



## The Effectiveness of Physics Teaching Materials on The Theme of “Global Warming Symptoms” based on Scientific Literacy to Increase The Students’ Cognitive Abilities

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### Abstract

The purpose of this research is to develop teaching materials based on scientific literacy with categories of scientific literacy that is balanced, feasible to use, easy to understand, and improve students’ cognitive ability. The study used pre-test and post-test control group design. Based on the results of the research, the ratio of the content of scientific literacy in the teaching materials developed with the ratio of 40%: 20%: 20%: 20%. Teaching materials are considered feasible to use with an average score of 91.67% eligibility score and legibility with an average score of 89.47%. The improvement of scientific literacy ability of students using scientific-based literacy materials was 0,51 while the students who used teaching materials circulating in school was 0,26. In the experimental class had increased of cognitive learning outcomes and the average of affective and psychomotor learning outcomes were higher than control class. This shows the literacy-based materials science material symptom of Global Warming could improve the ability of scientific literacy.

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## INTRODUCTION

Science is the basis of a technology. The development of science greatly influenced the development of technology and information. Education that is closely related with information technology is the education science. (Purpaningtias, 2015). Literacy of science or scientific literacy by the OECD (Organization for Economic Cooperation and Development) is defined as the ability to use scientific knowledge to make conclusions and solve problems about nature and human interaction with nature (Nbina & Obomanu, 2010). That most Indonesian students still have limited scientific knowledge and can only apply some situations (Rohmi P, 2015). Similarly, the ability to make analogies is the most difficult ability (Rusilowati, 2009).

One of the factors that influence the low literacy of students' science is the selection of learning resources. This is because learning resources are directly and closely related to the students during the learning process (Ekoharyadi, 2009). Few students are able to explain directly and make literal interpretations of the results of scientific inquiry or problem-solving related technologies (Angraini, 2014). Furthermore, Rusilowati et al (2015) also stated that the selection of teaching materials affects the achievement of science literacy.

Factors that affect the low literacy of students' science is the selection of learning resources. This statement is similar to the Irawan's research in Purpaningtias (2015) that is one factor that cause of the low literacy of students' science and it relates directly and closely with students is a learning source, both from textbook or the other sources. The textbook is a learning resource that can be used in the classroom. The textbook is the lessons book in a particular field of study which has the standard content that drawn up by some experts with special instructional intent and it has been completed by compatible and understandable teaching tools for users in schools and colleges so that it can support teaching-learning program. (Tarigan & Tarigan, 2009).

The students' literacy skills can be improved by presenting science materials that are always associated with social and technological issues of society. One of the most recent issues that relate science to society is the issue of environmental pollution (Subiantoro, et al., 2013). Science literacy is recognized as a necessity for all students who not only rely on their future learning but also on their career aspirations (Sarkar & Deborah, 2012). The purpose of this study is to determine the effectiveness of the textbook developed the physics textbook on the theme of global warming symptoms based on science literacy.

## METHOD

The research was conducted at SMA N 1 Bumiayu, Brebes, Central Java. The subjects of the study were students of class XI IPA 1 (as experimental class) and XI IPA 2 (as control class) in the academic year of 2016/2017. Validation of products was done through two stages of design validation and product validation. Design and product validation were done by judgement expert method.

Samples technique was taken by random sampling. The research design was used to test the effectiveness of teaching materials for experimental group while true experimental design was used to test of control group. For the feasibility test was conducted by experts and practitioners in the field, while the test legibility was done by students who had received global warming material. Furthermore, to know the influence of teaching materials after applied in the learning was done with the test method at the time of pre-test and post-test.

## RESULT AND DISCUSSION

The results of this study consist of product characteristics, product feasibility, product legibility, and product effectiveness.

### Characteristics of Teaching Material Based on Literacy Sciences

Physics teaching materials on the theme of global warming symptoms was only focused on the component of scientific literacy. The scientific literacy aspect of the teaching material is science as the body of knowledge represented by the "Let's Learn" section, science as a way of investigating represented by the "Let's Try" part, science as a way to think (a way of thinking) represented by the "Let's Think" section, and the interaction of science, technology and society represented by the "Science in Life" section. The image of each aspect of scientific literacy from teaching materials based on the literacy of Global Warming is presented in Figure 1.



Figure 1. The sections representing each Aspect of Literacy of Science in the Materials.

### Aspect of Literacy Sciences in Teaching Materials

Based on the results of load analysis each aspect of literature-based physics-based materials on the subject matter of global warming symptoms developed have a ratio of 40%: 20%: 20%: 20% and obtained a 2: 1: 1: 1 comparison. So, the characteristic of physics-based teaching materials of fluid-based static fluid material developed has fulfilled the ideal science literacy aspect composition.

### Feasibility of Teaching Materials based on the Literacy of Static Fluid Matter Science

The assessment of the feasibility of teaching materials also refers to the four categories of science literacy. The developed teaching materials are considered to be highly feasible for each aspect of eligibility assessed. Obtaining scores along with percentages of each aspect of the feasibility of teaching materials can be presented in Table 1.

Table 1. Table Result of Feasibility Test of Teaching Materials

Validator Code	Feasibility of Content		Feasibility of Presentation		Feasibility of Language		Feasibility of Graphics		Sains Literacy	
	Score	%	Score	%	Score	%	Score	%	Score	%
	VAL-01	61	89.71	73	91.25	44	84.62	46	88.46	96
VAL-02	64	94.12	68	85.00	42	80.77	42	80.77	99	91.67
VAL-03	64	94.12	75	93.75	44	84.62	51	98.08	102	94.44
Average	63	92.65	72	90.00	43.3	83.34	46,3	89.10	99	91.67
Category	Very Worthy									

The data in Table 1 shows that each aspect of eligibility of the prepared teaching materials has a percentage of eligibility of > 85.00%, except for the language feasibility aspect has a percentage of eligibility > 70.00%. According to Akbar (2003), the aspect with the percentage of feasibility > 85.00% included in the category very feasible while the percentage of more than 70.00% fall into the category worthy. In other words, it can be said that the literacy-based teaching materials are very worthy to be used in the learning process.

### Readability Level of Materials

Based on the analysis of the test results, the average number of test results that readability legibility got 89.47%, the average test results legibility of physics-based literacy materials on the subject matter of global warming that has been prepared included in the criteria of teaching materials easy to understand by students. The effectiveness test of teaching materials using the cognitive domain to find out whether the increase in literacy ability of science students' experimental class is higher than the increase of science literacy students control class. Increased student's literacy skills were calculated using a gain test based on the student's pretest-posttest score. The results of the analysis of students' literacy skills improvement can be seen in Table 2.

Table 2. The Improvement of Science Literacy Ability

NO	Score/Result	Class	
		Experimen	Control
1	Gain (g)	0.51	0.26
2	Test	15.29	

Based on hypothesis testing, the resulting *t-count* price is 15.29 while the *t-table* price with  $dk = 61$  and 5% significance level is 2.00, so  $H_0$  is rejected and  $H_a$  accepted. In the pretest-posttest analysis, there were also data on the improvement of every aspect of science literacy. Increased literacy ability of student's science experiment class and control class on each aspect can be seen in Figure 2.

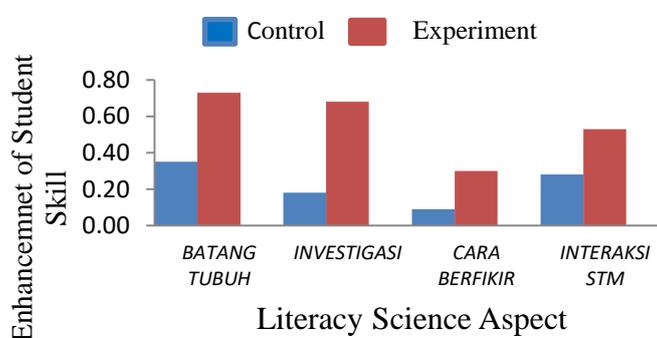


Figure 2. Comparison of Learning Outcomes of Each Aspect of Science Literacy

Hypothesis testing of the affective and psychomotor domains was conducted to find out whether there is a difference between affective and psychomotor classroom assessment of control and experimental class students. The average results obtained between the control and experimental classes are presented in Table 3.

Table 3. Average Grade Result of Control Class and Experiment Class

No	Assessment	Control	Experiment
1	Affection	58,53	69,41
2	Psychomotor	53,82	65,29

The product which was resulted from this development research was physics teaching materials of high school class XI material of global warming phenomenon based on science literacy

which had characteristic of special feature which become characteristic of teaching materials having complete and balanced literacy content of science. These features include *Let's Learn*, *Let's Try*, *Let's Think Scientifically* and *Science in Life*. The four aspects of science literacy are complete and balanced in the features. Each feature contains one dominant aspect of science literacy with a 2: 1: 1: 1 division.

According to feasibility test that has been implemented, science literacy aspect get percentage > 85% that is equal to 91.67% which mean aspect of science literacy in teaching material have been arranged well and suitable. Therefore, science-based literacy materials on the theme of global warming symptoms have been developed which can be used in learning. It is based on the average percentage of the results of feasibility test of teaching materials that is > 89.35% which means that the teaching materials are very worthy.

The text of the developed material is quite easy to understand. The results of data analysis of reading material readability obtained a positive result that had an average percentage of legibility of 89.47% and entered in the criteria easy to understand. This is accordingly proposed by Ayodele & Olagoke (2012) that the text materials to be presented to students must be matched to the reader's level of understanding and their age in order to get easy in understanding..

The highest percentage of respondents in the test legibility was 98.25% and the lowest obtained the results of legibility test 73.68%. The varied percentage of readability can be influenced by the reader factor. A good level of legibility besides indicating teaching materials have an easy to understand language and also good in quality. As proposed by Devetak and Vogrinc (2013) that the quality of teaching materials is in the quality of the language used because the text is the basis of the content in the science materials. The results showed that 90% of students used sentence form in the teaching materials of science as the conclusion of science learning.

To measure how much effectiveness of the use of science materials developed, in this trial, the data obtained pre-test and post-test cognitive domain which then analyzed the increase using a gain test. The results of the data analysis show that the experimental class has a gain of 0.51 and the control class is 0.26. The improvement of the experimental class is moderate but higher than the control class whose increase is relatively low.

Statistically the experimental class has a higher literacy capability compared to the control class. The same results also appear in affective and psychomotor domains. Experimental classes that use science-based literacy materials have a higher affective mean score than control classes that do not use science-based literacy materials.

Learning strategies that begin with reading if combined with science-based literacy materials would produce a positive impact on student learning outcomes. This is in accordance with the results of research conducted by Taslidere and Eryilmaz (2010), namely the integration of reading strategy and the use of science literacy teaching materials gives a significant positive effect on the improvement of students' cognitive learning outcomes compared with other strategies and learning methods. In his research, Taslidere and Eryilmaz used literary science-based materials written by Paul G. Hewitt entitled *Conceptual Physics*

## CONCLUSION

Global warming material lesson is based on the teaching material has the four characteristics of aspects contained in scientific literature with a complete and balanced. The completeness of the scientific literacy aspect is contained in the teaching materials that are the features of *Ayo belajar!* (Let's Learn!), *Mencoba yuk!* (Let's Try!), *Ayo Berpikir Ilmiah* (Come Scientific Thinking), and *Sain dalam kehidupan* (Science in Life) which is the implementation of the science aspect as the body of knowledge, science as a way of investigating, science as a scientific way of thinking and interaction of science, technology and society with the ratio 2: 1: 1: 1.

Based on the feasibility test of the teaching materials used has an average score of 91.67%, with the category very feasible. The developed teaching material is also easy to understand because it has an average reading rate of 89.47%. In the experimental class, the class that used the literacy materials developed science literacy had increased cognitive learning outcomes and the average result of affective learning and psychomotor was higher than the control class, a class that commonly used the teaching materials.

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