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The effect of science-technology-society (STS) model on scientific literacy and scientific attitude of students on the subject of buffer

M G Devi^{1*} and N Aznam²

¹Chemistry Education Department, Postgraduate Program, Universitas Negeri Yogyakarta, Indonesia

²Chemistry Education Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Indonesia

* E-mail: mentari.gayatridevi@gmail.com

Abstract. Scientific literacy and scientific attitudes are two conceptual foundations for students that have to be increased in both developing and developed countries. This research aims to identify the effect of science-technology-society (STS) model on scientific literacy and scientific attitude of students on the subject of buffer solution. This research was quasi-experimental research using nonequivalent control group design. The sample was determined by cluster random sampling technique. The sample of this study was two classes. One class as an experimental class consisted of 34 students which used STS model. Other class as a control class consisted of 33 students which used direct instruction model. The data analysis used the manova test at the significance level of 5%. The results of the study showed that there was significant effect of STS model on scientific literacy and scientific attitude of students on the subject of buffer solution.

1. Introduction

Indonesia is listed in one of the international evaluation programs which are the Program for International Student Assessment (PISA) organized by the Organization for Economic Cooperation and Development (OECD). The conceptual foundation in PISA emphasizes: scientific literacy. The term scientific literacy was first stated by Paul De Hart, an education expert, in 1958. Hurd defined scientific literacy as a way of understanding science and the application of science in everyday life [1]. Scientific literacy is a person's ability to understand science, communicate science both verbally and in writing and apply scientific knowledge to solve problems so that they have a high attitudes sensitivity towards themselves and their environment in making decisions based on scientific considerations [2]. PISA [3] defines Scientific literacy as:

“the capacity to use scientific knowledge to identify questions and to draw evidence-based conclusions to understand and help make decisions about the natural world and the changes made to it through human activity”

PISA also explains that there are three competencies used to measure scientific literacy: (a) identifying scientific issues; students recognize scientific issues or problems for the possibility of conducting scientific investigations and recognizing keywords from a scientific investigation, (b) explaining scientific phenomena; students will apply science in certain situations to describe or interpret scientific phenomena and predict change, students also compile descriptions correctly and



can provide explanations, (c) using scientific evidence [4]. Students interpret and describe the evidence for drawing conclusions as well as providing assumptions, explanations, and evidence from identified conclusions. Students also consider the implications of science and technology.

By participating in the PISA program, the government gets an overview of the ability of Indonesian students in reading literacy, mathematical literacy, and scientific literacy so that the results can be used as material in the formulation of policies to improve the quality of education in Indonesia. The results shown by PISA show that the ability of scientific literacy of Indonesian students is still deficient. The OECD report shows that Indonesian students' scientific literacy ranked 38th out of 41 countries in 2000, 48th out of 40 countries in 2003, 53rd out of 57 countries in 2006, 38th out of 40 countries in 2009 and ranked 64th out of 59 countries in 2012. From these data, it can be seen that Indonesian students have very low scientific literacy compared to other countries.

In addition to the problem of students' literary abilities, with the rapid advances in science and technology that bring great changes in the quality of community life, new problems arise that are related to global ethics, morals, and issues that threaten human survival [5]. The attitude of students is also one of the problems that must be considered in this case is scientific attitudes. Scientific attitudes is the impulse of feelings and beliefs that arise from within a person to behave or do something to an object by referring to the problem-solving procedure by using the steps of the scientific method [6].

Harlen reveals that the scientific attitudes contain two meanings, attitude toward science that describes a person's attitude to science, and attitude of science that describes the attitude inherent in a person after learning science [7]. PISA also describes scientific attitudes competencies, including indicating interest in science, supporting scientific inquiry, and motivation to act responsibly towards natural resources and the environment.

Based on the problems that have been described, it is necessary to have a learning model that can link scientific issues with technological developments to improve students' literacy skills and their relationship with society. Learning model that aims to make students also care about what is happening in the natural environment and can preserve the environment. One learning model that is considered to meet this need is the Science-Technology-Society learning model (STS).

The National Science Teacher Association (NSTA) defines STS as a learning model that links technology and science in the context of everyday life [8]. NSTA develops STS as a goal of science education. Learning science aims to develop scientific literacy for every individual who understands science, technology, and society and uses his knowledge in making decisions [9]. STS learning emphasizes student involvement in experiences and issues that are directly related to their lives. STS develops students with skills that enable them to become active, and responsible in responding to issues that affect their lives.

Poedjiadi suggests that the purpose of the STS learning model is to form individuals who have scientific and technological literacy and have a concern for the problems of society and the environment [10]. Learning using STS emphasizes student involvement in experiences and issues that are directly related to their lives. STS develops student skills that enable them to be active, and responsible for responding to issues that affect their lives.

Miller states that the STS model can make a substantial contribution in preparing students to face the latest technological issues and changes in science in society [11]. By linking science, technology, and society, it is hoped that this model will not only affect changes in scientific attitudes in a positive direction, but also teaches students to think about the long-term effects of using science.

Based on these data, the research is conduct by implementing the STS model to determine the effect of this model on students' scientific literacy and scientific attitudes of learners on buffer solution.

2. Method

This study is using a quasi-experimental approach to assessing treatment effects in the nonequivalent control group design [12]. The design of this study was chosen based on the purpose of the study to determine the effect of the STS learning model on the science literacy and science attitudes.

This research was conducted at SMA Negeri 4 Kota Ternate. The population in this study is 11th grade students of SMA Negeri 4 Kota Ternate majoring in science with the total population of 173 students. To determine the research sample, cluster random sampling method was used. Both written test and non-test techniques are used as the data collection methods in this study. Tests were conducted to determine the ability of students' scientific literacy before and after the implementation of learning using STS learning models and Direct Instruction (DI) model. Non-test techniques are carried out to measure students' scientific attitudes by questionnaire.

Manova then analyzed the results of the data found in the study. This data analysis method is used to conclude the results of the study based on the purpose of the study to determine the effect of STS learning models and Direct Instruction (DI) models in improving the ability of scientific literacy and scientific attitudes of students. Manova is used to test hypotheses using the SPSS program. Before carrying out the analysis, the test of the normality of the data distribution and the homogeneity of the variants were done first on the data that has been obtained.

The statistical hypothesis test proposed in this study is testing the hypothesis. The hypothesis aims to examine whether or not there is an influence of the STS model on the students' scientific literacy and scientific attitudes. Multivariate test statistics in this study used T^2 Hotelling.

3. Results and Discussion

Data on scientific literacy in this study was measured using an essay test instrument consisting of pretest and posttest data on experimental and control classes. Data on the scientific literacy in the STS class and DI class were then analyzed and summarized in table 1.

Table 1. Scientific literacy ability of STS class and DI class

No.	Description	STS Class		DI Class	
		Pre-test	Post-test	Pre-test	Post-test
1	Mean score	15.99	80.21	13.76	72.35
2	Minimum score	8.33	66.67	8.33	60.42
3	Maximum score	22.92	89.58	20.83	83.33

The scientific attitudes data in this study were obtained from the results of questionnaires filled out by students at the end of the learning process. The questionnaire consists of 18 statement items and filled by the STS class with the number of 34 students as respondents and the DI class with the number of 33 students as respondents. The data was then analyzed and the results of the data analysis are summarized in table 2.

Table 2. Results of the science attitude questionnaire

No.	Description	Scientific attitude questionnaire	
		STS class	DI class
1.	Mean score	72.0	66.5
2.	Minimum score	61.0	51.0
3.	Maximum score	84.0	79.0

Hypothesis testing in this study uses manova with the help of the SPSS program. Before testing the research hypothesis, a prerequisite test was done for the normality test and homogeneity test. Test of normality of scientific literacy data and scientific attitude in this research using Kolmogorov-Smirnov test. The results of the normality test of scientific literacy and scientific attitudes obtained the significance value of all variables more than the value of α (0.05) which means that the scientific literacy data and scientific attitudes of the experimental class and control class are normally distributed. The homogeneity test of scientific literacy data and scientific attitude in this research use

Levene test. The results of the homogeneity of scientific literacy and scientific attitudes obtained the significance value of all variables more than α (0.05) which means that the scientific literacy data and scientific attitudes of the experimental class and the control class have the same variance.

The hypothesis in this study was used to test the effect of STS model on scientific literacy ability and scientific attitude by using manova test. Based on the Multivariate Test table (table 3) obtained a significance value of 0.000 less than α (0.05) which means that there is an influence of STS learning model on the ability of scientific literacy and scientific attitude of students.

Table 3. Multivariate Tests table

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.997	12542.717 ^b	2.000	64.000	.000	.997
	Wilks' Lambda	.003	12542.717 ^b	2.000	64.000	.000	.997
	Hotelling's Trace	391.960	12542.717 ^b	2.000	64.000	.000	.997
	Roy's Largest Root	391.960	12542.717 ^b	2.000	64.000	.000	.997
Class	Pillai's Trace	.456	26.800 ^b	2.000	64.000	.000	.456
	Wilks' Lambda	.544	26.800 ^b	2.000	64.000	.000	.456
	Hotelling's Trace	.837	26.800 ^b	2.000	64.000	.000	.456
	Roy's Largest Root	.837	26.800 ^b	2.000	64.000	.000	.456

This research was conducted on SMA Negeri 4 Kota Ternate in the second semester on the subject of buffer solution. The learning in the experimental class uses the STS model and the learning in the control class using the DI model. The learning process undertaken in this study aims to improve the ability of scientific literacy and scientific attitudes. Learning was carried out as many as 5 meetings for the experimental class and control class.

The influence of STS model on scientific literacy skills and scientific attitudes can be seen from the results of the manova test. Manova test results show that the significance value 0.000 is smaller than α (0.05) so it can be concluded that the use of the STS model affects the students' scientific literacy skills and scientific attitudes of learners on buffer solution. This influence is due to the use of STS model which according to Poedjiadi can form individuals who have scientific literacy and have concerns about the problems around them. By having good scientific literacy, students are not only able to read and write science but are aware of its impact and care for the social environment and the surrounding environment.

The result can be concluded that there is an influence of the STM learning model on scientific literacy skills. This effect can be seen from the average of scientific literacy skill on the experimental class using the STS model which is higher than the control class using the DI model. The average value of the STS class is 80.21 with a minimum score of 66.67 and the maximum value is 89.58 while the DI class average is 72.35 with a minimum value of 60.42 and the maximum value is 83.33. This difference is in line with the research of Kapici et al. in that students included in the classroom applying the STS were found better able to apply the concept of science learned into everyday life [13].

According to Akgul, STS is a learning model designed to improve students' scientific literacy skills [14]. This is supported by the research of Rahayuni which proves that the STS is better than the problem-based learning model to improve scientific literacy skills, because in STS syntax there are phases where students are asked to associate the concepts that have been learned with the issues or phenomena that occur in daily life and the surrounding environment so students are trained to link science with the surrounding phenomena [15]. The research of Jin & Bierma prove that STS can improve students' scientific literacy skills [16]. This increase is because in the STS contained a method of scientific inquiry wherein the concept formation stage students are directed to find and solve problems related to science, technology, society, the environment including the history and nature of science [17].

The use of STS learning model also affects the students' scientific attitude. This can be seen from the questionnaire that the students filled at the end of the learning. From the results of the questionnaire analysis, the average score of the scientific attitude of students in the experimental class was found higher than the control class. The average scientific attitude of the STS class is 72.0 with a minimum score of 61.0 and a maximum score of 84.0 whereas in the DI class, the average score is 66.5 with a minimum score of 51.0 and a maximum score of 79.0. This result is in line with the research of Mandra; Jumantoro; Kartini et al. that the STM learning model has a significant effect on students' scientific attitudes [18-20].

Akcaay & Akcaay explained that with the STS model, teachers can create student-centered learning based on the surrounding environment so that they can hone critical thinking skills, problem-solving skills and improve students' scientific attitudes [21]. In addition, after participating in learning by using STS syntax students are more interested in learning science and allows for a career related to chemistry, this can be seen from the students' responses to the questionnaire given. In item 11 which is a description of aspect 3 shows that the students in the experimental class as many as 7 students answered strongly agree, 19 students agree, while 3 students were still hesitant and 5 students answered disagree. This result is in line with Chen et al. which shows that the existence of a positive attitude towards science correlates with students' commitment to science so that it can affect their interest in science and more likely to choose a career in science [22]. Relevant research conducted by Chonkaew et al. found that the majority of students studying with STS and environmental model have a positive attitude toward science [23]. Xiao & Sandoval also said that science-centered learning will produce positive results on students' interest in science [24].

4. Conclusion

Based on the results of the research and explanation that has been done, it can be concluded that there was a significant effect of STS model on scientific literacy and scientific attitude of students on the subject of buffer solution. The majority of students studying with the STS model have a positive attitude toward science. With STS students do not only listen to teacher lectures, but students also organize and summarize their knowledge so that students can better understand in depth the principles and theories they learn. The STS model is expected that students are motivated to find more additional information as well as relevant scientific evidence to support it in making decisions related to social-science issues and with the knowledge and the amount of information obtained will affect their attitude to be more responsible to the environment and natural resources.

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