Profile of senior high school students’ scientific literacy in Banda Aceh

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Abstract. This study aims to find out the profile scientific literacy ability of senior high school student in Banda Aceh. The scientific ability consists of competence to explain the phenomena scientifically; to evaluate and design scientific enquiry; as well as to interpret data and evidence scientifically. Data was collected by giving 9 questions which adapted from PISA (Program for International Student Assessment) 2015 consisting of content and procedural knowledge that examined on 11th-grade students at one of the schools in Banda Aceh. Based on the result, senior high school students have the less scientific literacy ability in the amount of 47.06%. Furthermore, it is necessary to do further study on the learning that gave rise to the scientific literacy of high school students so that information can be obtained to what extent the ability of teachers in generating scientific literacy on teaching.

1. Introduction
The 21st-century is the era of information and technology. The rapid advancement of communication technology and affordable transportation has triggered globalization and created global economies and communities, even global cultures [1-3]. Most educators, policy makers, and researchers with even a passing interest in science education would agree that a central goal of teaching science is to prepare young people to deal with science-related issues they are likely to encounter in their lives as citizens. Education is an important investment in producing human resources. A good education is one means to produce quality human resources. Quality human resources are an important factor in development in the era of globalization that prioritizes science and technology [4]. The 2013 curriculum will not solve the problems of quality and quantity of Indonesia's global competitive resources, if not systematically prepare them to develop the knowledge, skills and attitudes required by the 21st-century workplace. The role of learning in the mastery of 21st-century skills is to prepare future students who are critical, creative, competitive, able to solve problems and dare to make decisions appropriately so as to survive and grow productively in the midst of challenging global competition [5, 6].

In order to adapt to the rapid development of science and technology in this global era, somebody must have scientific literacy. Scientific literacy is the ability to understand the scientific and factual information that exists in the environment, health, economics, and problems faced by modern societies that rely heavily on technology and the advancement and development of science [7-10]. The competence domain of scientific literacy requires students have the competence to explain the phenomena scientifically; evaluate and design scientific enquiry; as well as interpret data and evidence scientifically. Such content domains include content knowledge; procedural; and epistemic [9]. Thus,
students who are educated in science will be able to use their knowledge in applying science processes to solve problems, make decisions, and understand those related to society and the environment. Increased scientific literacy depends on the development of collective interaction skills, personal development and suitable communication approaches as well as the need to exhibit sound and persuasive reasoning in putting forward socio-scientific arguments [11]. The ability of scientific literacy is very useful for students because it can apply their knowledge and the process of science they must engage in real situations with problems related to science, as well as with the idea of knowledge that makes citizens become responsive [4].

Currently, the quality of Indonesian students in terms of literacy ability of science is very low [3]. A study conducted by the Organization for Economic Co-operation and Development (OECD) in the 2000-2015 Student for International Student Assessment (PISA) program for students shows that the expectations of government regulation of education and culture as well as the Curriculum 2013 are still not fulfilled. Based on the results of the 2015 PISA study, Indonesia ranked 69 out of 76 countries with a score of 403 [12]. The scientific literacy measured by PISA is only for 15-year-olds or for junior high school students [9]. Another thing that has not been revealed is how the scientific literacy of students with age above 15-year-olds or senior high school students. Therefore, this research will be presented how the scientific literacy profile of senior high school students from each competence of scientific literacy by using questions of PISA 2015.

2. Method
This study aims to determine the profile of scientific literacy ability of senior high school students using qualitative methods. Qualitative research aims to investigate the quality of relationships, activities, situations, or materials and understand the phenomena of what is experienced by research subjects such as behavior, perception, actions, etc. holistically and by describing in the form of words and language [13]. Subjects in this study were students of 11th grade in one of senior high school in Banda Aceh in the even semester of the academic year 2017/2018. The instrument used is adapted by PISA 2015 as many as 9 items. These questions including content knowledge and procedural knowledge were given to the students of 11th-grade in one of the senior high school in Banda Aceh, which amounted to 34 students.

3. Results and discussion
The scientific literacy instrument used adapted from PISA 2015 consists of 9 items consisting of 4 questions for content knowledge and 5 questions for procedural knowledge. Content knowledge refers to the concepts needed to understand natural phenomena and changes made to nature through human activity. PISA 2015 defines the criteria for selecting content knowledge among others has relevance to real-life situations; represents an important scientific concept or major explanatory theory that has enduring utility; and appropriate for the developmental level of 15-year-olds [9]. Based on these criteria, the content knowledge has selected the knowledge needed to understand and interpret experience in the personal, social, and global context covers the fields of study of biology, physics, chemistry, and earth and space science. Procedural knowledge refers to the mental processes involved when answering a question or solving a problem such as identifying and interpreting evidence and explaining conclusions. It also includes the types of questions that science can and cannot answer, recognize what evidence is required in a scientific investigation, and recognize conclusions according to the available evidence. The scientific literacy result test of senior high school students can be seen in Table 1.

As explained earlier that the selection criteria of knowledge correspond to the developmental level of a 15-year-olds students [9]. According to the child development theory proposed by Piaget [14] that senior high school students of 11th-grade have entered into the formal operational phase (≥ 11 years). In this phase, the child’s way of thinking moves from concrete thinking to abstract thinking and hypotheses. That is, children are able to think rationally and solve problems scientifically, especially the process of thinking is done systematically that begins from the problem, understanding of the problem, proposed a hypothesis against problem-solving, collect and verify data and draw conclusions. However, the results in Table 1 show that senior high school students' scientific literacy ability using questions from PISA
2015 still include less with an average of 47.06%. The highest percentage of scientific literacy of senior high school students from the highest is the content knowledge and procedural knowledge. The results showed that the scientific literacy ability of senior high school students to the content knowledge is only 57.35%, while the procedural knowledge is equal to 41.91%.

**Table 1.** The scientific literacy result test of senior high school students in Banda Aceh.

| Knowledge       | Competence Domain                        | Question Number | Percentage (%) | Average (%) |
|-----------------|------------------------------------------|-----------------|----------------|-------------|
| Content         | Explain the phenomena scientifically      | 1; 4; 5; 6      | 57.35          | 57.35       |
| Procedural      | Evaluate and design scientific enquiry    | 2               | 41.18          | 41.91       |
|                 | Interpret data and evidence scientifically| 3; 7; 8; 9      | 42.65          |             |
|                 | Average (%)                              |                 | 47.06          |             |

The low ability of students’ science literacy is caused by the process of science learning in the classroom which is still only the transfer of knowledge from the teacher to the students which is done verbally so that less emphasis on the science process [15]. As a result, students are more likely to use memorization as a way to master knowledge than the ability to think or solve problems. In addition, science lessons at the school include more limited judgment with science content, while targets in PISA are more likely to apply scientific thinking in daily life and measure the ability to use scientific principles in a non-academic context [16]. Although science learning in schools emphasizes the mastery of content knowledge, the reality is that the mastery of students' concepts of science is still low. The demand for the completion of the subject matter by teachers according to the curriculum target forces students to accept the concepts of science that may not be fully understood. Therefore, many science concepts are misconceptions or simply memorized which in the end the concept is easily forgotten [16].

Table 1 also shows that science literacy skills of senior high school students when viewed from each competency domain percentage is still less once. The competency domain of senior high school students' scientific literacy in a row from the highest is to explain the phenomena scientifically (57.35%); interpreting data and evidence scientifically (42.65%); as well as evaluating and designing scientific enquiry (41.18%). In the domain of competence to explain the phenomena scientifically, students are shown with scientific phenomena that are often encountered students in everyday life. This provides an opportunity for students to understand the concept more easily so that students can explain observed scientific phenomena. As previously mentioned, internationally the students' science literacy score in PISA is 403 [12]. Students who are only able to achieve a score of about 403, are usually only able to remember simple fact-based science concepts, such as naming a scientific fact, knowing a scientific term, knowing simple formulas, and using it to evaluate or draw conclusions [10]. In addition, students in Indonesia are accustomed to working on low-level questions. This is supported by PISA analysis which revealed that 42.3% of Indonesian students are able to answer the level 1 questions while for level 5 and 6 only by 0.8% [12].

In the domain of competence to interpret data and evidence scientifically, students are required to analyze, interpret data, and also make a conclusion of the given case. The results showed that in this competency percentage is still very less but higher than the competence to evaluate and design scientific
information. In the competence of evaluating and designing scientific information, students are required to determine independent and dependent variables based on experiments conducted by the researcher. Both of these competencies require procedural knowledge. As explained earlier that the science learning process still has not emphasized the process of science [16]. Lack of experimenting with the concept of science will lead to less optimal acting mindset abilities (generic science competence) [17].

4. Conclusions
It can be concluded that the scientific literacy ability of senior high school students in Banda Aceh belongs to still less. The low ability of high school scientific literacy is caused by the learning process that has not emphasized the process of science and many misconceptions of science concepts or just memorized which in the end the concept is easily forgotten. Thus the need to do a deeper study of learning that led to the science literacy of high school students so that information can obtain the extent to which the ability of teachers in generating scientific literacy on teaching.

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