills of prospective elementary school teachers. The research method used was pre-experiment with the design of the one group pretest-posttest design. Research subjects were 33 prospective elementary school teachers in Sukabumi City. The calculation results from pre test and test post scores obtained N gain value of 0.43, after the statistical test using the t test results, it is obtained that Ho is rejected (asymp. Sig p-value = 0.00 <0.05) means that there is a significant effect of the application of STL learning towards science literacy skills of prospective elementary school teachers. Student attitudes obtained in indicator 1) support science inquiry (80.18%, good category) 2) responsible for natural resources and environment (77.02%, good category), and 3) indicators of interest in science (62.88%, good enough category). The conclusion of this study shows that practicing scientific literacy is suggested to start from elementary school teachers with learning methods / models / strategies based on science, technology, and literacy.

Keywords---Science Literacy, Science Technology Literacy

I. INTRODUCTION

The ability of Indonesian students recorded in competition of PISA (Program for International Student Assessment) in 2012 and 2015 has not been encouraging. The acquisition of Indonesian students in the 2012 PISA competition was ranked 63 out of 65 participants, it was under Qatar and above Peru (OECD, 2013). In 2015 the Ministry of Education and Culture explained that the scientific literacy skills of Indonesian students had increased in value from 327 to 359, so that in 2015 Indonesia's position rose to 61st rank out of 69 participating countries (OECD, 2016). Although the literacy skills of Indonesian students began to increase, the increase was still not been significant.

Several studies conducted in Indonesia also revealed the students' weaknesses in mastering science literacy (Angraini, 2014; Kharizmi, 2015; Novika, 2016; Rahmadani, et al, 2018). Students' abilities are only in the nominal category (initial) (Fitriani, 2012; Odja & Payu, 2014). Students have high ability in mastering concepts but they are low in solving problems and in application of science concepts (Pantiwati and Husamah, 2016).

Every citizen at various levels of education needs to have scientific literate knowledge, understanding and abilities (Hilman and Zakiyah, 2015). Students performance will not be high if they are not guided by creative and professional teachers. In science learning, students need to be facilitated by the teacher because science requires not only understanding scientific concepts, but also the logic of critical thinking, as well as the skills in applying it in their everyday life.

This is in line with what was revealed by Bybee (1993), that an important component that is able to bring a change to science teaching is a teacher, but the effort to apply scientific literacy skills is quite difficult if it is done by teachers who have been teaching for a long time, so the big efforts to train scientific literacy are needed in prospective teacher. Agents of change to succeed in applying science literacy to students must begin at the basic level. Based on the literature studies on the results of scientific literacy students of prospective

elementary school teacher are still very low, even though scientific literacy skills must be taught from an early age (Farihatin, 2013) and it is important to provide this ability to prospective teachers (Rahayu, 2016; Novitasari, 2018). Based on this opinion, the focus in this study is prospective elementary school students.

To overcome the problems that have been revealed, alternative learning strategies are needed that are able to train scientific literacy for prospective teachers, by linking concepts with its application in everyday life then using the concept in the process of rational decision making on social problems. Science Technology Literacy (STL) learning is one of the learning strategies predicted to overcome these problems. STL learning has the advantage of being able to help develop the ability to think creatively and logically about knowledge, science and processes in everyday life, being able to solve problems, make decisions and start improving the quality of life (Holbrook, 2005). In its application, STL learning refers to aspects: 1) Context-oriented and instilling learning processes into authentic problems (Vanderbilt in Nentwig et al, 2002), 2) Using self-directed and cooperative learning methodologies (Dubs in Nentwig et al, 2002), 3) aims at developing a number of expanded science basic concepts (Vanderbilt in Nentwig et al, 2002).

Based on the background that has been stated, the problems formulated in this study are: 1) What form of STL learning can be applied to train science literacy skills of prospective Elementary School teachers? 2) How is the implementation of STL learning? What is the effect of STL learning on prospective teacher literacy skills? 4) How is the prospective elementary school teachers scientific literacy attitude in STL learning?

The purpose of this study is to examine the effect of STL learning on science literacy skills of prospective elementary school teacher students, so that prospective teachers are expected to learn and practice, and gain adequate experience in developing and teaching science literacy for their students.

II. METHOD

The research method used was pre-experiment with the design of the one group pretest-posttest design. The research subjects were 33 prospective elementary school teachers in Sukabumi City. The subject taking technique in this study used purposive random sampling. The instruments used in this study consisted of three instruments, such as the question of scientific literacy, observation sheets and attitude scale.

The first instrument is a scientific literacy pack of questions given before and after the STL learning process. The questions were formulated in the form of objective tests with 25 multiple choice questions with four options with indicators referring to PISA 2015 (OECD, 2016). Previously, these scientific literacy questions have been validated by expert to see the validity of its content and then test the instrument, so that the question is certainly valid and reliable. The second instrument is the observation sheet used to capture students' activities in the seven stages of STL learning (Contact Phase, Curiosity Phase, Elaboration Phase, Decision Making Phase, Nexus Phase, Decontextualize, and Evaluation Phase). The third instrument is the scale of attitudes in favor of scientific inquiry, responsible for natural resources and environment, as well as interest in science.

Test score data are used to measure students' scientific literacy abilities aspects. This test score comes from the score of the initial test and the final test. Multiple choice questions scores are determined based on the Rights Only method, the correct answers are given a score of one and wrong answers or items that are not answered are given a zero score. The score for each student is determined by counting the number of correct answers.

The level of effectiveness of STL learning in improving scientific literacy on prospective elementary school teachers in terms of normalized gain values (n gain) using the method of calculation and classification according to Hake (1997). To test the normality of the data carried out using the SPSS 20.0 program using the Kolmogorov Smirnov test. Hypothesis testing of the data obtained was analyzed using the one sample t-test to see the difference in the two average abilities of prospective teachers after being given STL learning. The proposed hypothesis:

H0: There is no significant difference between pre and posttest

H1: There are a significant difference between pre and posttest

Test criteria: Reject H0 if asypm. Sig (p-value) <0.05

III. RESULT AND DISCUSSION

In this section the results will be explained according to the problems revealed in the introduction. The form of STL learning that can be applied to practice scientific literacy skills of prospective elementary School teacher is modified from the Holbrook (1998) and Nentwig et al. (2002) studies shown in table 1 below:

Table 1. STL Learning Activities

Stages	Activities
Contact Phase	Observe videos about floods, erosion, drought and their effects on humans.
Curiosity Phase	Questions that stimulate students to think: "What can we do to reduce environmental changes?"
Elaboration Phase	Exploration, formation and consolidation of concepts through discussion activities.
Decision Making Phase	Class discussion by students expresses their opinions in an effort to anticipate environmental changes in everyday life. At this stage the questions in the curiosity stage are discussed by students so that the best solutions to the problem of environmental change are obtained
Nexus Phase and decontextualize	Applying the same concept problem is given in different contexts where the same concept of knowledge is needed for solving it.
Evaluation Phase	Students are given the final test (posttest) with the same questions as the pretest questions. Posttest results are used to measure students' abilities after learning which is useful for assessing learning goal.

The implementation of STL learning is measured using an observation sheet. The results are shown in table 2 below:
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Table 2. Implementation of STL Learning

Observation Aspects	Number of Students	%
Contact Phase		
Observe video	33	100
Curiosity Phase		
Interested in the questions asked	13	39.39
Elaboration Phase		
Group discussion	5	15.15
Read sources (books) or access the internet related to material	25	75.76
Write down the results of observations and discussions	7	21.21
Decision Making Phase		
Students discuss in group actively	18	54.55
Students express their opinions actively	20	60.61
Nexus Phase and decontextualize		
Students convey ideas on how to reduce other environmental changes actively	8	24.24
Evaluation Phase		
Follow the final test and do the assignments	33	100

Science Technology Literacy (STL) consists of 7 learning stages namely Contact Phase, Curiosity Phase, Elaboration Phase, Decision Making Phase, Nexus Phase, Decontextualize, and Evaluation Phase. Contact phase and curiosity phase are able to foster students' motivation in learning, because at these stages a video is given about environmental changes (floods, erosion, drought) and then students think about scientific phenomena that happen and try to evaluate and design how efforts can be made to reduce the environmental change. While elaboration phase and the decision making phase helps students to interpret data, strengthen concepts, formulate problems, find solutions and make decisions to solve the problems of environmental change. The Nexus phase and decontextualize phase will train students to solve other problems, so that their problem solving skills will be more honed. Evaluation phase will provide an overview of student achievement in scientific literacy skills trained in STL learning.

Student scientific literacy improvement can be seen from the number of students who answer each question correctly before and after the implementation of learning process. Comparison of the results of the final test and the initial test and the n-gain value was used to

see the proportion of students' improvement who answered correctly on each question per indicator of scientific literacy and n-gain which is assumed to be the effect of the treatment, per indicator is shown in table 3.

Table 3. Acquisition of Scientific Literacy Process Score

Indicator of Science Literacy Process	Pre test	Post test	N-gain	Criteria
Explain scientific phenomena	40.3	69.13	0.5	Medium
Evaluate and design scientific investigations	23	55.76	0.5	Medium
Interpreting scientific data and evidence	54.5	87.88	0.7	High

The effect of STL learning on scientific literacy is also supported by the results of different two final test averages which prove that there is a significant influence between the final test and the predetermined criteria. The results of statistical tests are presented in Table 4.

Table 4. Statistic Test Result

	N	**X**	**Df**	**SD**	**Sig (2-tailed)**
Pretest	33	38.55	32	16.45	.000
Posttest	33	68.21	32	11.25	.000

Significancy Level P>0.05

Based on Table 4 above, after the normality test was carried out as a pre-condition test for the data, it was found that the data were normally distributed (p-value pretest 0.542 and posttest 0.373> 0.005). The normality test criteria is that H0 is accepted indicating that the data are normally distributed. Then it tested using the one sample t-test parametric test, the result is p-value 0.00 <0.05, which means H0 is rejected. This means that there is a significant difference in students' scientific literacy skills after learning is carried out.

In this study, the attitudes of students were also captured after giving STL learning. The attitude tested was adjusted to the theme of environmental change. Includes 3 indicators according to PISA 2012, namely 1) Responsibility for natural resources and environment, 2) Supporting scientific inquiry, and 3) Interest in science.

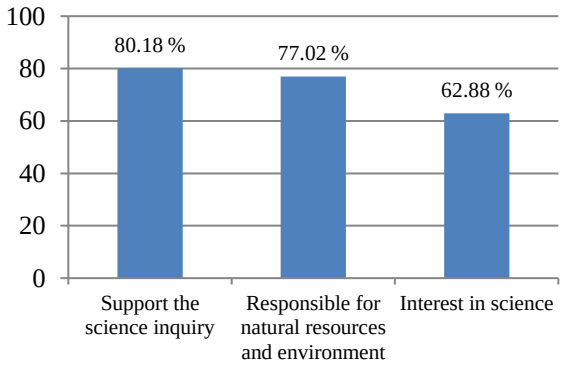

Figure 1. Comparison of the values of student science attitudes

The students' attitude recorded on the results of the attitude scale instrument is in the good category (graph 1). The aspect of supporting science inquiry is in the best category (80.18%), students behave to explain a phenomenon that occurs based on factual data. If there are sharp differences of opinion, they go with opinion which supported by logical arguments and not expressing opinions without strong argument. The responsible aspects of the natural resources and environment is in the good category (77.02%), students

show a personal sense of responsibility to preserve the environment, and show concern for the environmental impact of human behavior. In the aspect of interest in science is categorized medium (62.88%), students show curiosity in science related to social issues.

STL learning emphasizes on the process of student involvement to find material and experience-oriented directly, students are also stimulated to build curiosity through social issues in this study regarding in the environmental changes (including floods, erosion, landslides, droughts) caused by human activities. In the implementation of STL learning involves existing knowledge (activating knowledge) to acquire new knowledge (acquiring knowledge) and then understanding knowledge to be applied (applying knowledge) and ended with reflection (reflecting knowledge), if it is associated with learning theory then actually this learning is greatly influenced by the philosophy of constructivism.

The philosophy of constructivism states that learning is not just memorizing but constructing knowledge through experience, then students are expected to be able to apply the knowledge or experience gained into the real situations. In accordance with what was stated by Nentwig et al. (2002) that there are three theoretical foundations in science and technology literacy-based learning, they are science literacy, motivation theory and constructivism theory.

A model of the nature of science education is proposed, which is basically based on activity theory rather than logical positivism. This includes understanding of the nature of science, with links to achieving goals in the personal domain, emphasizing the development of intellectual and communication skills, and promoting character and positive attitudes, plus achieving goals in the domain of social education, emphasizing cooperative learning and social-scientific decision making. (Hoolbrook, 2007).

Science literacy is an important element in modern science technology education and it is crucial for all citizens not only for those who study or have a career in science (McPhearson, 2008), because more and more problems in the world relating to science and technology are always increasing and every member of society required to be able to participate in discussions actively and be involved in the decision-making process to solve the problems. Even more important is that there is a strong relationship between scientific literacy skills and the economic development of a country (Laugksch, 2000). Communities that are objective, process and have capability in science will be able to supply reliable scientists, engineers, and experts who at the final will be able to improve the economic level of a country (Windyariani, 2017).

STL learning has been proven able to improve scientific literacy as presented in tables 2 and 3, this is because STL learning guides students to integrate concepts with everyday life so that learning process is more contextual. Stages in STL students are presented with actual information that occurs associated with concepts. Furthermore, students are invited to understand some topics more deeply so that students really understand everything from the concepts of a specific topic to its applications in their daily life. Reliable human resources are certainly literate human resources (Kharizmi, 2015).

The science attitude in scientific literacy relates to problems that can be solved by scientific knowledge and can form the students to be able to make decisions at present and in the future (OECD, 2009). In this study, the attitude of prospective teachers on the three indicators supports scientific inquiry and responsible for the natural resources and environment are in the good category, while the indicators of interest in science are in the medium category. Attitude and awareness are seen as important components in individual scientific literacy, and they can bring individuals to the formation of scientific literacy. Someone needs to have a positive attitude towards science in order to master science knowledge properly, even need scientific expertise and cultivate themselves with attitudes and values of science in every dimension of life. If the science attitude has been embedded in prospective teachers then as an agent of scientific literacy, they will feel responsible for instilling the attitude of science to his students late.

IV. CONCLUSION

Based on the results of the research that has been done, STL learning influences the scientific literacy skills of prospective teacher students. From the results of the t test show H0 is rejected (asymp. Sig p-value = 0.00 <0.05), that means there is a significant difference in scientific literacy skills of students on their pretest and posttest. STL learning is able to improve scientific literacy of prospective elementary school teachers. Prospective teachers need to be trained in scientific literacy skills continuosly in order to be able to re-train their scientific literacy skills to their future students.

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