Scientific Literacy of Secondary School Students’ Related the Global Warming Subject

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Abstract. The purposes of this research to describe of scientific literacy of secondary school students related materials of global warming. This research used quantitative descriptive method. The sample research was seventh grade students of secondary school at Central Java, Indonesia. The research instrument used a scientific literacy test in the form of a description that includes four scientific literacy categories that are science as the body of knowledge, science as a way of investigating, science as a way of thinking, and interaction between science, environment, technology, and society. The results showed that the average scientific literacy of students in all categories was 43.39%. Scientific literacy of students in each category obtained a percentage of ≤54% with very less criteria for the science category as the body of knowledge, a way to investigate and a way of thinking. The category of interactions between science, environment, technology, and society is less criteria with average percentage 57.25%. This shows that the scientific literacy skills of SMP and MTs students are still low.

Keywords: scientific literacy, global warming

1. Introduction

The development of science and technology in the 21st century affects various joints of life including education, and is a fairly strategic field to be used as a vehicle for the development of quality human resources. Quality education directs the formation of values that students need to take life [1]. However, education in Indonesia is still less attention in learning, especially science education. If compared with other developing countries, the quality of education, especially science education in Indonesia is still relatively low [2]. According to [3], science knowledge only contains a set of facts that must be memorized still dominates the view of science education in Indonesia. Whereas in good science learning not only provides knowledge of a set of facts that must be memorized but also can give meaning to students. The meaning given to students in science learning can be obtained if students have good scientific literacy skills [4].

Science or science as one of the subjects at the secondary school level aims to prepare students to have scientific literacy skills and scientific attitudes [5]. Definition of scientific literacy as the ability to think scientifically to solve everyday problems related to science [6]. The National Research Council provides ideas where scientific literacy is considered to include an understanding of the concepts and processes of science that unite science as inquiry, physics, life sciences, earth and space science, science and technology, science in a personal and social perspective and history and nature of science [7]. Science literacy allows the use of scientific knowledge in decision-making related to everyday events and complex socio-scientific problems openly [8]. Scientific literacy is defined as a person's ability to distinguish scientific facts from a variety of information, recognize and analyze the use of scientific inquiry methods and the ability to organize, analyze, interpretation of quantitative data.
and scientific information [9]. Scientific literacy is intended for all students, regardless of whether later students become scientists or not [10]. Students who have scientific literacy can understand science concepts, communicate science both orally and in writing and are able to solve problems so that they have a high attitude and sensitivity to themselves and their environment in making decisions based on scientific considerations [11].

Through scientific literacy, students are able to use their scientific knowledge to deal with problems related to science issues. At present the world is aggressively proclaiming increasing global warming control programs. Global warming will make the earth hotter and plants difficult to grow, threatening the food crisis for humans. If it is not immediately anticipated, human life will be very difficult [12]. The other hand on the earth's layer there is a main component in the form of a gas component called the atmosphere, a solid component called the lithosphere and a component of water called a hydrosphere that has problems related to scientific issues. Therefore scientific literacy is very important for students to have on the subject of global warming and the earth's layers.

Scientific literacy are seen in the results of the PISA (Program for International Student Assessment) test which is a literacy study conducted by the Organization for Economic Co-Operation and Development (OECD) for 15-year-old students. Indonesia is one of the participants in the Program for International Student Assessment (PISA). Since participating in PISA in 2000, science education in Indonesia has undergone a tremendous transformation to create a foundation for capability and development. Between 2012 and 2015, science performance among 15-year-old students increased by 21 points [13]. This makes Indonesia's average score increase in 2015. Although Indonesia's science rankings increase, the scores achieved by Indonesia are still below the international average score. This shows that science literacy of students in Indonesia is still low.

Four categories of scientific literacy that are science as a body of knowledge, science as a way of thinking, science as a way of investigation, and the interaction between science, environment, technology, and society [14]. Environmental aspects in the interaction category were added by [15]. To measure literacy skills of students, especially in the field of science, can use evaluation tools based on scientific literacy [6]. That students' scientific literacy skills can also be measured using several PISA questions [16]. Measurement of scientific literacy is important to know the extent of students' literacy towards the concept of science. Measurement of scientific literacy according to [17] is also important to determine the extent to which students' understanding of science knowledge, understanding of various aspects of the science process and the ability to apply scientific knowledge and processes in real situations.

Given the importance of scientific literacy, based on this matter, it is necessary to measure scientific literacy to describe students’ scientific literacy, especially at the secondary school (SMP and MTs) level in the subject matter of global warming and the earth's layers.

2. Research Methodology

This research used descriptive quantitative method to describe the literacy skills of junior high school / MTs students in the material of global warming and the earth layer which was reviewed from four categories of scientific literacy. There are science as a body of knowledge, a way of thinking, a way of investigation, and interaction between science, environment, technology, and society. This research was conducted from secondary school A (at Brebes) and school B (at Batang). The research sample was 7 grade which was selected using simple random sampling technique. The instrument in this research is a science-based literacy question developed by the author with reference to the PISA questions in the form of descriptions of 25 items which has been declared valid and reliable and using PISA comparison questions as many as 7 questions.

The score of scientific literacy was obtained by finding the percentage of mastery of scientific literacy. The criteria of percentage of scientific literacy presented in Table 1.
Table 1. Criteria for Scientific Literacy.

| Percentage       | Criteria   |
|------------------|------------|
| 86% < P ≤ 100%   | Very good  |
| 75% < P ≤ 86%    | Good       |
| 60% < P ≤ 75%    | Enough     |
| 54% < P ≤ 60%    | Less       |
| P ≤ 54%          | Very Less  |

3. Result and Discussion

Students' scientific literacy were analyzed based on the test results obtained by students in answering questions about science-based literacy development and PISA questions in all scientific literacy categories and in each scientific literacy category. The average scientific literacy in all categories for developing scientific literacy and PISA questions are presented in Table 2 and Table 3.

Table 2. The Average Scientific Literacy.

| Categories of Scientific Literacy                           | School A (%) | School B (%) |
|-------------------------------------------------------------|--------------|--------------|
| Science as a body of knowledge                              | 41.36        | 41.36        |
| Science as a way of thinking                                | 39.92        | 41.18        |
| Science as a way of investigation                           | 38.16        | 42.17        |
| Interaction between science, environment, technology, and society | 57.25        | 51.36        |
| Average                                                     | 44.17        | 44.02        |

Table 3. The Average Scientific Literacy with PISA questions.

| Categories of Scientific Literacy                           | Score Average (%) |
|-------------------------------------------------------------|-------------------|
| Science as a way of thinking                                | 39.86             |
| Science as a way of investigation                           | 38.16             |
| Interaction between science, environment, technology, and society | 50.72             |
| Average                                                     | 42.91             |

In the PISA problem there is no scientific category as a body of knowledge because the original PISA that is in accordance with the material of global warming and the earth layer is still limited. The percentage of science literacy questions developed as well as PISA science literacy questions was obtained at an average of ≤54%. Based on the mastery criteria of scientific literacy including very less criteria. This shows that the average scientific literacy of each student in all scientific literacy categories is less because students are not accustomed to working on science-based questions.

The results of Angraini's research [8] also revealed that the low achievement outcomes of students were influenced by several factors including: (1) subject matter that had never been studied so students had difficulty in answering the questions given, (2) students were not used to working on the problem
use discourse, and (3) the teacher does not familiarize the learning process that supports students in developing scientific literacy.

3.1. Science as a Body of Knowledge
This category requires students to remember a knowledge or information in which there are facts, concepts, principles and laws, hypotheses and models. Students use their initial knowledge to process new information by connecting the new information with their initial knowledge [19]. Based on the results of the research presented in Table 2 and Table 3 the percentage of science categories as body of knowledge is < 54%. This shows that the students who have competence in the science category as a body of knowledge were very less. Low mastery in this category shows the ability of students still lacking in understanding concepts, principles and laws in integrated science subjects. Students who did not understand the basic concepts taught by the teacher and did not have facts, terminology and scientific concepts that sufficiently influenced the low mastery of scientific literacy in the science category as the body of knowledge [2].

3.2. Science as a Way of Investigation
This category requires students to answer questions through the use of charts, tables, and requires students to explain answers and involve students in experimenting or thinking activities. The National Research Council as cited by [2] states that scientific inquiry is a multidimensional activity which includes observation, finding problems, investigating sources, planning investigations, conducting experiments, collecting data, analyzing data and interpreting, submitting solutions, explaining and presenting the results of the investigation. The percentage obtained by the science category as a way to investigate the question of developing scientific literacy is 39.92% and in the PISA question is 39.86%. Table 3 shown at this category mastery of scientific literacy in the matter of developing scientific literacy obtained a percentage that is almost the same as mastery of scientific literacy in the PISA problem. Even though the percentage results obtained by the two questions are the same, the percentage of mastery of scientific literacy obtained in the question of developing scientific literacy and PISA questions shows low results. This is because students are not accustomed to facing scientific literacy-based questions that contain discourse and graphics or images that require the ability to observe them, besides that they are also influenced by a lack of emphasis on student activities because practicum or experimental learning is rarely done by students. Practicum carried out by students is only limited to conducting experiments and relating them to concepts without the preparation of reports.

The results of the research obtained are in line with the research of [21] which shows that on average the junior high school students studied do not yet have the ability to communicate the results of experiments. Based on the results of the research of [22], it was also shown that students' abilities in this category were still low because the instructors did not introduce and teach the material through experiments that stimulated higher-order thinking and were contextual. According to Leonard as quoted by [23], science lessons should emphasize student activities, reduce knowledge remembering, emphasize the ability of the process to get concepts, and spend most of the time in the laboratory or field work. One of the science learning activities that encourages students to be able to construct their own knowledge is by applying learning methods based on practical activities. Through practical activities carried out in integrated science learning, it will train students to be accustomed to being able to plan, implement, and evaluate their learning independently [24].

3.3. Science as a Way of Thinking
The percentage of mastery of student scientific literacy obtained in the matter of developing scientific literacy was 29.57% and in the PISA question was 38.16%. In this category, mastery of scientific literacy in the PISA problem is higher than the mastery of literacy in the matter of science-based literacy development, this is because there are more scientific literacy-based development questions than the PISA questions so that the possibility of more incorrect answers. Based on Table 3, compared with other categories, scientific literacy in the science category as a way of thinking has the lowest
percentage. This shows that there is still a lack of students' ability in inductive-deductive thinking and analyzing causal relationships so that in the science category as a way of thinking is at least mastered by students. In this category students' ability to analyzing causal relationships and causes of volcanic eruptions, tsunamis and earthquakes is still limited to aspects of the definition of knowledge. This is also revealed by [25] that students in general can only know concepts, principles, theories or scientific formulas but their understanding is limited to aspects of definition. In the study of [26], it was also stated that in general students had not been able to develop reasoned abilities, did not have the habit of reading while thinking and working in order to understand essential and strategic information in solving problems.

3.4. Interaction between Science, Environment Technology and Society.
The category of interaction between science, environment, technology and society, among others, illustrates the impact of science on society, the relationship between scientific literacy and the application of science and how technology helps humans and involves social problems and careers in science and technology. The percentage obtained in science literacy-based development questions is 57.25% and in the PISA question is 50.72%. At Table 3, mastery of scientific literacy in both the question of developing scientific literacy and PISA questions in this category occupies the highest diagram compared to other categories. Even so, the competency of interaction between science, environment, technology and society belongs to the less criteria. This is due to the lack of insight and knowledge of students, especially in the fields of science and technology. Science information obtained by students through technology also affects students' scientific literacy skills. According to [9] 40% of internet users are at U.S. reported that they obtained a lot of scientific information from the internet. [27] also stated that without good science knowledge, we would be weak technology users and not able to apply all existing technological sophistication.

Based on the results of the research of [28] the low understanding of students' concepts of science knowledge will have an impact on the low application of science in everyday life. Science that is understood and internalized by its role in peoples' live will be able to increase public awareness of environment. Therefore, learning science in schools needs to relate science with the technology and society environment [29]. One way that can be done to improve scientific literacy skills is by applying science literacy in learning. Sultan also revealed that Teachers need to apply scientific literacy in learning to prepare students for literacy [30].

4. Conclusion
Based on the results of the research that has been done, it was concluded that the average scientific literacy of students in all categories was 39.96%. Scientific literacy of students in each category for the science category as a body of knowledge, science as a way of investigating, and science as a way of thinking was obtained by a percentage of < 54% with criteria is very less. The interaction category between science, environment, technology, and society at 57.25% with less criteria. This shows the scientific literacy of secondary school students related to the subject matter of global warming and the earth layer is still low. Based on the results of the above research, the need to improve scientific literacy skills for all aspects of scientific literacy categories, both in the science category as a body of knowledge, science as a way of investigating, science as a way of thinking, and the interaction between science, environment, technology and society by developing devices learning that supports the implementation of scientific literacy at secondary school and the habitual practice of questions based on scientific literacy.

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