Scientific literacy competency of senior high school students based on question formats

N S Putra¹ and Agusnita²

¹ Jurusan Pendidikan IPA, Sekolah Pasca Sarjana Universitas Pendidikan Indonesia, Bandung, Indonesia
² Departemen Pendidikan Biologi, Universitas Negeri Padang, Air Tawar Barat, Padang, Indonesia

E-mail: nandamursamad@upi.edu

Abstract. One of success indicators on educational process is the achievement of students in scientific literacy competency. We can identify the profile of students’ scientific literacy by giving them a test using scientific questions. The purpose of this research is to reveal student scientific literacy competency based on question formats in biology topics. The research took place at SMAN 10 Padang. The sample of this research were 44 grade X students. Sample collection method used was simple random sampling. The questions were taken from The Programme for International Student Assessment (PISA)’s E-Book (Take the Test: Sample Question From OECD’s PISA Assessment). PISA questions consist of three question formats including 48 objective questions, 5 compound questions, and 10 essay questions. We found that student scientific literacy scores from objective, compound, and essay questions formats are 50.66%, 35.91%, and 42.72% respectively. The average of student scientific literacy competency score based on question formats is 43.9%. The average score category is very low. In testing the students’ scientific literacy competency based on question formats, it was revealed that students are easier to answer objective questions than other question formats.

1. Introduction
Science is the knowledge of objects and natural phenomena that is obtained from the results of thinking and research by scientists through experiments [1]. Natural Science examines the symptoms of the universe so that concepts and principles are formed [2]. Meanwhile, according to Amien [3], a knowledge must be included under the name of science if the knowledge is found through scientific methods. According to Trianto[4], the truth of science is proven through scientific methods, with characteristics: objective, methodical, systematic, universal, and tentative.

At this time, science learning, especially biology, tends to orate in products by memorizing concepts, theories, and laws, as well as the lack of active role of students in learning. So the situation is one of the factors that make students' scientific literacy skills low. As said by Armalinda [5] that in fact, teachers do not use different methods in science learning, especially biology, namely only lecture and question-answer methods. Meanwhile, science teachers usually use the lecture method that causes boredom for students [6].

In general, the purpose of education is to develop the mindset of students for having the best life. To achieve this goal, the learning process is carried out so that students can adapt to real life and be able to solve every problem of life. In education, the ability in science is a must for students. Each individual is
very required to understand science knowledge so that the knowledge can be applied in daily life as well as at work [7].

People who have good scientific literacy competency can use the concepts of science, theory, law, and science principles in their relationship with the environment appropriately. According to Rizkita [8], scientific literacy is a person's ability to distinguish science facts from various information and the ability to organize, interpret quantitative data and scientific information. Scientific literacy is needed because of the importance of thinking ability to understand the environment, health, economy, modern social, and technology [9]

Talking about science literacy means talking about science education for human life [10]. Akgul [11] stated that scientific literacy trains humans in solving problems in their life. Then, scientific literacy demands manifestations of skill and knowledge in every side of human life both in school, the environment, politics, economics, and social [12]. Holbrook and Rannikmae [13] stated that the emphasis on the meaning of scientific literacy is using the components of scientific literacy to recognize the symptoms that occur to have the right ability and attitude to live in society.

The level of scientific literacy in Indonesia is still low. This is evidenced by the OECD report through PISA in 2015 that Indonesia is in the position of 62 out of 70 countries [14]. While in the OECD report through PISA in 2012, Indonesia was 64th out of 65 countries [15]. Before that, in the OECD report through PISA in 2009 Indonesia was in the position of 60 out of 65 countries [16]. And in a 2007 OECD report, Indonesia ranked 50th out of 57 countries [17]. Indonesia averages were always 10 lowest countries for ability in scientific literacy.

Many factors that lead to low scientific literacy skills of students, such as science learning in Indonesia schools including its assessment are more focused on science materials/content, while PISA targets are more on the application of scientific way of thinking in daily life. Based on the observations of researcher at SMAN 10 Padang by interviewing biology teachers, information was obtained that PISA questions are not even known by some teachers. This was then supported by the teacher's statement after researcher demonstrated scientific literacy to biology teachers. The response received from teachers is that the questions of scientific literacy are different than the general questions because the questions are more applicable and students are required to solve problems in reading so that it is more demanding to develop the student's way of thinking.

Based on the problem, the research question is “How is the achievement of students scientific literacy based on the format of questions”. The questions tested in this study are as many as 63 questions consisting of objective questions, compound questions and essay questions taken from (E-Book) Take the Test: Sample Question From OECD’s PISA Assessment. Analysis based on the question formats aim to know the students’ ability to answer questions

2. Methodology

The purpose of this study is to know the tendencies and skills of students in answering scientific literacy questions in 3 formats of questions namely objective questions, compound questions, and essay questions. Therefore, data is collected by using the E-Book Take the Test: Sample Question From OECD's PISA Assessment which has been translated. This type of research is descriptive research. In this study, researcher analyzed scientific literacy on the biology matter of grade X students of SMAN 10 Padang City. The sample was selected with a simple random sampling technique. Lufri dan Ardi [18] stated that this technique is used when the selection of samples inhomogeneous populations with random attention so that each member of the population gets the same opportunity to be sampled.

The selection of samples is done by lottery. The total number of X graders is 298 students. The sample, which is 15% of the 298 students, was 44 students. Arikunto [19] stated that if the study subject is less than 100, it is taken all so that the research is a population study, but if the number of subjects is large, it can be taken between 15-20% or 20-25% or more. The data in this study is primary data, which is obtained directly from the subjects of studies. Research data is quantitative data that is the test results of students obtained using PISA questions. The instrument used is a standard PISA question published on the internet in the e-book format Take the Test: Sample Question From OECD’s PISA Assessment
which has been translated and then validated by experts. The questions tested in this study were 63 questions consisting of 45 objective questions, 5 compound questions, and 10 essay questions.

The data obtained from the tests that had been scored was converged to the specified criteria.

\[ NP = \frac{R}{SM} \times 100\% \]  

where

NP : Value (%) of scientific literacy test  
R : Score obtained by student  
SM : Maximum Score of all answer

Next, the value is converted into categories as shown in table 1:

| Value       | Category    |
|-------------|-------------|
| 86% - 100%  | Very high   |
| 76% - 85%   | High        |
| 60% - 75%   | Enough      |
| 55% - 59%   | Low         |
| \( \leq 54\% \) | Very Low   |

3. Result and Discussion

Based on the results of the study in SMAN 10 Padang, it has been reported that the average of the scientific literacy ability of students in general 47.48%. Then, obtained data on student scientific literacy test based on question formats can be viewed in table 2.

| Number | Question Formats | Value (%) | Category |
|--------|-----------------|-----------|----------|
| 1      | Objective       | 50.66     | Very Low |
| 2      | Compound        | 35.91     | Very Low |
| 3      | Essay           | 42.72     | Very Low |

By viewing the values of objective, compound, and essay question formats, successive data are obtained as follows: 50.66 (very low), 35.91 (very low), and 42.72 (very low). Measuring the achievement of student scientific literacy based on the question format aims to know the student's habits in answering questions.

Although the literacy results of the students based on the format of the question are all categorized very low, from data above it has been written that compound and essay questions are the most difficult questions. The reason for the low average score in both formats is that students have difficulty in reasoning because the question requires high analysis. For the essay question, students are required to fully understand the discourse-given and then be able to connect it with the daily reality of students. Therefore, students must have high analytical skills and extensive knowledge to answer the question. So many questions were skipped by students. One of the factors of a low level of students scientific literacy is that our students are not used to dealing with questions that contain graphs and long discourse [21]. In other words, the weakness of students in analyzing discourse or text is an image of the student's ability to think.

Then, the ability of students to answer questions in an objective format is higher and exceeds 50%. In this format, students are more accustomed to answering because school exams are more likely to be in this format. However, scores that are still not high caused objective questions are also required to be more thorough in working on the question. In the objective questions, the option is almost similar so that makes students often mistaken in answering. Then, students are also freer in answering because if
they do not know the answer, students can guess the answer. Sudjana [22] stated that objective tests also have weaknesses that allow students to guess answers so that they cannot see the reality of the student’s actual thinking abilities.

4. Conclusion
Student scientific literacy competency based on the question formats found that students' tendencies are easier to answer objective questions. In this format, students are more accustomed to answering because school exams are more likely to be in this format. However, the lucky factor also affects the high score of students in the objective format because the students can guess the answer. These results show that students' analytical ability to answer scientific literacy questions is still low and below average. So, teachers should implement creative learning processes that can improve students' analytical abilities. And then, teachers should also familiarize students with analytical questions that train students' analytical skills.

5. References
[1] Poedjiadi A 1987 Sejarah dan Filsafat Sains (Bandung : Depdikbud Proyek Pengembangan Lembaga Pendidikan Tenaga Kependidikan-IKIP)
[2] Jasin M 2012 Ilmu Alamiah Dasar (Jakarta : Rajawali Pers)
[3] Amien M 1987 Mengajarkan Ilmu Pengetahuan Alam(IPA) dengan Menggunakan Metode Discovery dan Inquiry Bagian I (Jakarta : Depdikbud Direktorat Jenderal Pendidikan Tinggi Proyek Pengembangan Lembaga Pendidikan Tenaga Kependidikan)
[4] Trianto 2011 Model Pembelajaran Terpadu (Jakarta : PT Bumi Aksara)
[5] Armalinda S 2013 Analisis Kesulitan Belajar Biologi Siswa Kelas X Negeri 2 Lubuk Basung Kabupaten Agam (Padang : Universitas Negeri Padang)
[6] Laindjong S N, Alibasyah L M P and Paudi I 2014 Meningkatkan Hasil Belajar Siswa Pada Pembelajaran Dengan Menggunakan Media Gambar di Kelas V SDN 05 Biau J. Kreatif Tadulako Online 5 51–62
[7] Ayuningtyas 2016 Profil Kompetensi Literasi Sains Siswa Berdasarkan The Programme For International Student Assesment (PISA) pada Konten Biologi (Kuasi Deskriptif Siswa Kelas IX SMP se-Kecamatan Kedaton. di Bandar Lampung) (Lampung: Universitas Bandar Lampung)
[8] Rizkita L, Suwono H and Susilo H 2016 Analisis Kemampuan Awal Literasi Sains Siswa Sma Kota Malang Pros. Seminar Nasional II 2 (Malang. Universitas Muhammadiyah Malang) 771–781
[9] Pratiwi S N, Cari C and Aminah N S 2019 Pembelajaran IPA Abad 21 dengan Literasi Sains Siswa J. Materi dan Pembelajaran Fisika (JMPF) 9 34–42
[10] DeBoer G E 2000 Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform J. of Research in Science Teaching 37 582–601
[11] Akgul E M 2004 Teaching Scientific Literacy through a Science Technology and Society Course: Prospective Elementary Science Teachers’ Case’ The Turkish Online Journal of Educational Technology 3 2002–05.
[12] Adolphus, Telima and A A Arokoyu 2012 Improving scientific literacy among secondary school students through integration of information and communication technology’ARPN Journal of Science and Technology 2 444–8
[13] Holbrook J and Rannikmae M 2007 The nature of science education for enhancing scientific literacy *International Journal of Science Education* **29** 1347–62

[14] OECD 2016 Results from PISA 2015 Retrieved from https://www.oecd.org/pisa/PISA2015-Indonesia.pdf.

[15] OECD 2014 PISA 2012 result in focus. OECD Publishing (Online) Retrieved from http://www.oecd. org/pisa/keyfindings/pisa-2012-result-overview.pdf.

[16] OECD 2010 PISA 2009 results: Executive Summary (Online) Retrieved from https://www.oecd.org/newsroom/43125523.pdf.

[17] OECD 2007 PISA 2006 science competencies for tomorrow’s world. Vol 1 (Paris, France: OECD) Retrieved from http://www.oecd.org/dataoecd/1/53/38484866.pdf.

[18] Lufri dan Ardi 2017 *Metodologi Penilitian* (Padang : UNP Press)

[19] Arikunto S 2008 *Dasar-dasar Evaluasi Pendidikan* (Jakarta: Bumi Aksara)

[20] Purwanto N 2013 *Prinsip-Prinsip dan Teknik Evaluasi Pengajaran* (Bandung: Remaja Rosda Karya)

[21] Diana S, Rachmatulloh A and Rahmawati E S 2015 Profil Kemampuan Literasi Sains Siswa SMA berdasarkan Instrumen Scientific Literacy Assesments (SLA) *Pros. Seminar Nasional XII Pendidikan Biologi FKIP UNS* 285–291.

[22] Sudjana N 2014 Penilaian Hasil Proses Belajar Mengajar (Bandung: PT Remaja Rosdakarya)