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How to improve student's scientific literacy

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Abstract. The purpose of this research are to analyze a factors influencing the improvement of students' scientific literacy in Indonesia, to describe the profiles of students' scientific literacy based on science text books-based on scientific literacy, learning models, and worksheet-based on scientific literacy. Data analysis was used the percentage discription and t-test. The study results in the science textbooks-based on scientific literacy an effective stimulant to increase students' scientific literacy. Learning model such as Project Based Learning, Problem Based Learning, Cooperative Learning, Discovery, Inquiry and etc., that can increase student science literacy is a scientific approach model. The worksheet-based on scientific literacy can also increase students' scientific literacy.

1. Introduction

Science education has been applied in Indonesia for years, but the result for Indonesia in international level especially for scientific literacy is still poor. Based on the *Programme for International Student Assesment (PISA)* results, students scientific literacy in Indonesia is still low compared to the International mean score around 500 as shown in Table 1 [1,2].

Table 1. The Score and Rank of Indonesian Student Scientific Literacy at PISA

Year	Score	Rank
2000	393	38 from 41 countries
2003	395	38 from 40 countries
2006	393	50 from 57 countries
2009	383	60 from 65 countries
2012	383	64 from 65 countries
2015	403	62 from 70 countries

Scientific literacy defined by OECD (*Organization for Economic Co-operation and Development*) as an ability to conclude and to solve problem about nature and interaction between nature and society [3]. Factors that can influence the student's scientific literacy result are the textbook selection, worksheet, learning model, and evaluation tools based on science literacy [4,5,6]. Textbook is the learning source that connected directly to the students. A science textbook that based on scientific literacy must have some basics categories [7]. The basics categories of science textbook are science as



the body of knowledge, science as the investigative nature, science as a way of thinking, and interaction of science, technology and society. Rusilowati *et al.* [4] added one of the categories on the science textbook is interaction with environment.

The purpose of this research are to analyze factors affecting improvement in Indonesia. Further, to describe the profiles of students' scientific literacy based on science textbooks, learning models, worksheet, and evaluation tools containing scientific literacy.

2. Methods

This study was used the Meta analysis procedure. Data collection from the results of several previous studies. The data collecting at Junior High School in Central of Java, South of Sulawesi and North of Sumatera. Instruments data acquisition using scientific literacy test. The data analysis done with percentage discription and N-gain.

3. Results and Discussion

3.1. Factors Affecting Students' scientific Literacy Improvement in Indonesia

Some of the factors that influence students' science literacy are: 1) textbooks was used, 2) learning models, 3) learning media, 4) worksheet, and 5) evaluation tools based on science literacy. Textbooks that have paid attention to the content of science literacy will, of course to influence the students' science literacy. The proportional content of science as a body of knowledge, science as a way of investigating, science as a way of thinking, and the interrelation of science with the environment, technology and society, can certainly condition students to science literacy. Learning models that pay attention to the literacy load of science can certainly increase students' science literacy as well. Learning media is absolutely used in learning if students are prepared for science literacy. By using worksheet on the learning Process should be developed to reveal students' science literacy. Habituation is based on science literacy, of course can increase the students' science literacy. The literacy aspect loaded in books, worksheets, media, learning model and evaluation are as follows.

3.1.1. Science as the body of knowledge. This category typifies most textbook and presents information to be learned by the reader. Textbook materials in this category are presents facts, concepts, principles, laws, hypotheses, theories, models and asks student to recall knowledge or information.

3.1.2. Science as the investigative tools of nature. This category reflects the active aspects of inquiry and learning, which involves the student in the methods and processes of science such as observing, measuring, classifying, inferring, recording data, making calculations, experimenting, etc.

3.1.3. Science as a way of thinking. These aspects of the nature of science represent thinking, reasoning, and reflection, where the student is told about how the scientific enterprise operates.

3.1.4. Interaction of science, environment, technology, and society. This aspect of scientific literacy pertains to the application of science and how technology helps or hinders human kind.

The balance proportion was showed on the percentage indicators for each aspect. The first aspect (Science as a way of thinking) has 40% number of all indicators, and the other has 20%. The balance proportion of scientific literacy aspects for science textbook is 2:1:1:1. This proportion similar to the previous researcher [8].

3.2. Described The Profiles of Students' Scientific Literacy

3.2.1. Profiles Based on Textbook

The balance proportion of the scientific literacy aspects are showed by the indicators for each aspect in every material in textbook. The aspect of science as the body of knowledge has 40% of indicators from all indicators in one material. The others aspects, science as the investigative nature, science as a way of thinking, and interaction of science, environment, technology and society have 20% of indicators for each.

Textbook characteristics are containing all of four scientific literacy aspects and have a balance proportion of scientific literacy aspects. Four scientific literacy aspects presented on main part in textbook, they are “Let’s go to Learn”, “ Let’s go to Try”, “Let’s go to Scientific Thinking”, and “Science in Life”. Let’s go to Learn is representation of *Science as the body of knowledge*. Let’s go to Try is representation of *Science as the investigative nature*, Let’s go to Scientific Thinking is representation of *Science as a way of thinking*, and Science in Life is representation of *Interaction of Science, Environment, Technology and Society*.

The science textbook based on scientific literacy can increase on the students’ scientific literacy. Textbook is the learning source that connected directly to the students [4]. It’s showed on the gain factor and posttest score of experimental group that higher than the control group. The result of effectiveness textbook shown at Table 2.

Table 2. Result of effectiveness of the textbook

Code of Textbook	Teaching Method		Gain Factor*)	
	Experimental Group	Control Group	Experimental Group	Control Group
A	Cooperative Learning + Science Textbook Based on Literacy	Cooperative Learning + Science Textbook not Based on Literacy	0.60	0.30
B	Direct Instruction + Science Textbook Based on Literacy	Direct Instruction + Science Textbook not Based on Literacy	0.63	0.42
C	Cooperative Learning + Science Textbook Based on Literacy	Cooperative Learning + Science Textbook not Based on Literacy	0.37	0.18

*) Note: maximum score of gain factor is 1.00

From the data, the learning strategies that used in experimental and control group are the same. The effectiveness result shows that the gain score from pretest to posttest, of the theme A, B, and C are quite similar.

3.2.2. Profiles Based on Learning Models

The teaching strategy that was used in gain score are Cooperative Learning, and Direct Instruction. The Direct Instruction gain was better than the Cooperative Learning. This is because the complexity of the material taught by cooperative learning is more complicated than direct instruction. So, not because the learning model is used. But the average gain of science literacy learning achievement students’ experimental group better than control group. The average score gain of experimental and control group in this research was classified as a middle and low category, respectively. Furthermore, for the learning models that can be used to increase science literacy in this research are Problem Based Learning [9] and Project Based Learning [10, 11].

3.2.3. Profiles Based on Worksheet

Worksheet-based on science literacy can also be used to improve students' science literacy. The results shows that the by using of worksheet-based on science literacy is able to increase students'

understanding of physics which is the gain score is 0.77. The science literacy of students also increases of 0.72. An increases of every aspect of science literacy can be seen in Table 3.

Table 3. Increases of every scientific literacy aspects based on worksheet

	Knowledge			Procces/Investigating		
	Content	Prosedural	Epistemik	Interprating	Inferencing	Evaluating
Pretest	54.0	20.0	50.0	44.7	26.0	20.0
Posttest	98.0	57.0	98.0	91.0	56.0	82.0
N-gain	0.95	0.42	0.96	0.84	0.40	0.77

3.2.4. Evaluation Instrument Based on scientific literacy

The profile of students' scientific literacy which is measured using instrument with characteristics of scientific literacy [12] as shown in Figure 1.

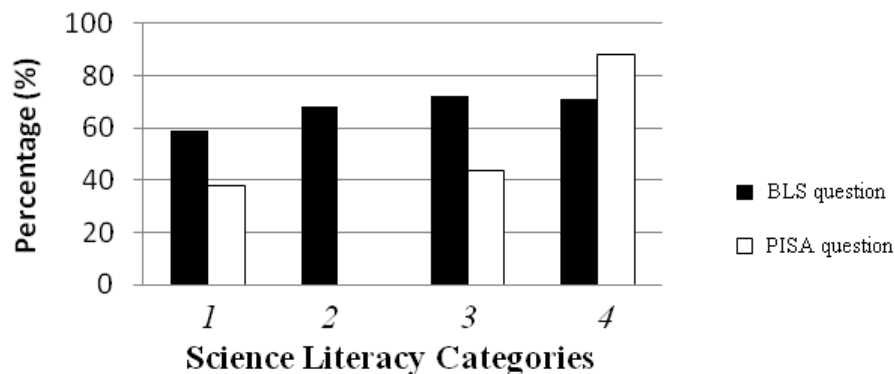


Figure 1. The Profile of Students' Scientific Literacy

The final trial results showed that the category of science as a way of thinking is the highest among the other categories is 72. This category requires students to think critically, interpret data, and linking concepts with another one. The category of science as a body of knowledge is only 59 that mean the ability of the students in understanding science concepts is sufficient.

The learning evaluation determines how the students learning well and a part of the investigation to education improved. The learning evaluation provides feedback to students, educators, parents, policy makers, and the public about the effectiveness of educational services [13]. Teachers were invited to start introducing and giving material with various strategy that scientific literacy, such as teaching concepts by experiments which exciting order thinking skills, used evaluation instrument based on scientific literacy, so students' scientific literacy can be increased very well [14, 15].

4. Conclusion

Some of factors affecting on the students' science literacy are: (1) textbooks, (2) learning models, (3) learning media, (4) worksheet, and (5) evaluation tools based on science literacy. Textbook, learning models, worksheet, and evaluation tools who develop based on scientific literacy can improve the students scientific literacy.

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