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DEVELOPING TEACHING MATERIALS IN INTEGRATED NATURAL SCIENCE CLASS BASED ON INQUIRY LABS TO IMPROVE STUDENTS' SCIENCE LITERACY

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ABSTRACT

The low scientific literacy of Indonesian students indicates the low quality of science/science education. Reality on the ground in the science learning process is that teachers only use textbooks and have not developed inquiry labs-based teaching materials. The research objective is to develop an integrated science teaching material based on inquiry labs that is valid, practical, and effective. The type of research is research and development (r&d). The test was conducted in class VIIB of MTsN 6 Sijunjung. The instruments used are expert validation sheets and student questionnaires. The data analysis technique used in this research is qualitative and quantitative analysis. The results of the validation of teaching materials have an average value of 89, meaning are very valid. The average practicality test results for teaching materials are 84, meaning are very practical. The results of statistical tests on students' scientific literacy tests were effective in increasing students' scientific literation.

Keywords: Teaching Materials; Integrated IPA; Inquiry Labs; Scientific literacy.

INTRODUCTION

Scientific literacy is needed by every citizen in the current industrial revolution era. Scientific literacy is closely related to students' learning process in science class at school. However, there are several problems related to the process of learning science at school, such as students' perception about science as very difficult subject. This perception comes from memorization lots of formulas in physics. Wibowo, F.C (2015) stated that natural science, especially physics, is considered difficult since it is dentical with complex formulas and concepts. Therefore, to equip students with scientific literacy, the process of learning natural science is needed to be improved.

Students' scientific literacy level can be measured through PISA (Programme for International Students Assessment). PISA is used to monitor the outcomes of education system in relation to the learning achievement of 15 year old students. Data on the scientific literacy level of Indonesian students can be seen in table 1:

Table 1. Indonesian Students' Scientific Literacy level in PISA from 2000 - 2015

Year Study	Average score Indonesia	Average score International	Ranking Indonesia	Total country study
2000	393	500	38	41
2003	395	500	38	40
2006	393	500	50	57
2009	383	500	60	65
2012	382	501	64	65
2015	403	493	62	69

Source: https://www.oecd.org/pisa/

Based on Table 1, it can be seen that the tendency of Indonesian students' achiement is still low. In 2015, there was an increase in ranking from the previous year, from 64 to 62, but Indonesia was still ranked 62 out of 69 countries. The low scientific literacy of Indonesian students indicates the low quality of science education. A common problem in science learning is the assumption that as long as learning has accommodated many facts and theories, it means that students are considered to understand science literacy. Therefore, the learning process is considered good, regardless of how effective students are in the inquiry process of the problem they face. This is clearly different from the framework on scientific literacy of PISA in which science learning does not only

require knowledge of concept and theories, but also require students to have knowledge of general and practical procedures related to scientific investigations and how to integrate them (Probosari, et al., 2016).

Susanti, et al. (2019; 65) stated that the teaching of natural science will be more meaningful if the learning process is conducted in the suitable environment as the learning source so that there will be a connection between learning concepts and daily activities in the environment where students live. One of the learning models that can improve students' scientific literacy skill and will be meaningful for students is called Inquiry Labs Learning. The Inquiry Labs Learning is able to place students as scientists because students are directed to find specific concepts through laboratory experiment activities (Saputra, et al.: 2017).

The Inquiry learning process can be carried out well if teachers have prepared teaching materials that are in accordance with the characteristics of inquiry learning. Novitasari et al. (2016) stated that the supporting teaching materials used in learning are generally limited to textbooks containing the teaching materials to be delivered. Therefore, students will rarely reread the textbook and rarely have difficulties in understanding the content of the teaching materials. Based on observations, most teaching materials or books used by teachers as learning resources do not engage students to play active roles in exploring and discovering scientific concepts for themselves, but only making students memorize the material and become passive learners. Thus, the development of teaching materials based on inquiry labs is needed. The objective of this study is to develop integrated science teaching materials based on inquiry labs that are valid, practical and effective.

LITERATURE REVIEW

A. Teaching Materials of Integrated Natural Science

According to the Teaching Materials Development Guide from the Ministry of National Education in 2008, it is explained that teaching materials are all forms of materials used to assist teachers/instructors in carrying out learning process in the classroom. Teaching materials are information, tools and texts needed by teachers to plan, study and implement in the classroom (Suprawoto, 2010).

Integrated natural science is a study in the field of science consisting of Physics, Biology, Chemistry and Astronomy. Good materials of this subject are considered to present the concepts of science relating to real life (Arlitasari, 2013). The forms of

teaching materials vary, such as:

1. Printed materials, such as handouts, books, modules, students' worksheets, brochures, leaflets and etc.
2. Audio visual, such as: video/film, VCD
3. Audio, such as radio, cassette, audio CD
4. Visual, such as photos, images, and models
5. Multimedia, such as interactive CD, *computer based*, internet (Suprawoto, 2010).

   Teachers' teaching materials supports teachers in carrying out learning and students will be more assisted in learning (Depdiknas, 2008). Furthermore, the functions of teaching materials are such as:

   1) Guidelines for teachers who will direct all of their activities in the learning process, and a substance of competence that should be taught to students.
   2) Guidelines for students who will direct all of their activities in the learning process, and as a substance of competence that should be studied/mastered.
   3) Evaluation tool for achievement/mastery of learning outcomes.

The content of teaching materials is designed in such a way to achieve the objectives of learning, and the teaching system is adjusted to the characteristics of the students who use it. A teaching material should at least include, such as:

1) Study instructions (student/ teacher instructions)
2) Competence to be achieved
3) Content of learning materials
4) Supporting information
5) Exercises
6) Work instructions which can be in the form of worksheets
7) Evaluation
8) Response or feedback on the evaluation results (Depdiknas. 2008)

Good teaching materials are those that meet the valid, practical and effective criteria (Sudirta, 2014). The valid criteria are such as the feasibility of content, language, presentation, and graphics (Depdiknas, 2008). The practicality can be seen through the ease of using teaching materials in learning at school and at home. Meanwhile the effectiveness is fulfilled if 75% of students achieve the learning objectives that have been formulated (Sukmadinata, 2005).

B. Inquiry Labs

The Inquiry Model encourages students to connect their knowledge to the application in everyday life, and it also helps students to develop thinking skills, so they are able to find concepts. The Inquiry Model can improve students' scientific literacy through the ability to investigate so that students do not only learn science as a product, but also as a process and application (Wenning, 2010). This is in line with Liliawati et al. (2014) who found that the Inquiry model is able to let students play their active roles in learning process, so they can build their own concepts of knowledge and discovery. The stages of Inquiry include *observation, manipulation, generalitation, verification, application* (Wenning, 2011).

Inquiry learning has several characteristics that distinguish it from other learning models. First, in Inquiry learning, the teacher does not communicate the knowledge, but only helps students build their own knowledge. Second, inquiry learning is oriented to the development of thinking skills. Third, the interactions that occur among students, teachers, and the environment play a very important role in creating a learning atmosphere to build students' knowledge. Fourth, the teacher's role is as a questioner. Fifth, students are given the widest opportunity to develop knowledge and express their opinions through unlimited hypotheses.

C. Science Literacy

Programme for International Student Assessment (PISA) defines science literacy as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence in order to understand and make decisions regarding the nature and chances made to human activities. A scientist must not only have scientific knowledge, but also have high scientific literacy with an understanding of the character of science, its limitations, and its consequences (PISA, 2013). Nazilah, et al (2019) stated that students should be familiar with science literacy tests in the learning process. Assessment of science literacy is standardized by the Organization for Economic Co-Operation and Development (OECD) with the emergence of the Programme for International Student Assessment (PISA) in 1997.

The most important thing in the development of students' scientific literacy includes knowledge of science, the process of science, the development of scientific attitudes, and the students' understanding of science so that students not only know the concept of science but also can apply scientific abilities in solving various problems and can make decisions based on science considerations (Yuliati, 2017). Based on some

understandings of scientific literacy, students are expected to be able to apply the knowledge gained at school to be applied in everyday life so that students can have sensitivity and concern for the surrounding environment.

RESEARCH METHOD

A. Research Methodology

This study is a research and development study using a four-D models which consists of four stages. According to Thiagarajan in Trianto (2011), the four stages are defining, designing, developing, and disseminating. The procedures of this study include:

1. Defining Stage

   The defining stage is carried out as follows:

   a. Identifying problems to get an overview of the learning process and to find out what problems are faced in science learning.
   b. Curriculum analysis carried out through an analysis of competencies, materials, and learning objectives that will be achieved by students
   c. Student analysis conducted to determine the characteristics and learning styles of students
   d. Formulating the problem. After finding several problems related to teaching materials for natural science learning, a solution to the problems was formulated, namely developing teaching materials for integrated natural science based on Inquiry Labs.

2. Designing Stage

   This stage aims to prepare teaching materials for integrated natural science based on Inquiry Labs and to prepare learning content according to students' needs. The design steps that will be carried out are:

   a. Creating themes and designing the display of teaching materials
   b. Distributing teaching materials, starting from the cover page, the introduction and so on
   c. Arranging the teaching materials
   d. Asking input on the teaching materials from colleagues
   e. Improving teaching materials according to input from peers

3. Developing Stage

   At this stage, validation, practicality, and effectiveness test on the teaching materials are developed. If the teaching materials are not valid, practical and

effective, then improvement will be made to obtain valid, practical and effective teaching materials.

4. Disseminating Stage

   At this stage, the teaching materials that have been developed on a wider scale are used, for example in other schools. In this study, the dissemination stage was carried out in other schools.

B. The Research Instrument

The research instruments used in this study include:

1. Validity test; questionnaire/ validation sheet
2. Practicality test; practicality questionnaire
3. Effectiveness test; scientific literacy test

C. Product Trial

The product trial was carried out in grade VII B MTsN in the 2019/2020 school year.

D. Data Analysis Technique

The data analysis techniques used in this study were qualitative and quantitative analysis:

1. Validity and Practicality

   The questionnaire that will be developed refers to a Likert Scale, then it is converted into values in the following way:

$$B = (X/Y) \times 100\%$$

The X is the score filled in the questionnaire, the Y is the maximum score on each statement, the B is the level of validity and practicality. The way to measure the categories of validity and practicality in the following table:

Table 2. The category of Validity and Practicality

Interval	Categories
0-20%	Tidak Valid/Tidak Praktis
21 % - 40 %	Kurang Valid/Kurang Praktis
41 % - 60 %	Cukup Valid/Cukup Praktis
61 % - 80 %	Valid/Praktis
81 % - 100 %	Sangat Valid/Sangat Praktis

Source: Arikunto (2010)

2. Effectiveness

Testing the effectiveness of teaching materials is done by giving scientific literacy tests to students through pre-test and post-test. After the pre-test and post-test were carried out, the normality and homogeneity tests were carried out on the test data. Furthermore, to test the effectiveness of teaching materials that have been developed, relevant statistical test is carried out based on the results of normality and homogeneity test of students' scientific literacy test results.

RESULTS

A. The Defining Stage

At this stage the researcher discusses the problems that occur in natural science learning. Identifying problems aims to get an overview of the learning process and find out what problems are faced in natural science learning. Aspects analyzed at this stage are aspects of the natural science learning process, the natural science teaching materials used in science learning, and the relationship between learning process, media, teaching materials, and students' motivation.

Based on the questionnaire distributed to students, it was found that 83% of natural science learning carried out by teachers through lecturing method. The rest of students stated that natural science learning was carried out through inquiry labs/ experimental/ practical method. This finding is in accordance with interviews conducted with natural science teachers who stated that the learning process of natural science was more dominantly carried out through lecture method compared to the inquiry labs/ experimental/ practical method. Many materials that should be taught using the inquiry labs were carried out using the lecturing method because of the lack of laboratory equipment available in the laboratory. The reason is that the lecturing method is easier to apply in the learning process of natural science at school. This is very different from the inquiry labs method where the teacher must design well and systematically and must be creative, especially if the laboratory equipment in the school is incomplete. A study conducted by Guntara, Y & Nona, M.M. (2019) stated that the most important task of a teacher in the learning process using the inquiry training model is that all learning activities must be under the supervision of the teacher. Likewise with classroom management in the inquiry learning process where students must have the skills to conduct experiments, be able to work in groups, and be able to communicate to present their findings in front of the class.

In the aspect of media used in the science learning process, it is known that the media most often used by teachers is animated video which is played on a laptop and watched using an LCD. Meanwhile, practicum tools are rarely used in natural science learning because of the limited available laboratory equipment. Furthermore, it is known that the available teaching materials are textbooks (85%) and hand outs. Based on these data, it is known that teachers rarely develop teaching materials for natural science that can be used by students as references and sources of information in the learning process. Darman, D. R, et al. (2017) stated that the limited teaching materials in the science learning process is a problem that must be solved because teaching materials are something that is very important in the learning process in schools to improve scientific literacy and student performance as well as for teacher efficiency. This is in line with the opinion of Yusmanila, Y, et al (2017) in which to maximize the function of teaching materials, the materials need to be developed by teachers so that the teaching materials used by students in the learning process are in accordance with the curriculum and student characteristics. In addition, the lack of teaching materials developed by teachers, especially inquiry-based teaching materials, can cause students not to have scientific literacy skills. Kamala, I., et al. (2016) stated that there was a significant positive relationship between students' scientific literacy when students used the inquiry lesson-based module. While the results of Utomo, E.N.P (2018) stated that the inquiry lesson-based module was effective in improving students' scientific literacy. Thus, learning with the inquiry method and the availability of inquiry-based teaching materials greatly affect students' scientific literacy skills.

In the aspect of the relationship between the learning process, media, and teaching materials with student motivation, it is known that teaching materials that have an attractive appearance make students enthusiastic in learning science, and students prefer group learning compared to individual learning. One method of group learning is the inquiry method. The results of research by Dwi, D. F. (2018) that inquiry learning can make students work together through group discussions where students give each other input so that students with weak abilities are more motivated and easy to understand the material. In addition, the experimental/practicum/inquiry labs method can increase enthusiasm in learning science. This is in accordance with the results of Yusmanila & Widya's (2020) research that the Group Investigation learning process using the Inquiry Labs method focuses more on student activities. Students have freedom in their activities so that students are enthusiastic in learning and more motivated in the learning process

through experimentation and discovery.

B. The Designing Stage

This stage aims to prepare teaching materials for integrated natural science based on Inquiry Labs, and to prepare learning content according to student needs. The design steps that have been carried out are:

1) Creating a theme
2) Designing the display of teaching materials.
3) Distributing the teaching material starting from the cover page, the introduction section and so on.

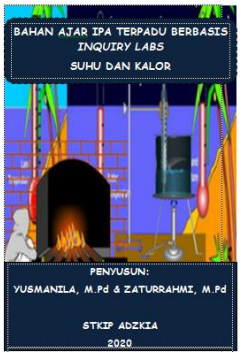

Figure 1. The Cover Page of Teaching Materials for Natural Science Based on Inquiry Labs

3) Arranging teaching materials.
4) Asking colleagues for input on the teaching materials made.
5) Improve teaching materials according to peer input.

C. The Developing Stage

The teaching materials that have been designed are validated by three experts, namely Dr. Jendriadi, M.Pd (Language Expert), Dr. Ismira, M.Pd (Expert in Media), and Desy Eka Muliani, M.Pd (Expert in Materials). The validation results can be seen in table 2:

Table 3. The validation results of teaching materials

No	Aspects validated	Score	Criteria
1	Kelayakan Isi	89	Sangat Valid
2	Validasi Konstruksi	92	Sangat Valid
3	Validasi Bahasa	82	Sangat Valid
Mean score		88	Sangat Valid

Based on table 2. It can be seen that the integrated science teaching materials based on inquiry labs are in very valid criteria. However, there are some suggestions from validators for the improvement of integrated science teaching materials. The following is a validator's suggestion regarding integrated science teaching materials based on inquiry labs.

a. Advice from material experts

1. Sources or references are reproduced and use up to date references
2. The material is adjusted to the ability level of junior high school students

b. Advice from media experts

1. The font used is consistent, do not differ from one another
2. The pictures used in the teaching materials should be real pictures, not cartoons

c. Advice from a linguist

1. Improve writing and adapt it to the General Guidelines for Indonesian Spelling
2. Improve the use of punctuation marks

Suggestions from the validator are improved so that the teaching materials made are getting better. After the suggestions from the validator are fixed, the next step is the product trial. The product trial was carried out in class VIIB of MTsN 6 Sijunjung. Product trial was carried out to determine the practicality and effectiveness of integrated science teaching materials based on inquiry labs. The practicality of teaching materials is obtained through practicality questionnaires filled out by teachers and students. The results of the practicality test of teaching materials can be seen in table 3.

Table 4. The results of Practicality test of teaching materials

No	The aspects measured	Score	Criteria
1	The practicality by teachers	89	Very practical
2	The practicality by students	79	Practical
Mean		84	Very Practical

Based on the results of the practicality test by teachers, the average score of 89 was obtained. Meanwhile, the average score of 79 was obtained from the practicality test by students. The average score (mean) of the practicality score of teaching materials for integrated natural science is 89 which is in the very practical criteria. Thus, the teaching materials for integrated natural science are practically used in the classroom. The

effectiveness test was carried out in class VII B of MTsN 6 Sijunjung. To find out the results of the effectiveness test of teaching materials for integrated natural science based on Inquiry Labs, the t-test was used. The following are the results of the t-test of the pre-test and the post-test data.

The T-test

Group Statistics

	Jenis Test	N	Mean	Std. Deviation	Std. Error Mean
Nilai Hasil Test	Pre Test	8	43,13	15,338	5,423
	Post Test	8	68,75	10,938	3,867

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Nilai Hasil Test	Equal variances assumed	1,325	,269	-3,847	14	,002	-25,625	6,661	-39,911	-11,339
	Equal variances not assumed			-3,847	12,657	,002	-25,625	6,661	-40,054	-11,196

Figure 2. The results of t-test on Pre-test and Post-test Data

Based on the figure above, it can be seen that the Significance Value of Levene's Test for Equality of Variances is 0.269 > 0.05. This indicates that the data variance between Pre-test and Post-test is the same. Based on the Independent Sample Test in the table above, it can be seen that the significance value is 0.002 < 0.05. This indicates that there is a difference between the results of the Pre-test and the Post-test. Thus, it can be concluded that the teaching materials for Integrated Natural Science based on Inquiry Labs are effective in improving students' Scientific Literacy.

D. Dissemination Stage

At this stage, the teaching materials for integrated natural science based on Inquiry Labs that are valid, practical and effective are distributed on a wider scale. In this study, the dissemination was carried out to students from other classes in the same school, namely grade VII A and VII C of MTsN 6 Sijunjung.

CONCLUSION

Based on the results of the study and the data analysis regarding the development of contextual modules, the following conclusions are made:

1) The results of the analysis at the Define Stage concluded that natural science learning

is more often carried out through Lecturing Method compared to the Experimental Method or Inquiry Labs. The teaching materials for natural science come from textbooks and handouts. The method and teaching materials in natural science class have not facilitated students to have scientific literacy skill. Therefore, it is necessary to develop integrated science teaching materials based on inquiry labs to improve students' scientific literacy skill.

2) The design of teaching materials for integrated natural science class based on Inquiry Labs has a high level of validity with an average score of 88 experts and is in the very valid criteria.
3) The teaching materials for integrated natural science based on Inquiry Labs are practical to be used in integrated natural science class in grade VII at MTsN. It can be seen by the average score of students' response towards the practicality of teaching materials for integrated natural science class based on Inquiry Labs which is 79 or in the practical category, and the teachers' response is 89 or in the very practical category.
4) The teaching materials for integrated natural science based on Inquiry Labs are effective in improving students' scientific literacy. It can be seen from an increase in the results of students' scientific literacy test.

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