The Effect Of STEM Integration On Primary School Students' Scientific Literacy

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Abstract: This study aims to determine the effect of integrating STEM education on elementary school science learning activities to student's scientific literacy. The study was conducted for 3 weeks at an elementary school in West Jakarta. 40 students that involved in the study were divided into 2 classes. Each class consists of 20 children, and each of them labeled as control class and experiment class. The instrument was a 10 item test that developed from scientific literacy indicators PISA 2015. Data processing was carried out in two ways, first statistically test used to see the significance of difference in scientific literacy achievement from both class control and experiment. Wilcoxon test on both class normalized gain showed significance of 0.004 which is smaller than the normal level α = 0.005 which means that the hypothesis was accepted, where the integration on STEM education could significantly improve students' scientific literacy. In addition, a qualitative analysis also conducted to get deeper understanding of students' improvement. The result shows that students who studied with the integration of STEM education have improved the quality of answering questions and provide a better explanation than the students who study with common project-based study.

Index Terms: STEM Education, Scientific literacy, Elementary Students.

1. INTRODUCTION

Based on the 2016 OECD (Organization for Economic Co-operation Development) report, the results of the PISA test for the ability of elementary school students - junior high schools for science, languages, and mathematics are ranked 63 out of 72 countries. PISA (Program for International Student Assessment) is a triennial survey program created by the OECD to offer a view and insight into the rules and practices of education in a country, and then help monitor trends in the achievement of knowledge and skills in the countries that are incorporated. The PISA conducted in 2015 focused on testing the ability of scientific literacy with collaborative reading, mathematical skills, and problem-solving as a perfect assessment. Since participating in PISA in 2000, science education in Indonesia has shown a fairly good transformation, this is evidenced by an increase of 21 points in the 2012 and 2015 survey periods, making Indonesia the fifth fastest growing education system development from 72 countries are participating in this program. Even so, Indonesia is still ranked 9th lowest of all countries included in the PISA test. This means that science education in Indonesia must continue to innovate and develop learning activities that have been carried out in the 2012-2015 timeframe to pursue the average OECD achievement in 2030 as expected by Indonesia's current minister of education, Muhadjir Effendi. Science education / science education as a curriculum component must be able to provide a model for forming effective communication and decision making through cultural and linguistic differences. For this reason, global scientific literacy is needed so that all students and educators can access the same information and conceptual knowledge even with different language explanations. PISA (Program for International Student Assessment) is defined as the capacity to use scientific knowledge, identify questions and to draw conclusions based on evidence to understand and help make decisions about the natural world and human interaction with nature. The concept of scientific literacy was originally introduced by Hurd in 1958 and has been used in various literacies for almost more than 50 years. According to Hurd (Vieira, et al, 2017), science and technology are the prominent characteristics of the modern world, which require the ability of scientific literacy to be mastered by each of its citizens. In line with this, Miller (Ogunkola, 2013) states that one of the issues agreed upon by European and American leaders without the need for much consolidation is that scientific literacy skills are important, and community mastery of these abilities will provide good benefits to the community. However, the importance of scientific literacy has not been matched by the good attention of the government to provide a clear reference on indicators of achieving these abilities (Vieira, et al, 2017). This is evidenced by the broad definition of scientific literacy, and its purpose in education still has many meanings. So, in the end, this ability is ignored because it confuses its achievement. So the researchers (Snow & Dibner, 2016) identified 3 important aspects that can be most reversed based on the terminology of scientific literacy, namely 1.) knowledge content related to theory, law, and definition, 2.) understanding of scientific practice relating to the ability to ask, hypothesize, design research, and 3.) community intellectual achievement related to social processes that occur in the community related to decision making for environmental development, health, and so forth. Vieira, et al, (2017) in their perspective states that a student is said to be scientifically literate if the student is able to perform scientific process skills such as finding scientific problems, constructing productive questions, interpreting variables, comparing, observing, concluding, and concluding draw a conclusion. According to the Head of the Ministry of Education and Culture, the relatively low achievement of Indonesian students on the PISA science literacy test is influenced by many things, such as the family's socioeconomic background, students in some schools are not required to study science (science), and he acknowledges that the governance of science learning activities in Indonesia is still low as evidenced by the achievements of science in public schools and private schools have significant differences. This shows that in most schools in Indonesia, proportional science learning is still difficult to achieve with the reason that it is difficult to meet the completeness of learning facilities and infrastructure. These reasons make proportional science learning governance often ignored, which results in science learning being carried out only as a prerequisite to curriculum fulfillment alone. According to the US National Science Educational Standards the achievement of scientific literacy is closely related to equity (equity and excellent), so all schools must be able to provide the broadest opportunity for students to explore learning activities. Grant & Dianne (Ogunkola, 2013) suggested 4 strategies in developing scientific literacy in the classroom; 1.) a list of fun and challenging topics for learning activities, 2.) connect science concepts learned in class with problems in the environment around students, 3.) invite students to act like researchers who are looking for problems in-depth, and try to find solutions to these problems, and finally, 4.) invite students to evaluate the activities that have been implemented, if they have not been considered successful, invite students to revise activities and repeat again so that the best solution can be achieved. Through this strategy, students are expected to become more familiar with the world around them through what they have learned in class. To accommodate the development of learning activities with strategies like the above, researchers tried to integrate STEM education in science learning activities in primary schools, especially on environmental themes. STEM education is a combination of science and mathematics concepts, with engineering and technology skills that aims to bridge the knowledge gained by students in the classroom with skills that can be used outside the classroom. Some research results show that learning science in the context of technology and design is very potential in increasing scientific literacy (Permanasari, 2016). Honey, Pearson, and Schweingruber (2014) recommend 4 groups of scientific skills that need to be trained in each learning activity; 1.) understand, use and can provide scientific explanations, 2.) evaluate explanations and scientific evidence, 3.) understand the development of scientific knowledge, and 4.) participate actively in scientific practice both in the classroom and outside the classroom. These skills are multi-disciplinary so that they are under the implementation of science learning activities that are integrated with STEM education. Through STEM education students are challenged critically, creatively, and innovatively to solve real problems, which involve collaborative group activities. Through the processes carried out in the integrated science learning STEM education, it is expected that students' scientific literacy skills can be improved compared to learning with conventional learning models.

2 METHODS

This research was conducted in an elementary school in West Jakarta by using 2 samples of fifth-grade students, each consisting of 20 students, VA class as an experimental class, and VB class as a control class. The research design used was a quasi-experimental design with a static group pre-test post-test. Learning activities are carried out in an environment with each class doing project-based learning activities. The difference is that the STEM syntax is only used in the experimental class. The research instrument consisted of 10 breakdown items developed from scientific literacy indicators and used during pre-test and post-test. To find out the data to be processed when answering the hypothesis, the pre-test was tested statistically to see whether or not there were differences in initial ability in each class. T-test results showed a significance of 0.308, which was greater than $\alpha = 0.05$. this shows that there is no difference in initial abilities between students in the experimental class and the control class. Based on these results, to answer the research hypothesis, N Gain will be used to see whether or not there are differences in the ability of scientific literacy after each class carries out learning activities. Description of the assessment is carried out using a Likert scale so that through the same instrument, it can also be known changes in the ability of scientific literacy of students before and after carrying out learning activities.

3 RESULT AND DISCUSSION

The purpose of this study is to see whether or not the influence of the integration of STEM education in the learning activities of environmental themes that have been implemented. To see this effect, normalized gain ¬ is statistically tested to see if there are any differences in achievement shown by students in both classes, after N-gain through prerequisite tests, it is known that the data are normally distributed, but not homogeneous. To know the difference in the average of the two classes, N-Gain was then tested nonparametrically using the Wilcoxon test, with the following results

TABLE 1

DESCRIPTION FREQUENCY OF N-GAIN SCORE

		N	Mean Rank	Sum of Ranks
n.gain.B - n.gain.A	Negative Ranks	13[a]	10.50	136.50
	Positive Ranks	4[b]	4.13	16.50
	Ties	3[c]		
	Total	20		

From the table above it can be seen that as many as 13 students in the control class (VB) have lower N-Gain than students in the experimental class (VA), as many as 4 students in the control class have greater N-Gain than students in the experimental class, and as many as 3 students in the control and experiment class got the same score.

TABLE 2

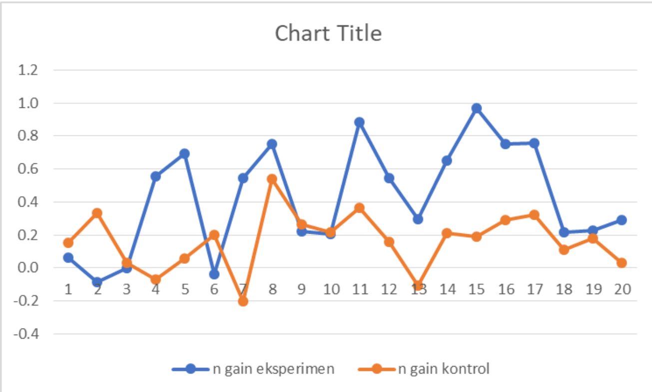
NONPARAMETRIC TEST RESULTS OF NORMALIZED GAIN SCORE

	n-gain B- N gain A
N	40
Z	-2.848[b]
Asymp. Sig. (2-tailed)	0.004

From the Wilcoxon test results, it is known that the significance value of 0.004. the basis for decision making in the Wilcoxon test, if the Asymp.sig value. (2-tailed) is less than 0.05 then H1 is accepted, that is, there is an influence on the integration of STEM education in the activities of learning environmental science themes. To find a clearer picture of the differences in achievement in each control and experiment class, consider the following graph.

FIGURE 2

GRAPHIC OF NORMALIZED GAIN SCORE



From the graphic image above, it can be observed that the experimental class N-Gain represented by the blue line has a majority score that is higher than the N-Gain achieved in the control class. This shows that the integration of STEM education in science learning activities can significantly improve the ability of scientific literacy. The indicators of scientific literacy outlined in the item include the ability of students to remember scientific knowledge in accordance with the problems faced, the application of scientific knowledge, the ability to make predictions, assess the appropriateness of predictions circulating in various media, hypothesize, and explain the implications of the application of scientific knowledge to the community . From the answers given by students in the experimental class, it is known that students are better able to understand the existing problems and how the process is solved. Students in the control class tend to have difficulty understanding story problems, so the responses given are often mistaken. As for questions that can be understood by control class students, students generally only give short answers without giving many explanations. This is closely related to the syntax that is raised through the integration of STEM education, namely the stages of reflection, research, discovery, application, and communication. In the reflection activity, students are asked to show ill-defined problems through visual facilities that can be found, whether pictures, videos, or actual problems. Students are directed to imagine and feel the problem in real activity and asked the respondents if they experience it. Furthermore, in research activities, students are invited to gather as much information about solutions that can be used to solve problems found in the reflection phase. Furthermore, in the discovery phase students are invited to design and create tools that will be used to solve problems. Furthermore, in the application phase, students are invited to try out the tools that have been made, if they are still not perfect, then this phase is also a phase of tool development and then after it is perfect, the tool will be published and reported in the communication phase. It is this publication and communication that well defines the outcome as a solution to the ill-defining problem delivered at the beginning of the learning activity. The learning process carried out using the STEM approach supports the achievement of Higher Order Thinking Skills (HOTS) in the cognitive processes of HOTS students, related to other media to solve scientific problems (Chien & Lajium, 2016).

4 CONCLUSION

Based on the results obtained both through statistical calculations and descriptive analysis of the frequency of increasing the students' ability to answer per point questions, the researchers concluded that the integration of STEM education in science learning activities in primary schools had positive implications for student learning achievement. However, the active role of the teacher is also very much needed by nature to facilitate learning activities with the STEM approach to provide references and boundaries so that the learning activities run smoothly and accordingly.

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