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| THE EFFECTIVENESS OF PHYSICAL MEDICINE BASED ON SAINS LITERATION TO INCREASE STUDENTS’ COGNITIVE ABILITIES  **Yeni Purwiyantinia,b,**🖂**, Ani Rusilowatia, Budi astutia**  aPhysic Education Program, Pascasarjana Program, Universitas Negeri Semarang, Indonesia  bSMA Al Hikmah Sirampog, Brebes, Indonesia | | | |
| **Info Articles**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  *History Articles:*  Accepted…... 2018  Approved........... 2018  Published......... 2018  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  *Keywords:*  *Bahan ajar, Literasi Sains, Pemanasan Global* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | **ABSTRACT**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  The purpose of this research is to develop teaching materials based on science literacy with categories of science literacy that is balanced, feasible to use, easy to understand, and improve students’ cognitive ability. The study used prestest-postest control group design. Based on the results of the research, the ratio of the content of science 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 science literacy ability of students using science-based literacy materials is 0,51 while the students who use teaching materials circulating in school is 0,26. In the experimental class have increased cognitive learning outcomes and the average of affective and psychomotor learning outcomes are higher than control class. This shows the literacy-based materials science material symptom of global warming can improve the ability of science literacy  © 2018 Universitas Negeri Semarang | |

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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 is closely related to information technology is science education (Purpaningtias, 2015). In the standard content of primary and secondary education stated science education, especially physics is expected to be a media for students to learn themselves and the natural surroundings and prospects of further development in applying it in everyday life. Based on these objectives science education should focus on students' science literacy, as proposed by the National Research Council (1996).

Literacy of science 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). Research on basic life skills assessment such as reading achievement, mathematics and science of Indonesian children aged 15 years at international level is still quite low in the range 382-395. Based on the results of the analysis it can be said that most Indonesian students still have limited scientific knowledge and can only be applied to some situations only (Rohmi P, 2015). Similarly, the ability to make analogies is the most difficult ability (Rusilowati, 2009).

One of the factors influencing 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 used in the learning process can affect the achievement of science literacy.

Factors affecting the low literacy of students' sciences, among others, factor selection of learning resources. This statement is in line with the results of research Irawan in Purpaningtias (2015) is one factor that causes low literacy of science students as well as directly and closely related to students is a source of learning, both from textbooks and from other sources. The textbook is a learning resource that learners can use in the classroom.

Textbooks have an important role in learning science, especially if the teaching materials are charged with scientific literacy (Chiappetta et al., 1991). The textbook is a textbook in a particular field of study which is a standard book, drawn up by experts in the field with instructional intents and objectives, complemented by harmonious and understandable teaching tools by the users in the schools and college so that it can support something of teaching 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 imbalance in the content of science literacy in current student physics textbooks has become one of the causes of the students' science literacy ability is still quite low.

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. The effectiveness of the teaching materials used is viewed from the feasibility and the level of legibility of the textbook so that it can improve students' cognitive abilities after using the textbook in the learning process.

**METHODS**

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 2016/2017. Validation of products is done through two stages of design validation and product validation. Design and product validation is done by judgement expert method.

Sampling technique taken by *random sampling*. The research design used to test the effectiveness of teaching materials is the experimental design of *Pretest-Posttest Control Group Design* using the *True Experimental Design* method. 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 done with the test method at the time of *pretest and posttest*.

**RESULTS AND DISCUSSION**

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

**Characteristics of Teaching Material Based on Literacy Sciences**

Teaching materials that are developed is a literacy-based materials science material of global warming symptoms in it only discusses the material of global warming that developed with attention to the component of science literacy. The developed science-based literacy materials contain aspects of scientific literacy expressed by Ciappetta (1991).

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’sTry" 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 science literacy from teaching materials based on the literacy of static fluid matter science is presented in Figure 1.

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**Sains dalam kehidupan**

** Ayo Berpikir Ilmiah !**

**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 science literacy in the developed teaching material shows a comparison of 40%: 20%: 20%: 20%. In his research Wilkinson (1999) conducted an analysis of 20 physics books circulating in Victoria. So the comparison of the scientific literacy component of science as the body of knowledge, science as a way of investigating, science as a way of thinking, the interaction between science, technology, and society in teaching materials should satisfy 2: 1: 1: 1 comparisons. 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 feasibility test of the product or physics teaching materials on the phenomenon of global warming based on science literacy is conducted using feasibility questionnaire based on the National Education Standards Agency (BSNP) which is the content feasibility aspect, presentation technique, language assessment, and graffiti. In addition, 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. Data obtained from the assessment of three validators through a closed questionnaire to the product. 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**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ValidatorCode | Feasability of Content | | Feasability of Presentation | | Feasability of Language | | Feasability of Graphics | | Sains Literacy | |
| Score | % | Score | % | Score | % | Score | % | Score | % |
| VAL-01 | 61 | 89.71 | 73 | 91.25 | 44 | 84.62 | 46 | 88.46 | 96 | 88.89 |
| 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.

**Level of Readability of Materials**

The legibility test is performed using a test pass. Hump ​​test filled by experimental class XI students of IPA 2. Test legibility is done to determine the level of legibility or ability of teaching materials to be understood by students. 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 students 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 | | |
| Experimental |  | Control |
| 1 | *Gain* (g) | 0.51 |  | 0.26 |
| 2 | Test |  | 15.29 |  |

Based on hypothesis testing, the resulting *tcount* price is 15.29 while the *ttable* price with dk = 61 and 5% significance level is 2.00, so Ho is rejected and Ha accepted. Based on hypothesis testing, it means that the improvement of literacy ability of science students using science-based teaching materials is higher than the improvement of students' science literacy ability using the commonly used instructional materials.

In the pretest-posttest analysis, there were also data on the improvement of every aspect of science literacy covering aspects of science as a body of knowledge (aspect 1), science as a way of investigating (aspect 2), science as a way of thinking (aspect 3), and interaction between science, technology, and society (aspect 4), Increased literacy ability of students 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. This test uses an independent sample comparative test type polled variance. The average results obtained between the control and experimental classes are presented in Table 3.

**Tabel 3.** Average Grade Result of Control Class and Experiment Class

|  |  |  |  |
| --- | --- | --- | --- |
| No | Assessment | Control | Experiment |
| 1 | Afektif | 58,53 | 69,41 |
| 2 | Psikomotorik | 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.

Let's Learn is a feature of teaching materials that mostly contain aspects of science's, first literacy of science as a body of knowledge. The content of Let's Learn is a theory, basic concepts, and supporting information theory developed based on indicators and learning objectives. Features Come on Learning is the most complete feature because it contains three other aspects of science literacy. Dominant is the aspect of science as the body of knowledge.

The second scientific literacy aspect of science as an investigative or investigative process is largely poured into the *Let’s Try It* feature and a small portion of the *Let's Learn* feature. Especially on the Let’sTry feature displayed some activities and work procedures that can be tested by students. Some of the activities contained in the *Let’s Try* feature can be grouped in school or individually at home.

Aspect of science as a process of investigation is also contained in the text and discourse *Let's Learn* that contains images of human activities that cause global warming. Students are trained to understand some of the causes of global warming, draw conclusions from the data, and explain the reasons for the answers through material discussions through group discussions. This aspect can also be used indirectly in any features of the teaching materials.

The third aspect of science literacy, science as a way of thinking, is largely embodied in the Feature of Scientific Thinking features and a small portion of it is contained in the text and discourse Let's Learn, in the Let's Think Scientifically discourse of a character and the discovery or the results of thinking. In the discourse is told the idea underlying an invention and the process by the scientist or character. Inside the feature Let's Learn the aspect of science as a way of thinking contained in the discussion of cause and effect of a natural event.

The fourth aspect of science literacy is the interaction of science, technology and society embodied in the features of Science in Life. This feature contains about the positive and negative impacts of technology as well as the community's interrelationship with surrounding natural events. In addition to the features of Science in Life, the interaction aspects of science, technology and society are also applied in the text and discourse on the feature Let's Learn especially the discussion of technology and human behavior on the environment.  
 In addition to the four main features, there are also additional features such as features Did You Know, Let’s Find the Solution and Working with Friends. These additional features have function to add interesting information related to learning materials, student group activities, and practice questions. Another function of the existence of additional features became adders to the attraction of teaching materials so that does not seem monotonous.

The research results of Utami's (2014) indicates that the circulating teaching materials in general do not yet have a balanced comparison of scientific literacy aspects. Most teaching materials have the science aspect as a body of knowledge of> 50% while the other aspects do not have the same comparison. Therefore the features in the developed material have the comparison 2: 1: 1: 1 for the feature Let's Learn, Let’s Try, Let’s Think scientifically in life.

The comparison refers to the opinion of Wilkinson (1999) that balanced science materials have comparison scientific literacy aspects of 40%, 20%, 20% and 20%. For the aspects of science as a body of knowledge, science as a process of inquiry, science as a way of thinking, and interaction of science, technology and society, the comparison 2: 1: 1: 1 in teaching materials was obtained from comparing the number of learning indicators contained in each major feature with the total number of learning indicators on each learning material.

The learning indicator is chosen as a measure of the comparison of the scientific literacy aspect in the teaching materials based on the function of the indicator as the guidance of the development of teaching materials. According to Depdiknas (2008) effective teaching materials should be appropriate indicators so as to increase competency achievement maximally. Therefore, learning indicators are chosen as a reference to the balance of scientific literacy aspects.

Science material must be accompanied by illustrations that are explicit in the material text. In the main feature, especially the feature Let's Learn the illustrations are displayed that serves to increase the reader's understanding. The combination of images and texts positively affects students' understanding concepts. This is suitable with the results of previous research by Devetak and Vogrinc (2013) ie visual and verbal combinations have a positive effect because it allows students to match and compare information on images and explanations on the text.

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 feasibility test of the teaching materials used questionnaire which was filled by three validators. The questionnaire contains the criteria of good teaching materials in accordance with the standard of the teaching materials specified by the National Education Standards Agency (BSNP) as well as the categories of science literacy aspects that should be present in the teaching materials.

The results of feasibility test also get advice from the validator. The suggestion is used to make teaching materials improvement better. Suggested recommendations became the basic of revision teaching materials. The suggestions are related to the appearance or design of teaching materials. For example suggestions related to the display that conveyed by one of the validators are some of the illustrations shown hyperbolic and the displayed images have not been referenced. On suggestions relating to the material that is the basic concept needs to be deepened by the author for the material presented in accordance to real and up to date conditions.

The percentage of high feasibility test results is a reflection that the teaching materials are developed well enough. References to the development of teaching materials are the Teaching Material Development Guidelines published by the Ministry of National Education in 2008. The guidelines describe the steps in developing teaching materials and the signs that must be considered. One of the important points in the development of teaching materials according to Depdiknas (2008) that the teaching materials developed should be a derivative of the competence to be achieved so that the material developed to provide meaning for students who study it, the competence seen in the indicator of learning or learning objectives.

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 percentage of legibility obtained through the test of hiatus, legibility still has typography.

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. According to Essem Educational Limited (2007) the factors that influence the readability of a text such as; the physical form of the text, the reader's knowledge, the reading ability of the reader, difficulty in vocabulary, structure of the text, the coherence and the syntax.

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.

The effectiveness of the product in the form of literacy materials on the science of global warming symptoms that have been developed can be determined by comparing the improvement of cognitive, affective, and psychomotoric learning achievement of the experimental class with the control class. Through the comparison, it is known that the developed teaching materials can increase the literacy of students' science significantly so that it is effective. The experimental class is a class that uses science-based literacy materials in the learning process. Control class is a class that does not use science-based literacy materials but using the materials that are commonly used is the book Physics SMA published from Erlangga.

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.

In addition, being influenced by teaching materials, the success of learning is also influenced by methods and learning strategies. Differences in control class treatment and experimental class are found only in the use of teaching materials. In the learning process, the two classes use the same learning of reading and lecture strategies. This learning strategy is chosen based on the appropriateness of the learning process in the curriculum applied in the school where the research is Curriculum K13 where learning uses a scientific approach. Students are facilitated to find out by applying scientific approach based on applicative skills.

The teacher was only as a facilitator who provided justification if only there was misunderstanding of the concept. In otherwise, 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.

Contextual learning strategies or lectures will provide a saturated learning atmosphere if not combined with other learning strategies. Therefore, in the learning process is also accompanied by practical activities or experiments that make students mapping concepts that have been studied to assemble information and translate it in the form of tables and graphs. This is consistent with Oliver's (2009) research results: 2 out of 3 students liked reading and mapping concepts rather than reading alone, because mapping concepts can be done by all students regardless of their reading ability.

**SIMPULANCONCLUSIONS**

High school physics class XI materials of global warming symptoms can be said to be based on science-based literacy. It 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 Let's Learn, Let’s Try, Come Scientific Thinking, and 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 a 2: 1: 1: 1 ratio

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 uses the literacy materials developed science literacy has increased cognitive learning outcomes and the average result of affective learning and psychomotor is higher than the control class, a class that commonly uses the teaching materials.

. Penerapan PjBL pada materi fluida dinamik di salah satu sekolah swasta selama lima kali pertemuan dapat mengarahkan siswa melakukan aktivitas literasi sains dan kreativitas siswa.

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