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Research Article

Student's scientific literacy on environmental pollution material based on SETS learning approach combined with Vee Diagram

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ABSTRACT

The student's scientific literacy is vital in improving students' awareness of several issues. This study was intended to describe the effect of the SETS learning approach combined with Vee Diagram on students' scientific literacy especially on Environmental Pollution Material. This study used a nonequivalent pretest-posttest control group design. The survey involved 60 students who were selected using cluster random sampling technique. The quantitative data, in terms of pretest, posttest, and N-gain scores were analyzed using Independent-sample t-test at the 5% significance level. The results showed that, based in the N-gain scores, the experiment class was classified in moderate category and the control class belonged to low category. This means that the SETS learning approach combined with Vee Diagram influence student's scientific literacy on Environmental Pollution Material. Therefore, this combination is recommended to be implemented in class to enhance students' scientific literacy skills.

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INTRODUCTION

Science learning requires a learning approach that can find facts, concepts, and solve problems and issues that occur in the surrounding environment. This situation requires teacher's innovation to change the way of passive learning into active learning, responsive, and meaningful for students and the surrounding community (Burden & Kearney, 2016; Indriati, 2012; Setiawati & Corebima, 2018; Suwono et al., 2017). Teachers are also required to carry out the development in the learning process (Chebii et al., 2012; Gultepe, 2016; Saptasari et al., 2019). The learning approach by using SETS (Science, Environment, Technology, And Society) is one of the developments in the learning process that has been researched recently (Sya`ban & Wilujeng, 2016; Trihastuti, 2017).

In the industrial revolution 4.0 era, science and technology are developing rapidly, students require to understand technological developments and their impact on the environment. To answer this challenge, one of the skills that must have by the student is scientific literacy (Holbrook & Rannikmae, 2009; Purwani et al., 2018; Rahayuni, 2016; Suwono et al., 2017). Scientific literacy means respect for science by increasing the components of self-learning to contribute to the environment (Nofiana & Julianto, 2018). Scientific literacy according to PISA is the ability to use scientific knowledge, identify questions and conclude based on evidence to understand nature changes due to human activities (Bybee et al., 2009). Scientific literacy will greatly help everyone to respond to problems critically as a phenomenon that often occurs, especially those related to science and technology (Novitasari, 2018). The definition of scientific literacy shows that literacy skills not only require students to understand the knowledge of science, but students must also be able to understand various aspects of the scientific process and the ability to apply science knowledge in real life (Hadi et al., 2020).

Based on the interview with one of the science teachers in SMPN 26 Bandar Lampung, showed that the learning outcomes of students were classified as a low category (below the criteria). In addition, students' knowledge of scientific literacy is still relatively low. Teachers have not been able to define scientific literacy skills, indicators of scientific literacy skills, and strategies how to developed scientific literacy skills. In addition, learning science in this school is still focused on memorizing concepts and theories only, the teacher also has not tried to let students make the observations or having a practicum directly (Sya`ban & Wilujeng, 2016). SETS learning approach can be an alternative to improve students' scientific literacy skills. Through this learning approach, students are also expected to understand the linkages between Science, Environment, Technology, and Society on environmental pollution material by applying concepts possessed from various related sciences (Ghofur & Raharjo, 2018).

The application of the SETS approach in learning was not significant in increasing the students' scientific literacy. Consequently, the SETS approach needs to be integrated with the Vee diagram to enhance the students' scientific literacy. The vee diagram is one of the effective constructive learning strategies (Sofianto et al., 2016). The usage of the Vee diagram is intended to help the learning process using the graph to build knowledge, communication through certain stages, and help students to find something new. Students can understand their role in the learning process and how to continue the progress (Suprapto, 2017). SETS learning approach can be strengthened if combined with Vee diagrams that can improve students' scientific literacy skills (Yuliyati, 2017; Amalia, 2019). According to Bybee et al., (2009) scientific literacy has three competency aspects that can be achieved by students through the SETS learning approach and the Vee diagram, such as: (1) identify scientific issues, (2) explaining scientific phenomena, (3) using scientific evidence (Bybee et al., 2009).

Based on the facts and problems that have been described above, there is still a lack of information related to the using of Vee Diagrams in the SETS learning approach that can improve students' scientific literacy skills on environmental pollution material. So, this study aims to prove the effect of the SETS learning approach combined with Vee Diagrams that is considered capable of improving students' scientific literacy skills on environmental pollution material. Due to the importance of scientific literacy for student's awareness of the environment, health, economy, society, and technology (Pratiwi et al., 2019). Therefore, measuring scientific literacy is important to determine the level of student's scientific literacy to increase the Indonesia education quality in the future.

METHOD

This research was conducted in February 2020, which took place at SMPN 26 Bandar Lampung. The survey involved 60 students were selected by using cluster random sampling techniques. This study used a quasi-experiment research design with a pretest-posttest nonequivalent control group design technique. This study used two research classes. The first class was the control class that only used the discussion method, while the second class was the experiment class that used the SETS learning approach combined with the Vee diagram. The instruments used in this study were in Table 1.

Table 1. Research instrument

No.	Aspects	Instrument	Type of Data
1.	Scientific Literacy	Multiple Choice Test	Primary Data
2.	Vee Diagram	Essay Test	Primary Data
3.	Responses to the use of SETS Learning Approach with Vee Diagram	Likert scale questionnaire	Secondary Data

Data processing in this study was carried out using statistical analysis software SPSS 17.0. Data analysis techniques in this study were instrument test that requires validity, reliability, difficulty level, and difference power tests. The aspects of students' scientific literacy were analyzed using a normalized gain score, normality test, homogeneity test, and the Independent Sample t-test at the 5% significance level.

RESULTS AND DISCUSSION

The data results were pretest, posttest, N-gain, and inferential statistics of the control class and experiment class (can be seen in Table 2). Based on the results of the normality test obtained Kolmogorov-Smirnov value sig. > 0,05, which means that the data is distributed normally, and for the homogeneity test the data is homogenous (Levene-Test sig. > 0.05). The average pretest of the experiment and control class obtained the value of 53,6 and 38,4 sequentially. After treatment was given, it's obtained the average posttest value of the experiment and control class by 72,5 and 65,7 sequentially. Thus, the average value of the experiment class is higher than the control class.

Table 2. The results of data processing of control and experiment class pretest and posttest.

Value	Class	Average ± up to	Normality test	Homogeneity test	Independent sample T-test
Pre-test	E	53,6 ± 7,99	0,200	0,251	Sig. (2-tailed) 0,000 < 0,05
	C	38,4 ± 11,59	0,126		
Post-test	E	72,5 ± 11,51	0,200	0,251	
	C	65,7 ± 14,12	0,200		
N-Gain (%)	E	53,3 ± 0,12 (Medium)	0,222	0,424	
	C	31,4 ± 0,13 (Low)	0,832		

Note: E= Experiment; C= Control

The independent sample t-test result showed that sig. (2 tailed) 0,00 < 0,05, which means the average N-gain of the cognitive aspect of learning results between control and experiment class is significantly different. The average N-gain value of the experiment class (53,3) is higher than the control class which is only 31,4.

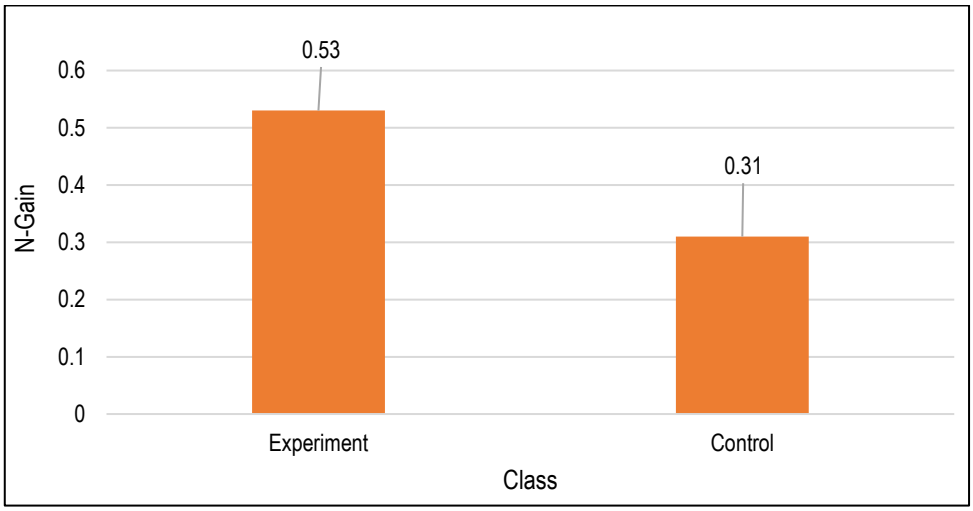

Figure 1. N-gain Pretest-Posttest Graph

The difference in N-gain between the experiment and control class is shown in Figure 1. The average result of the experiment class is higher if compared to the control class because SETS approach learning combined with the Vee diagram requires students to think critically about the problems given and be able to do scientific literacy to find problem solutions during the learning activity. Following the opinion about SETS, the learning approach provides students with an understanding of the role of the environment in science, technology, and society so that students can take advantage of the knowledge (Eliyanti et al., 2019). This is also following the research conducted by Dwipayana (2017) which obtained an N-gain score for STM learning models (Science, Technology, Community) higher than the DI (Direct Instruction) learning model.

Pretest-posttest questions are questions that have been adjusted with the scientific literacy achievements aspects. Scientific literacy aspects examined in this research are (1) defining scientific questions;

(2) explaining scientific phenomena; and (3) using scientific evidence. Thus, the average value of pretest-posttest based on scientific literacy aspect on experiment and control class can be seen in Figure 2 and Figure 3.

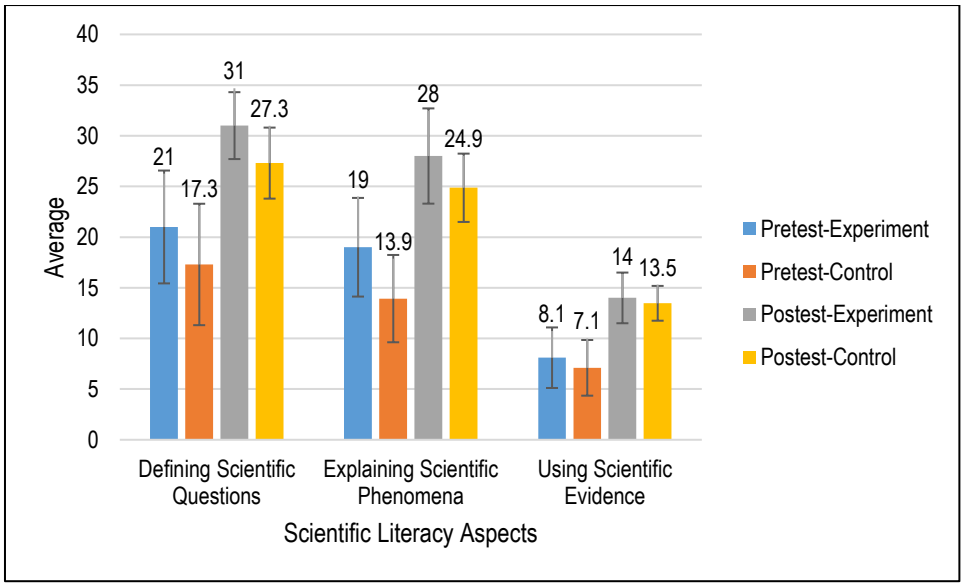

Figure 2. The average value of pretest and post-test based on scientific literacy aspects.

According to Bybee et al., (2009), scientific literacy has three competency aspects that can be achieved by students through the SETS learning approach and the Vee diagram. First, identify scientific issues, which means that students can identify problems for scientific investigation and identify keywords to find scientific information. Second, explaining scientific phenomena, which means that students can apply science in certain situations, describe or interpret scientific phenomena and predict changes, identify appropriate descriptions, provide scientific explanations and predictions. Third, using scientific evidence, which means students can interpret scientific evidence, make conclusions, communicate, identify assumptions, evidence, and reasons behind conclusions, and understand the social implications of science and technology. Based on the average pretest and posttest value based on scientific literacy aspects (Figure 2), both of the classes showed the increase of student's scientific literacy average on the three aspects, but the increasing number of scientific literacy aspects in the control class is not significant than the experiment class. Results conducted by Amalia (2019) showed a significant difference in the student's scientific literacy aspects between the learning process using SETS approach are better than the learning process using discussion method.

The results of the achievement level tests on aspects of scientific literacy competencies indicate that there is a significant influence on the student's scientific literacy abilities in all three aspects by SETS learning approach with Vee diagram. It can be caused by the experiment class using the learning approach at each meeting where the learning phase is always carried out. The students are asked to identify some of the problems presented, then develop science-based investigations to investigate issues related to the source of information obtained previously. The implementation of problem-based learning can improve students' scientific literacy because it can support the learning process that is relevant to the material (Anugrah et al., 2021). Scientific literacy is the ability to understand science, communicate science, and apply science's ability to solve problems. Students shared roles to find solutions to these problems. Different from classes that use the method of discussion, students are only asked to discuss and analyze problems scientifically without being required to do a learning organization to do the stages of getting detailed problem-solving (Yuliati, 2017). Based on the average value of pretest and posttest in each aspect of scientific literacy in the experiment and control class (Figure 3). The N-gain scores of the experiment class in all three aspects of scientific literacy were included in the high category, while the control was included in the low category.

Students in the experiment class are required to be able to present and develop scientific attitudes to solve problems that are presented scientifically as well. Students are also required to be able to modify, discover, and even make technology to solve problems in their environment. Therefore, students must carry out investigations through various reliable reference sources, so the knowledge gained is also comprehensive. The main elements of scientific literacy are the development of scientific literacy students include knowledge of science, scientific processes, development of scientific attitudes, and students' understanding of science so that students not only

know the concept of science but can also apply scientific skills in solving various problems, and can make decisions based on scientific studies (Harlen, 2014).

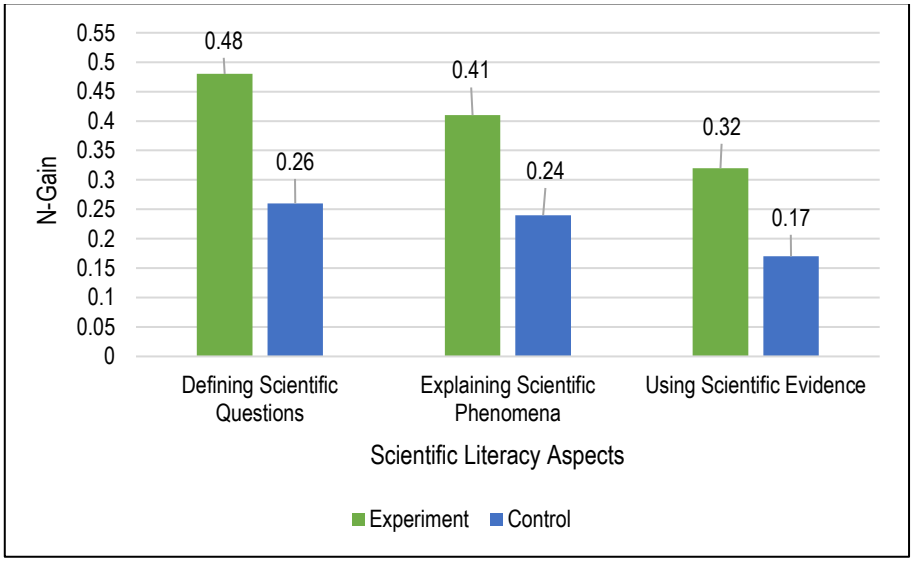

Figure 3. N-gain pretest-posttest graph based on scientific literacy aspects

Unlike the experiment class, the learning process in the control class requires students to investigate the problem and present the process to solve it, but students are not required to modify or create a technology to solve problems in their environment. Students are also not required to present the relationship between science, technology, and society. Hence, that students do not explore knowledge widely and only rely on a few references, for example, schoolbooks without further investigation. This results in a higher average pretest-posttest score in the experiment class when compared to the control class which can be interpreted that the scientific literacy ability of the experiment class students tends to be higher than the control class.

The explanation above is in line with research that applies the SETS learning approach to see its effects on students' scientific literacy abilities on environmental pollution material. From all the data obtained in the study, it was clear that the SETS learning approach had a significant effect. SETS learning can help students in understanding science, the development of science and technology, and their impact on the environment and society. Therefore, it can be concluded that the SETS learning model can improve the scientific literacy of students (Trihastuti, 2017). The SETS learning approach provides an opportunity for students in mastering each material. This is based on the characteristics of the SETS learning approach which has systematic stages to require students to construct the knowledge they get. The first step of the SETS learning approach is delivering opinions related to science and technology issues (brainstorming an issue or topic), in this step, students are required to think creatively to clarify the scientific issues and to analyze the relationship with the material being taught (Agustini & Suardana, 2013). The STS Model (Science, technology, society) could increase science and technology literacy students because it emphasizes the process of gaining knowledge, higher-order thinking skills, problem-solving (Adipura, 2012). In addition, the Vee diagrams can also improve students' scientific literacy because it can help students construct their knowledge by using the worksheet (Yolida et al., 2021).

The score result of Vee diagrams made by students can be seen in Figure 4. Each component of the Vee diagram created by students' scores is indicated very high. Based on the graph, there are four components of the Vee diagrams were assessed, there are Object, Theory/principle/concept, Transformation, and Knowledge Claim. The result shows that the students get very high grades in the four components. It means students are not only able to answer the questions related to the practicum activities, but also links between concepts (thinking) and methods (activity). Vee diagrams can also increase students' motivation in learning, hence it has a good impact on higher-order thinking skills compared to lecture and demonstration learning methods (Wicaksono, 2018). Hindriana (2016) showed that using Vee diagrams as a learning tool is easier in designing learning strategies and practicum in the classroom. Vee diagram has an important role in improving students' scientific literacy skills in the experiment class. The Vee diagram is also consisting of (1) focus question component, (2) conceptually it is divided into conceptual structures (thinking), (3) concepts and objects (events), and (4) methodology (doing) is divided into notes, data transformation/interpretation, knowledge claims and

claims of values (M. Chaidir et al., 2018). These are good at making students in logical thinking and improve learning outcomes. In addition, Vee diagrams provide students to build connections between theoretical knowledge and work lab activities (Handayani & Widiantie, 2020). From these results the students are skilled in making focus questions, data/events, recording and transformation of data as well as claim value, however, the concepts and claim knowledge are still lacking. Hence, skills improvement is still needed to continue for the maximum results (Suprapto, 2017).

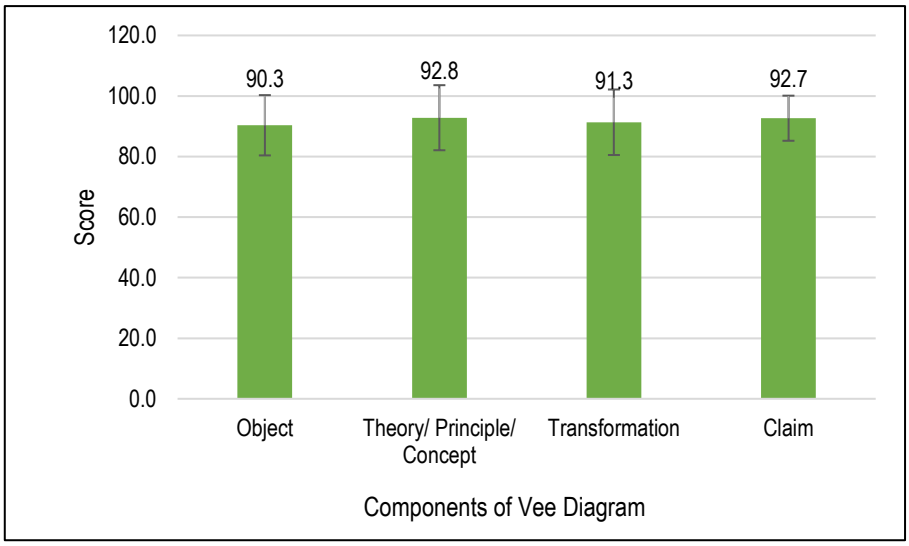

Figure 4. Student's score of Vee diagram

Furthermore, it was also obtained the percentage of student responses data about the implementation of the SETS learning combined with Vee diagrams (Figure 5). It is to find out students' opinions about the learning model for the actual implementation of the study through qualitative data. The results of students' responses to SETS learning with Vee diagrams consist of interests, benefits, and participation. Students showed a higher interest than other aspects of benefits and participation because the Vee diagram in SETS learning is a new thing for students. They usually learned using worksheets with questions such as exams, but this method is more interesting to students than conventional learning.

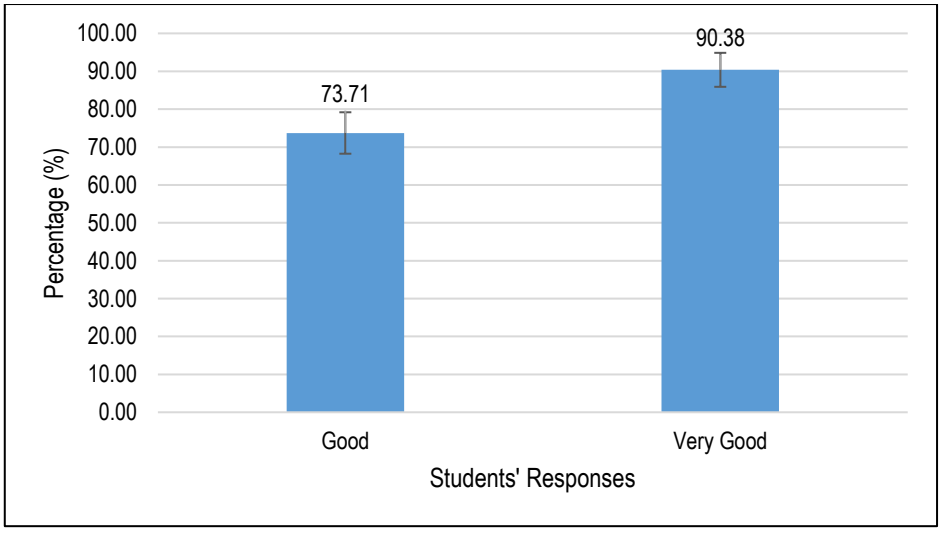

Figure 5. Percentage of student responses to SETS learning with Vee diagrams

The results of the questionnaire are presented in Figure 5 which shows a positive response which is the response of 'very good' and 'good' of the learning approach to the concept of environmental pollution. This is similar to the result of Oktavia (2015) that regarding student participation in class which is a tangible form of

student behavior in learning activities. Mental and emotional involvement encourage them to contribute and be responsible for achieving satisfactory learning (Ruvalcaba-Romero et al., 2017). This participation can be shown by actively participating in lessons, how students understand the teacher's lessons, asking questions, how students do and collect assignments. Therefore, students can also give a good impression of learning that is applied (Khizar, Rasheed, Iqbal, Akhtar, & Khalid, 2020).

CONCLUSION

Based on the results and discussion, it can be concluded that the SETS (Science, Environment, Technology, and Society) learning approach combined with the Vee diagram has a significant effect on increasing the scientific literacy ability of students on Environmental Pollution material, but it still needed an effort to maintain the scientific literacy of all students. The SETS approach with the Vee diagram can be used as a reference for schools to implement science learning due to the result of significantly improve students' scientific literacy skills.

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