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Improving the Ability of Science Literation Aspects in Students' Science Competency of Middle Fluid Materials

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Abstract:

The purpose of the research is to find out and describe the achievement of students' scientific literacy abilities. This research used descriptive quantitative method. The research subjects were 2 classes of VIII grade students each classes consisted of 32 people of Junior High School in Pematangsiantar in Odd Semester 2019/2020 Academic Year. The research instrument used was a scientific literacy test in the form of multiple-choice questions and essays covering the concepts of static and dynamic fluid. For class VIII1 aspects explained scientific phenomena with n-gain 0.64 (64%), design and evaluated scientific questions with n-gain 0.62 (62%) and interpreted scientific data and evidence with n-gain 0.60 (60%). For class VIII2 aspects explaining scientific phenomena with n-gain 0.54 (54%), designing and evaluating scientific questions with n-gain 0.59 and interpreting data and scientific evidence with n-gain 0.60 (60%). The achievement category tended to be moderate which showed that the literacy ability of students' scientific competencies in fluid material was moderate. The results of the paired t-test statistics showed that for each aspect of science competency showed sig. <0.05 meant there was a significant increase in scientific competency literacy. The modified inquiry learning model that was used is effective in increasing the scientific literacy of science competence of students in Class VIII of Junior High School of fluid material.

Keywords:

Science Literacy, Science Competence, Modified Inquiry, Fluid

1. Introduction

Science literacy can be interpreted as scientific knowledge and skills to be able to identify questions, obtain new knowledge, explain scientific phenomena, and draw conclusions based on facts, understand the characteristics of science, awareness of how science and technology shape the natural, intellectual and cultural environments, and the willingness to engage and care about issues related to science [7]. The National Research Council [6] states that the set of scientific competencies needed in

science literacy reflects the view that science is a ensemble of social and epistemic practices that are common to all sciences, which frames all competencies as actions.

The definition of scientific literacy, that the content of learning is expected to fulfill 21st century skills; 1) learning and innovation skills include mastering diverse skills, learning and innovation, critical thinking and problem solving, communication and collaboration, and creativity and innovation, 2) digital literacy skills include information literacy, media literacy, and ICT literacy, 3) career and life skills include flexibility and adaptability, initiative, social and cultural interaction, productivity and accountability, and leadership and responsibility [13].Increasing the nation's competitiveness in following the development of the globalization era and the industrial revolution 4.0 is important to be pursued. The condition that is experienced by the Indonesian people at this time is that there are not many human resources (HR) who are able to follow the progress of science and technology optimally. Quality human resources must be able to compete globally both in terms of mind, expertise, and skills. To create quality human resources is certainly closely related to education that plays a role in giving birth to the next generation of the nation who are able to compete in the international world because education contributes greatly in preparing the nation's cadres. Quality education directs the formation of values needed by students in life [11]. One of the parameters of a country's education quality is illustrated by the achievements of its students in attending domestic and international studies.

Science literacy is a person's ability to understand science, communicate science, and apply science knowledge to solve problems so that they have a high attitude and sensitivity towards themselves and their environment in making decisions based on scientific considerations [12]. PISA (Program for International Student Assessment) is a literacy study conducted by the Organization for Economic Co-Operation and Development (OECD) and the Unesco Institute for Statistics. The program aims to periodically analyze at the international level the literacy abilities of third grade students in junior high and first grade high schools in aspects of reading (literacy), mathematics (mathematics literacy), and science (scientific literacy) [7,8]. Indonesia is one participant country that actively participated in this literacy study conducted by PISA The average score of Indonesian scientific literacy based on the results of the PISA study from 2000 to 2018 is presented in Table 1.

Table 1. *The Literacy Capabilities of Indonesian Students in the Results of thePISA Study 2000-2018.*

Year	International average score	Indonesia	Rank	Participating of countries
2000	500	393	38	41
2003	500	395	38	40
2006	500	393	50	57
2009	500	383	60	65
2012	501	382	64	65
2015	493	403	64	72
2018	489	396	70	78

(PISA, 2000-2018; OEDC, 2001-2019)

Based on the results of a scientific literacy study conducted by PISA during Indonesia's participation, it is illustrated that the ability of Indonesian students to compete at the International level is still at the lower level. This is a serious problem that needs to be resolved in order to improve Indonesia's achievements at the international level, especially in the field of science. Indonesian students with

scientific literacy scores of around 400 points means that they can only remember scientific knowledge based on simple facts (such as names, facts, terms, simple formula) and uses general scientific knowledge to draw or evaluate a conclusion [10] The scientific literacy in PISA 2015 [7] is defined by three competencies, namely explaining phenomena scientifically, evaluating and designing scientific questions and interpreting data and evidence scientifically. Explaining the phenomena of science and technology requires an understanding of the contents of science itself or content knowledge. The second and third competencies emphasize how scientific knowledge is generated with a high level of trust. This competency must understand a variety of standard methods and procedures for practicing to build scientific knowledge called procedural knowledge. Procedural knowledge can be interpreted as a series of steps, which are collectively known as procedures. This competency also requires competence of epistemic knowledge, which is defined as an understanding of the reasons for carrying out scientific inquiry practices, claims for what is produced, and defining basic terms such as theories, hypotheses and data [6] Procedural and epistemic knowledge is needed to identify acceptable questions for scientific inquiry, to assess whether appropriate procedures have been used to ensure the claim is true, and can give consideration to scientific or economic issues. Özgelen [9] argues that someone who is literate in science can make decisions in everyday life by using scientific processes, scientific knowledge, and values.

Low literacy contributes to the country's low productivity, i.e. the amount of output produced by the country in a period. Low productivity will affect the level of welfare which is characterized by low per capita income, i.e. the level of income of all people in a country if it is evenly distributed. Low literacy also contributes significantly to poverty, unemployment and inequality. The results of the 2018 PISA study show that there are at least five quality teachers in Indonesia that are considered to be able to hinder learning, namely: (1) Teachers do not understand student learning needs; (2) Teachers are often absent; (3) Teachers tend to reject change; (4) The teacher does not prepare learning well; (5) Teachers are not flexible in the learning process.

The teacher must be independent both in thinking, behaving, and in acting. Teachers must be independent in the corridor that has been outlined by the government through the mandate of the law in accordance with the vision and mission of our national education. Teachers are expected to think and be independent in choosing learning media, teaching materials, reference books, methods, and learning models before acting in front of the classroom according to the demands of the situation and conditions in their school environment [4]

The concept of scientific literacy expects students to have a high sense of concern for themselves and their environment in dealing with problems of daily life and make decisions based on scientific knowledge that they have understood. In line with the PISA statement [7,8] for assessment purposes it states that scientific literacy can be characterized as consisting of three interrelated aspects. [6] states that all competencies must be framed by a scientific action so that literate students are people who are able to understand and do. The aspects of scientific competence at PISA 2015 and 2018 are shown in Table 2.

One alternative that is believed to increase scientific literacy is to improve the quality of science learning in schools. Science is concerned with finding out about nature systematically, so that science is not only mastering a collection of knowledge in the form of facts, concepts, or principles, but also a process of discovery. Science

education is expected to be a vehicle for students to learn about themselves and the natural environment, as well as the prospects for further development in applying it in their daily lives. The learning process emphasizes providing direct experience to develop competencies in order to explore and understand the nature around scientifically. One way is to vary the models used in the learning process of science. Therefore, it is necessary to have an appropriate learning model and can be used by teachers to create conducive classroom situations and conditions so that the learning process can take place in accordance with the expected goals.

Table 2. *Aspects of Science Competencies PISA 2015 and 2018.*

Indicator	Scientific competences
Explaining phenomena scientifically	1. Recalling and applying appropriate scientific knowledge; 2.Identifying, using and generating explanatory models and representations; 3. Making and justifying appropriate predictions; 4. Offering explanatory hypotheses; 5. Explaining the potential implications of scientific knowledge for society
Evaluating and designing scientific enquiry	1. Identifying the question explored in a given scientific study; 2.Distinguishing questions that are possible to investigate scientifically; 3. Proposing a way of exploring a given question scientifically; 4. Evaluating ways of exploring a given question scientifically; 5. Describing and evaluating a range of ways that scientists use to ensure the reliability of data and the objectivity and generalisability of explanations.
Interpreting data and evidence scientifically	1. Transforming data from one representation to another; 2. Analysing and interpreting data and drawing appropriate conclusions; 3. Identifying the assumptions, evidence and reasoning in science-related texts; 4. Distinguishing between arguments that are based on scientific evidence and theory and those based on other considerations; 5. Evaluating scientific arguments and evidence from different sources (e.g. newspaper, Internet, journals).

(OECD, 2019)

Preliminary study has been done in the form of direct questions and questionnaires to students of class VIII at one junior high school in Pematangsiantarshows that their understanding of scientific literacy is very low. Students only 40.0% have heard, memorized and understood the definition of scientific literacy. Holbrook and Rannikmae [3] states that science learning is less relevant, lessdesirable, and not popular for most students, because the curriculum places more on the material being studied not applied at least in practice let alone applied.

2. Research Method

This research was classified into quantitative descriptive research. Before it, the treatment has developed a science learning device. The tool developed is a modified inquiry learning model for science literacy, syllabus, lesson plan, student learning sheet in the form of concept summaries, student activity sheets science literacy tests (not exactly equivalent)referring to the questions PISA 2015, and assessment sheet. The research subjects were two classes in Junior High School students in Pematangsiantar, each class consists of 32 odd semester students in the 2019/2020

Academic Year. The selection of subjects is based on consideration of Junior High School with grade A accreditation andJunior High School is implementing the 2013 curriculum. Another consideration is that the Junior High School is willing to make improvements and innovations in learning with many variations of learning models and methods. Based on preliminary studies conducted previously, scientific literacy and students' science process skills are still low, so efforts should be made to improve it. The study design uses the one-group pretest-posttest design [1]. The pretest and posttest scores of students' scientific literacy were analyzed by n-gain. N-gain shows the magnitude of increase in students' scientific literacy before and after learning $n_{gain} = \frac{(Sf - Si)}{(S\max - Si)} x100\%$

with:

$N_{gain:}$ normalized gain

$S_{f:}$ posttest value

$S_{i:}$ pretest value

$S_{max:}$ maximum value

2.1. Research Instruments

The research instrument used was a scientific literacy test on aspects of scientific competence in the form of multiple choice questions and essays. The number of multiple choice questions is 15 items and essays are 6 items so there are a total of 21 questions, so that each aspect of competence gets 5 multiple choice questions and 3 items essay. This literacy test has been validated by three lecturers and two science teachers who are competent in science. The distribution of items on aspects of science competence is presented in Table 3.

Table 3. *Distribution of Science Literacy Test Aspects of Science Competence.*

Competences	Number of question
Explaining phenomena scientifically	1, 3, 5, 14, 15 (mc), 17, 20 (e)
Evaluating and designing scientific enquiry	2, 8, 9, 10, 12 (mc), 18, 19 (e)
Interpreting data and evidence scientifically	4, 6,7, 11, 13, (mc) 16, 21 (e)

Note: mc is multiple choice test; e is essay test

2.2. Data Analysis

Research data were analyzed by gain-normalization. Gain /n-gain normality test is a test that can provide a general meaning of an increase in learning outcome scores between before and after the learning model or method is applied [2]. If n-gain <0.3 was low category; 0.3 <n-gain <0.7 was medium category and 0.7< n-gain was high category. Paired t-test statistical analysis was performed to determine whether the increase in learning outcomes before and after using the model or method increased significantly with the P-value ($\alpha = 0.05$). For testing the paired t-test used SPSS v 20 software.

3. Results and Discussion

The results of calculating the average literacy ability of students' scientific competencies on fluid material were presented in Table 4 and Figure 1.

Table 4. *TheAchievements of each Aspect of Science Competency.*

Class		Pretest $\overline{X}$	Postest $\overline{Y}$	Gain $(\overline{Y} - \overline{X})$	N-gain	Criteria
$VIII_1$	Explaining phenomena scientifically	14.58	69.17	54.58	0.64	Medium
	Evaluating and designing scientific enquiry	19.79	69.17	49.38	0.62	Medium
	Interpreting data and evidence scientifically	15.83	66.25	50.42	0.60	Medium
$VIII_2$	Explaining phenomena scientifically	17.50	62.08	44.58	0.54	Medium
	Evaluating and designing scientific enquiry	19.38	67.08	47.71	0.59	Medium
	Interpreting data and evidence scientifically	15.83	66.04	50.21	0.60	Medium

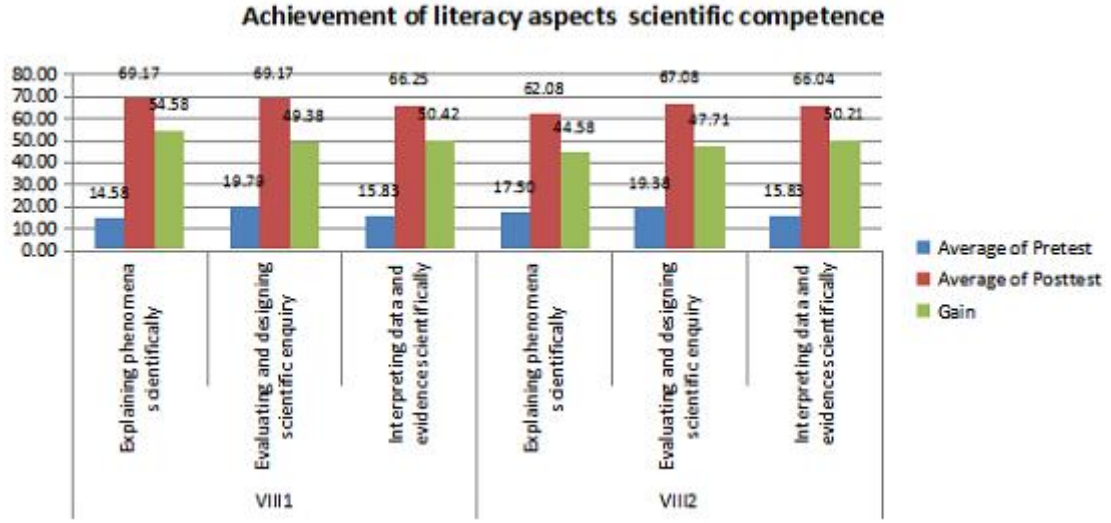

Figure 1. *The Average of achievement Science ScienceLiteracy aspect Science Competencies of $VIII_1$ and $VIII_2$Class.*

Kolmogorov-Smirnov normality of posttest data science literation of aspects scientific competence were presented in Table 5.

Table 5. *Literacy Normality Test Results Aspects of Science Competence.*

Class	Aspects of Science Competence	N	Kolmogorov-Smirnov Z	Asymp. Sig. (2-tailed)
$VIII_1$	Explaining phenomena scientifically	32	.641	.806
	Evaluating and designing scientific enquiry		.750	.703
	Interpreting data and evidence scientifically		.617	.807
VIII2	Explaining phenomena scientifically	32	.718	.680
	Evaluating and designing scientific enquiry		.719	.849
	Interpreting data and evidence scientifically		.760	.762

Significance of sig> 0.05 in class VIII1 and VIII2 showedthat the post-literacy scores of science competence were normally distributed. Increased scientific competency literacy by comparing pretest and posttest score data with Paired sample t-test with a significance level $\alpha = 0.05$ (2-tailed) was presented in Table 6.

Table 6 showed the values of sig. <0.05 for each aspect of scientific competence, meaning there was a significant increase in scientific competency literacy. Means the

modified inquiry learning model that is used is effective in increasing the literacy of science competencies of students of Class VIII Junior High School with fluid material. In learning with the inquiry model of teaching modification and interaction that gave more confidence, appreciation and encouragement to students' ability to look for problem solving. Modified learning models of inquiry arises the courage to try, express and study ideas or new ways that were the product of the creation of ability to science, the scientific process and the product of science itself.

Table 6. *Paired t-Test for Literacy Science of the Aspect Science Competency.*

Class	Aspects of Science Competence	T	Df	Asymp. Sig.(2-tailed)
$VIII_1$	Explaining phenomena scientifically	-39.947	31	.000
	Evaluating and designing scientific enquiry	-31.246	31	.000
	Interpreting data and evidence scientifically	-36.289	31	.000
VIII2	Explaining phenomena scientifically	-33.220	31	.000
	Evaluating and designing scientific enquiry	-39.870	31	.001
	Interpreting data and evidence scientifically	-32.118	31	.000

4. Conclusions and Suggestions

Student activities during learning were classified as very good at each learning implementation. In the observer notes, students actively engaged in activities that were relevant to learning while the activities that were not relevant were very small percentages at each meeting. Literacy competency test results on average aspects have an average normalized gain in the medium category, which showed that the mastery of scientific literacy was in the moderate category. The results of the statistical analysis showed that the value of sig. <0.05 for each aspect of scientific competence, meaning there was a significant increasing in scientific competency literacy. Means the modified inquiry learning model that was used was effective in increasing the literacy of science competencies of students of Class VIII Junior High School with fluid material. Thus the learning model with orientation syntax, problem definition, hypothesis submission, hypothesis testing, and evaluation (follow-up) used was feasible and effective to improve literacy in scientific competence.

The next researcher needs to train students brainstorming which is used to get ideas out of each group member that is conducted in a structured way. It needs preliminary training at a specific time, so that during the learning process students have no difficulty working on worksheets and conducting investigations. Student worksheets and textbooks used during learning are better distributed to students before learning so that students find it easier to understand worksheets. The solution chosen should be able to be effectively overcome the obstacles of students' intellectual abilities so it does not create new problems in the implementation modification of the learning model inquiry.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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