Junior high school students’ scientific literacy on earth science concept

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Abstract. This study aims to investigate junior high school students’ scientific literacy on earth science concept through scientific literacy test. The context of earth science in this research consists of layer of earth, earthquake, and volcano. The research instrument employed was 14 multiple choices with four alternative answers that covered 3 competencies of scientific literacy. The participants of this study were 29 students enrolled in grade 8 in a public junior high school in Bandung. The data were analyzed by using descriptive statistics in form of percentage and bar chart. The results show that the average score of each competency in respective way is: 67.59% for explaining phenomena scientifically, 58.62% for evaluating and designing scientific enquiry, and 61.64% for interpreting data and evidence scientifically. The findings could be interpreted that the scientific literacy on earth science concept of the 8th grade junior high school students was in medium category. This research suggests to develop scientific literacy ability with levels of inquiry as science practices.

1. Introduction

The rapid development of science and technology in the 21st century encourages people to raise the ability in knowledge and science skills. The term literacy was firstly introduced by Paul De Hart Hurd, a renowned science educator, in 1958 in his article entitled "Science Literacy: Its Meaning for American Schools". In his article, Hurd used the term literacy to explain the understanding of science and its application in social life [1]. Furthermore, many opinions arise regarding the definition of science literacy. Meanwhile, according to OECD [2], scientific literacy is the ability to use knowledge and scientific attitude, not only to understand the phenomenon or problem but also to be involved in solving the problem based on knowledge owned.

Recognizing the importance of scientific literacy for students, OECD (Organizational for Economic Cooperation and Development) countries organize an assessment called PISA. PISA (Program for International Student Assessment) is an International standard assessment to assess the knowledge and skills of 15 years old students in various countries in the world. It assesses some knowledge and skills such as reading literacy, math, science, and problem solving. Since 2000, Indonesia has been involved in international-scale learning assessments such as PISA. The result of PISA 2015 assessment shows Indonesia is still in the bottom rank when compared with the results of PISA in 2012, the rank increased. If in 2012 Indonesia is ranked 64 out of 65 countries of PISA participants, in 2015 Indonesia is ranked 62 out of 69 participating countries with an average score of 403 for science, 397 for reading, and 386 for mathematics [3,4]. Someone is said to have the ability of science literacy if he/she mastered the 3
competences that explain phenomena scientifically, evaluate and design scientific inquiry, and interpret data and evidence scientifically [2].

Indonesia is a country located on the ring of fire. In addition, Indonesia is at a meeting between three boundaries of tectonic plates, namely the Eurasian plate, the Pacific plate, and the Indo-Australia plate. This is what causes frequent disasters such as earthquakes and volcanic eruptions. Natural disasters that also become one of the contexts in PISA enter the branch of science that is the earth science. The students' literacy ability in the context of disasters covering the earth's layers, earthquakes and volcanoes, are very important to master. Hence, the purpose of this study is to identify the ability of science literacy of junior high school students, especially on the aspect of competence (explain phenomena scientifically, evaluate and design scientific inquiry, and interpret data and evidence scientifically) on earth science topics.

2. Method
Subjects in this study were 29 students of grade 8 of junior high school consisting of 15 boys and 14 girls who have been taught earth science concept. This study used 14 multiple choice questions based on the topic of grade 7 namely earth's layers of matter and disasters that include layers of earth, earthquakes, and volcanoes. In addition, the questions were also based on the PISA 2015 framework in the context of natural disasters that were be adapted to 3 aspects of competence (see Table 1). The instruments have been reviewed and judged by 4 lectures. Each student writes the absence number on the answer sheet provided. The time spent solving this science literacy test was around 25-30 minutes.

| Competencies                              | Indicators                                                                 |
|-------------------------------------------|-----------------------------------------------------------------------------|
| Explain phenomena scientifically           | Recall and apply appropriate scientific knowledge                           |
|                                           | Identify, use, and generate explanatory models and representations            |
|                                           | Make and justify appropriate predictions                                      |
|                                           | Explain the potential implications of scientific knowledge for society       |
| Evaluate and design scientific inquiry     | Propose the way of exploring a given question scientifically                 |
| Interpret data and evidence scientifically | Analyse and interpret data and draw appropriate conclusions                  |
|                                           | Transform data from one representation to another                            |
|                                           | Distinguish between arguments that are based on scientific evidence and theory and those based on other considerations |

For each correct answer is given a score 1 and for every empty or incorrect answer given score 0. After providing a score of each students’ answers, the next step is doing the categorization (see table 2) based on the percentage by using the formula below [5]. Descriptive statistics were conducted from students’ score and percentage to describe and analyze student’s scientific literacy ability.

\[ NP = \frac{\text{raw scores obtained by students}}{\text{the ideal maximum score}} \times 100\% \]
Table 2. Categorization of students’ scientific literacy score

| Percentage (%) | Predicate   |
|----------------|------------|
| 86 – 100       | Very high  |
| 76 – 85        | High       |
| 60 – 75        | Medium     |
| 55 – 59        | Low        |
| ≤ 54           | Very Low   |

3. Results and Discussion

3.1. Results

Descriptive analysis of students’ scientific literacy that was tested by 14 questions is presented on Table 3. The table indicates that the percentage of average score of students’ scientific literacy as whole is 63.55% which is in low-medium category.

Table 3. Data of student’s scientific literacy

| Parameter     | Score | Score   |
|---------------|-------|---------|
| Total student | 29    | 89.66   |
| Total score   | 258   |         |
| Average score | 8.89  |         |
| Precentage (%)| 63.55 |         |
| Category      | Medium|         |

Figure 1 shows the average percentage of students’ scientific literacy competencies in each question. The highest average of students’ answer is question number 13 while the lowest is question number 6. Question number 13 is related to earthquake effect with the competency in explaining phenomena scientifically. Question number 6 is related to evidence of plate tectonic movement with competency in interpreting data and evidence scientifically. More details of the data distribution for each competency is presented on figure 2.
From the figure 2, it can be seen that explaining phenomena scientifically competency is the highest competency compared to interpreting data and evidence scientifically and evaluate and design scientific inquiry. Figure 2 indicates that the average percentage of all indicator in each competency is in medium and low category. The sample of the question is presented on figure 3 below.

3.2. Discussion
Students’ science literacy, especially on earth science concept is very important so that students are able to answer the challenges of the 21st century, especially in the context of natural disasters, such as earthquake and volcano. The low-medium achievement of students’ scientific literacy can be caused by several factors such as Indonesian students who are poorly trained in solving problems with the same level as the PISA problem. The questions tested in the national examinations are still at levels 1 and 2 (when compared with the PISA questions) which tend to be memorizing or understanding basic concepts. Therefore, in the PISA test, Indonesian students are not able to solve the problems at level 5 and 6 which is a matter of high difficulty [4,6].
The ability of students’ scientific literacy especially in the competency aspect can be trained through teaching and learning activity such as through science-based learning process [7]. There are many learning models that can be used by teachers, one of them is levels of inquiry. Some experts have divided inquiry into several levels. Among them are Wenning, who divided inquiry into 6 stages namely discovery learning, interactive demonstration, inquiry lesson, lab inquiry, real-word application, and hypothetical inquiry [8].

For junior high school students, the levels of inquiry can be practiced from discovery learning through inquiry lesson. In the levels of inquiry practices, students’ scientific process skills can be trained. Students are directly involved through experiences presented and guided by questions so that students can have meaningful perceptions [9]. Thus, it is expected that students’ scientific literacy, especially on the aspect of competence can increase.

4. Conclusion
The ability of students’ scientific literacy especially on three aspects of competency such as explaining phenomena scientifically, evaluating and designing scientific inquiry, and interpreting data and evidence scientifically is still relatively in low-medium category. These aspects of competency can be trained through learning which involved the science practices, such as levels of inquiry. Through levels of inquiry, it is expected that students’ science process skills can be trained so that the competency aspect of scientific literacy can increase.

Acknowledgments
This study was financially supported by Lembaga Pengelola Dana Pendidikan (LPDP), Kementerian Keuangan. The author would like to express the gratitude to postgraduate programs in Universitas Pendidikan Indonesia, especially the science education program of postgraduate program. My gratitude goes to Prof. Bayong Tjasyono HK, M.Si., Dr. Taufik Ramlan R, M.Si., Dr. Parsaoran Siahaan, M.Pd., Dr. Endi Suhendi, M.St, who have reviewed and considered the research instrument and also all people who have helped me that I cannot mention their name here.

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