Science and mathematics literacy of elementary school students related to water cycle

A Sujana¹,²,⁴, D Rachmatin² and R L Panjaitan³

1 Primary School Teacher Education Program, Universitas Pendidikan Indonesia, Jalan Mayor Abdurrahman 211, Sumedang 45322, Indonesia
2 Department of Mathematics Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia.
3 Primary School Teacher Education Program, Universitas Pendidikan Indonesia, Jalan Mayor Abdurrahman 211, Sumedang 45322, Indonesia

*atepsujana@upi.edu

Abstract. Primary school students are the main foundation for the next level, so they must have strong scientific literacy and mathematical literacy. This study aims to describe the scientific and mathematical literacy of grade 5 elementary school students related to the water cycle. In this study descriptive method was used. Measurements were made of 43 elementary school students in the fifth grade in urban areas and they had studied water cycle material. The instruments used were in the form of scientific and mathematical literacy test questions in the form of descriptions. Data processing of research results was carried out using simple statistics, and the results showed that scientific and mathematical literacy of grade V elementary school students related to the water cycle was still low. Information on the results of this study is expected to be used as a reference for elementary school teachers so that the learning done is more meaningful.

1. Introduction

Elementary school students (SD) are the main foundation for continuing education at a higher level. One of the lessons given to elementary students is science and mathematics. Science and mathematics are very important lessons, so they are given to elementary students (SD), high school (SMP), junior high (SMA) and high school (PT). This is because almost all aspects of human life are closely related to these two lessons. Thus, organizing and allocating time for school science reflects the importance of science for everyday life and working world [1].

For each individual, science and mathematics play a role in analyzing the problems faced to find alternative solutions to the most appropriate problems by not harming anyone. As for citizens, the role of science and mathematics is used in many contexts, both personally, socially and globally. Therefore, everyone, especially elementary students must have strong scientific and mathematical literacy, as a provision to continue their education at the next level and to solve problems in life.

Literacy is very important for every individual to adapt to the environment in which he is located. Many studies have been done before in measuring the increase in scientific and mathematical literacy, but they did so separately. Therefore, we want to know how science and mathematics literacy of elementary students in one learning related to the water cycle [2].
Science literacy is characterized by a person's ability to acquire scientific knowledge and apply it in overcoming individual and social problems [3]. Meanwhile, mathematical literacy is the overall skills, knowledge, beliefs, dispositions, thinking habits, communication skills, and problem solving skills in life and the world of work [4]. Mathematical literacy is not limited to the ability to apply quantitative aspects in mathematics, but also involves mathematical knowledge in a broad sense [5]. The aspects of scientific and mathematical literacy consist of context, knowledge, attitudes and competencies [2].

Science and mathematics literacy can be obtained from the family environment, community environment, and school environment. However, the school environment has a very large role in improving one's literacy. Efforts to improve the literacy of science and mathematics in particular in elementary schools are strongly influenced by the ability of teachers to carry out learning. Although the national curriculum suggests that learning must be student-centered, it still requires the role of the teacher. Thus, the role of teachers is very important in promoting scientific and mathematical literacy both at school and in the community [6]. Learning science and mathematics by teachers at school can help students develop various skills needed such as problem solving skills and critical thinking skills in everyday life [7]. Therefore, the literacy of science and mathematics teachers must also be high, in order to instill scientific literacy in their students.

2. Method
This descriptive study aims to describe the scientific and mathematical literacy of fifth grade elementary school students regarding the water cycle. The water cycle is chosen because the material is contextual. This research was conducted for four months, starting from May to August 2018. This study involved 43 elementary students from schools located in Sumedang district, West Java, Indonesia. The instrument used in the form of scientific and mathematical literacy test questions in the form of descriptions and interviews with the intention to strengthen the answers to students written tests. The answers from each student were then processed to conclude the extent to which students scientific and mathematical literacy are related to the water cycle.

3. Result and discussion
3.1. Elementary student science literacy
The water cycle is one of the science materials given to elementary school students in grade 5. The water cycle is contextual material, because it is very closely related to everyday life. The water cycle describes the movement of water from one form to another due to changes in temperature. The water that was originally in liquid form will turn into steam due to the sunlight that warms the sea, river lakes and other surface water. The steam will rise into the atmosphere and will eventually turn into a solid. The dense water will then fall back to the earth in the form of rain.

Thus this process occurs continuously without stopping. With the existence of a water cycle, the water in nature will always be there, even though the amount is not the same depending on the season. In Indonesia, which has two seasons, the presence of surface water in the rainy season is very much compared to the dry season. The major components of the water cycle are: Precipitation, Evaporation, Transpiration, Evapotranspiration, Surface Runoff, Condensation, Infiltration, Groundwater base flow, Sublimation, and Interception [8]. The process of water cycle occurs as shown in figure 1.
Figure 1. Water cycle process [9].

Water sources in the water cycle which are generally known by elementary students come from surface water such as from the sea, lake ponds and so on. Even though the water cycle that occurs does not only come from these sources. Many phenomena in everyday life are actually categorized into the water cycle, such as when drying clothes after washing. Generally, teachers in explaining the water cycle in schools are less related to daily life, so student’s scientific literacy is low. From the example of drying clothes, students can mostly explain the meaning of the water cycle, but they have difficulty in explaining the process of the water cycle that occurs until the water can get to their homes for their daily needs. Examples of student answers related to this as in figure 2.

Figure 2. Examples of student answers regarding the arrival of water to the home related to the water cycle.

Most students are also unable to explain the process of the water cycle from drying clothes. In addition, many also cannot explain how the impact of tree felling activities and replanting trees in the forest in relation to the water cycle. Complete results of elementary students of scientific literacy assessments related to the water cycle are listed in table 1.
Table 1. Student literacy related to the water cycle.

| No. | Questions                                                                 | Number of students |
|-----|---------------------------------------------------------------------------|--------------------|
|     |                                                                           | Able to explain    | Unable to explain |
| 1   | Explain the meaning of the water cycle                                    | 40                 | 3                 |
|     | Explain the occurrence of the water cycle in the drying process of clothes | 18                 | 25                |
| 2   | Explain the process of the water cycle until the water can get home       | 15                 | 28                |
| 3   | Describes the cycle of water until the water can get home                 | 15                 | 28                |
| 4   | Explain the influence of human activities in cutting and planting trees   | 20                 | 23                |
| 5   | and planting trees related to the water cycle                             |                    |                   |

The low level of students scientific literacy related to the water cycle is allegedly due to the low scientific literacy of their teachers. The results showed that the literacy of teachers and prospective elementary school teachers related to the theme of water had not been as expected [10]. The same thing also happens to the air theme, where the literacy is still low [11]. In addition to these factors, the low level of scientific literacy of elementary school students is also due to the teacher's lack of accuracy in carrying out learning. Learning is less related to students' daily lives even though many phenomena in life can be used as material in explaining the material to students. Learning that relates to the context of student life is very important because students build knowledge based on scientific phenomena in a social context [12].

Students are also less accustomed to doing scientific investigations such as observing, measuring, predicting, asking questions, etc., so that they experience difficulties when asked to describe events in daily life scientifically. Whereas the activities of observing, predicting, concluding, and asking questions are central to investigative activities [13].

Therefore the teacher should conduct learning that can develop these skills through innovative learning such as through problem-based learning, project-based, inquiry, integrated and so on. The reluctance of teachers to use innovative learning models in class is actually not only the inability of teachers to use the model, but it takes more time to implement it. In addition, curriculum demands that emphasize student’s ability to master concepts in science rather than scientific skills are one reason for the lack of use of innovative learning models.

3.2. Elementary student mathematics literacy

Just like scientific literacy, math literacy is also very important for everyone. Mathematical literacy is part of mathematics and the foundation for the development of science and technology, and is a benchmark for the progress of development in a place [14]. Mathematical literacy is not limited to the ability to apply quantitative aspects of mathematics but involves mathematical knowledge in a broad sense, such as a roadmap, understanding planning in creating a new home, etc. [5]. The structure of mathematical literacy is shown in Figure 3.
Figure 3. Tree structure mathematical literacy [5].

In the case of drying clothes, most students can determine the length of time needed to dry clothes quickly. However, most students cannot explain how efforts should be made so that the costs incurred for drying clothes are not large.

Figure 4. Examples of student mathematical answers related to the water cycle.

Mathematical literacy of elementary school students who have not met expectations is influenced by several factors, one of which is caused by students’ ability to read texts. This is because the mathematical nature of the problem may not be clear to the reader, the reader must have the skills in describing the text so that the information needed to solve the problem or answer questions can be collected [15]. Mathematical literacy of students who have not met expectations shows the need for teachers to develop more appropriate learning.

Even though nowadays, the knowledge gained by students does not always have to come from the teacher, but almost completely depends on the teacher's experience in teaching in class. In order for mathematics learning in elementary school to be more able to improve student literacy, the teacher must pay attention to several factors, including (1) having to understand the mathematical concepts taught, (2) must understand the characteristics of elementary students, and (3) can choose the right learning strategies and the mathematics assignment must be adjusted to the characteristics of elementary students [16].

4. Conclusion
Mathematical literacy of science and literacy of elementary students is very important in solving problems faced. Therefore it is very important for elementary school teachers to develop the literacy for their students. This is because building young generation's literacy that begins with elementary students
is an important step to ensure that future generations are ready to be involved in solving problems in all aspects of life [17]. Although scientific and mathematical literacy is very important, but the scientific and mathematical literacy of elementary students in some schools in Sumedang is not yet in line with expectations. This condition must be a concern, because if left unchecked it will have an impact on other aspects of life. The various causes of the lack of conformity of science and mathematics literacy of elementary school students are influenced by several factors, including the learning material provided is less related to daily life, students are not used to conducting scientific investigations, and less appropriate learning methods implemented by teachers in schools.

References
[1] Sothayapetch P, Lavonen J and Juuti K 2013 A Comparative Analysis of PISA Scientific Literacy Framework in Finnish and Thai Science Curricula *Science Education International* **24** 1 pp 78–97
[2] PISA 2009 *Assessment Framework Key competencies in reading, mathematics and science* (OECD. www.pisa.oecd.org)
[3] Nbina J B 2013 The Relative Effectiveness of Guided Discovery and Demonstration Teaching Methods on Achievement of Chemistry Students of Different levels of Scientific Literacy *Journal of Research in Education and Society* **4** 1 pp 1-8
[4] International Life Skills Survey 2000 *International Life Skills Survey* (Canada: Statistics Canada, Policy Research Initiative)
[5] De Lange J 2006 Mathematical literacy for living from OECD-PISA perspective *Tsukuba Journal of Educational Study in Mathematics* **25** pp 13–35
[6] Eshach H 2006 Science Literacy in Primary Schools and Pre-Schools *Moment Eurasia J. Math. Sci. & Tech. Ed* **3** 2 pp 167–169
[7] Candrasekaran C 2014 Productive Methods of Teaching Middle School Science *International Journal of Humanities and Social Science Invention* **3** 7 pp 15-25
[8] Balasubramanian A and Nagaraju D 2017 *The Hydrologic Cycle – Wellowner.org*. Retrieved from http://wellowner.org/groundwater/the-hydrologic-cycle/
[9] Trenberth K E 2014 *Water Cycles and Climate Change BT-Global Environmental Change* pp 31–37 https://doi.org/10.1007/978-94-007-5784-4_30
[10] Sujana A, Permanasari A, Sopandi W and Mudzakir A 2014 Literasi Kimia Mahasiswa PGSD dan Guru IPA Sekolah Dasar *Jurnal Pendidikan IPA Indonesia* **3** 1 pp 99-107
[11] Sujana A 2014 *Literasi Kimia Mahasiswa PGSD dan Guru IPA Sekolah Dasar Pada Tema Udara Mimbar Sekolah Dasar* **1** 1 pp 631–658
[12] Ginns I S and Watters J J 1999 Beginning elementary school teachers and the effective teaching of science *Journal of Science Teacher Education* **10** 4 pp 287-313
[13] Cervetti G N, Barber J, Dorph R, Pearson P D and Goldschmidt P G 2012 The Impact of an Integrated Approach to Science and Literacy in Elementary School Classrooms *Journal of Research in Science Teaching* **49** 5 pp 631–658
[14] Adeyemi and Adaramola 2014 Mathematics Literacy as a Foundation for Technological Development in Nigeria *IOSR Journal of Research & Method in Education (IOSRJRME)* **4** 5 pp 28–31
[15] Mullen J 2009 Enhancing Mathematical Literacy *Mathematical and Computing Sciences Masters* Fisher Digital Publications
[16] Firdaus, Wahyuudin and Herman 2017 Improving primary students mathematical literacy through problem based learning and direct instruction *Educational Research and Reviews* **12** 4 pp 212–219
[17] Stevenson K T, Carrier S J and Peterson M N 2014 Evaluating strategies for inclusion of environmental literacy in the elementary school classroom *Electronic Journal of Science Education* **18** 8 pp 1-17