

Biology Scientific Literacy of Indonesian Students: Case Study in Aceh Tamiang - Aceh

Fitriani¹⁾, Fauziyah Harahap²⁾, Binari Manurung²⁾

¹⁾ Post Graduate Program, Biology Department, Universitas Negeri Medan, Indonesia

²⁾ Lecturers of Biology Department Universitas Negeri Medan - Indonesia
Jl. Willem Iskandar Psr. V Medan Estate, Kotak Pos No. 1589 Medan, Indonesia, 20221

Corresponding Author: Fauziyah Harahap

ABSTRACT

The aim of this study was to find out students' scientific literacy skills of Biology in Aceh Tamiang. The research method applied a survey descriptive analysis in which the sample was 301 students of the entire 12 schools and each class was taken by cluster random sampling technique. To obtain the data, multiple choice and essay tests as well as the observation for measuring students' science process skills were employed. The results showed that students' scientific literacy skills in Aceh Tamiang were 40.61% and it belongs to the low category. The average of science as a body of knowledge, science as a way of thinking, science as a way of investigation and interaction of science, environment, technology and society were 37.42%, 50.55%, 55.97% and 18.48% respectively, all of them belong to the low category in which the percentage value was below 60%.

Keywords: Scientific Literacy, Body of Knowledge, Way of Thinking, Way of Investigation, Interaction of Science, Environment, Technology and Society

1. INTRODUCTION

One of the most important successes to overcome the challenges in the 21st century is science literacy, the ability of people in understanding, communicating, and applying the biology concepts in their real lives. A scientific literacy nowadays has become a guidance to be mastered well by every person, either in the real life or in the business world. A scientifically literate person can use scientific information to face the problems in daily life and also to produce some of useful and beneficial scientific products. In the fields of business, there are a lot of occupational activities that require the higher-order thinking skills, where people should be able to learning, reasoning, thinking creatively, making decisions, and solving problems. To be able to survive in competition to overcome the

global opportunities and challenges in the near future, every person is strived to have an adequate scientific literacy including the knowledge about science, science process skill and scientific attitude as well.

Pudjadi (2005) ^[1] has suggested that "science is sort of knowledge about the objects and natural phenomena obtained from the philosophical thoughts and researches of scientists in the way of making experiments using the term scientific method". According to National Science Teachers Association (1997), ^[2] scientific literacy is a knowledge and comprehension of any scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. It also includes specific types of abilities. PISA-OECD (2000) ^[3] mentioned that a

scientifically literate person has a fundamental scientific knowledge and concept, a skill to do a scientific investigation process and to implement the knowledge, comprehension and other various contexts widely.

In order to pay attention to the history of grading achievement on the competition of international science that was conducted by PISA, Indonesia students' achievement tend to be decreasing (see Table 1).

Table 1. Indonesia's students achievement based on the criteria of PISA

Year	International Average Score	Reading	Rank/Amount of Participants	Mathematic	Rank/Amount of Participants	Science	Rank/Amount of Participants
2000	500	371	39/41	367	39/41	393	38/41
2003	500	382	39/40	360	38/40	395	38/40
2006	500	393	48/57	391	50/57	393	50/57
2009	500	402	57/65	371	61/65	383	60/65
2012	500	396	64/65	375	64/65	382	64/65
2015	500	397	66/72	386	66/72	403	66/72

Source: Indonesia PISA Center, 2015

Based on the results of PISA that has been conducted in 2015 suggested that Indonesia's achievement was below the average score of international level (Manurung *et al*, 2017).^[4]

The scientific literacy skills in PISA was lowering because students were difficult to read and understand the material contents more precisely and accurately. So the skills of science program students in Aceh were below the average score of National Examination. Books that have been used so far were not sufficient. It was in line with the relevant study of Nurlaili (2011)^[5] who stated that a book is a guide for a student whose scientific literacy level was low with the theme of science as a body of knowledge for the X textbook (70.1%) as well as for the Y textbook (87.1%) was categorized to be "good", on the aspect of science as a way of investigation for the X textbook (27.2%) as well as for the Y textbook (10.9%), on the aspect of science as a way of thinking for the X textbook (2.5%) and for the Y textbook (1.1%) and subsequently on the aspect of interactions of science, technology, environment, and society for the X textbook (0.2%) and for the Y textbook (0.9%), all of these three aspects were categorized to be "not good". A scientific literacy skill, particularly in Aceh Tamiang has not been clearly known yet, it will be extremely important to find out about the description of scientific literacy skills of the eleventh grade students,

especially in Aceh Tamiang for the topics of plant cells, structures and tissues as well as animal cells, structures and tissues that provides the learning experiences to comprehend the science concepts and processes.

Due to the issues aforementioned, the test of scientific literacy is very essential to be done to figure out how much further students' scientific literacy achievement in Aceh Tamiang considered from those aspects of scientific literacy skills. The aspects of scientific literacy aforementioned including science as a body of knowledge, science as a way of investigation, science as a way of thinking, and interaction of science, environment, technology, and society (Chiappetta, 1993)^[6]

2. RESEARCH METHOD

2.1 Location, Time, Population and Sample of the Study

This study was conducted in Senior High Schools all over Aceh Tamiang from January to August 2017. The population was the entire eleven in six grade students of Public High Schools in Aceh Tamiang about 1.520 students in total while the entire eleven in six grade students of Private High Schools in Aceh Tamiang about 197 students in total. The sample was taken by cluster random sampling technique. In each class of eleventh grade exists in every school, the sample was taken proportionally and randomly. The total sample was 301

students.

2.2 Research Type and Design

The research type was a survey descriptive analysis. It was aimed to find out the whole description about students' scientific literacy skills in Aceh Tamiang on the aspects of science as a body of knowledge, science as a way of thinking, science as a way of investigation, and the interaction of science, environment, technology and society as well.

2.3 Research Instruments

The instruments of students' scientific literacy were used to find out their scientific literacy skills on the dimensions of science as a body of knowledge, science as a way of thinking, science as a way of investigation, and the interaction of science, environment, technology and society. The test instruments were compiled by adapting and referring to the indicators of scientific

literacy assessment in line with curriculum 2013. The tests consisted of 35 multiple choice with five options on the dimension of science as a body of knowledge, the 8 essay test on the dimension of the interaction of science, environment, technology and society, the 10 essay test on the dimension of science as a way of thinking, and eventually 9 indicators on the observation sheet for the science process skill on the dimension of science as a way of investigation.

3. RESULTS AND DISCUSSION

3.1 RESULT

3.1.1 Scientific Literacy Skills of the Eleventh Grade Students

The results of scientific literacy skills of the 11th grade students in Aceh Tamiang were presented in Table 2.

Table 2. The Average of Students' Scientific Literacy Skills (%)

No	Dimension	N	Value	Category
1.	Science as a Body of Knowledge	301	37.42	Low
2.	Science as a Way of Investigation	301	55.97	Low
3.	Science as a Way of Thinking	301	50.55	Low
4.	Science as the Interaction with Science, Environment, Technology, Society	301	18.48	Extremely Low
Average		301	40.61	Low

Based on Table 2 aforementioned, it could be confirmed that the average of students' scientific literacy in Aceh Tamiang was 40.61% belongs to low category. Subsequently, the average of science as a body of knowledge, science as a way of investigation, science as a way of thinking were 37.42%, 55.97%, and 50.55% respectively, all of these aspects belong to

the low category, meanwhile the average of interaction of science, environment, technology and society was 18.48% and it belongs to the extremely low category.

Furthermore scientific literacy skills of biology for students based on the difference of school area, school status and gender were presented in Table 3.

Table 3. Scientific Literacy Skills of Biology for the Eleventh Grade Students in Aceh Tamiang Based on the Difference of School Area, School Status and Gender.

No	Dimension	School Area				School Status				Gender			
		n	Village	n	Town	N	Public	n	Private	N	Male	N	Female
1	Science as a Body of Knowledge	149	40.28	152	34.61	186	41.01	115	31.60	150	34.68	151	40.17
2	Science as a Way of Investigation	149	57.64	152	54.31	186	55.92	115	-	150	50.08	151	58.18
3	Science as a way of Thinking	149	56.78	152	44.67	186	54.28	115	41.29	150	44.56	151	52.18
4	Interaction of Science, Environment, Technology and Society	149	20.45	152	14.93	186	22.65	115	7.77	150	24.60	151	24.19
	Average	149	43.79	152	37.13	186	43.47	115	26.89	150	38.48	151	43.68

Based on Table 3 aforementioned, it could be stated that students' scientific

literacy skills whose schools were located in the village area (43.79%) were higher than

students whose schools in town (37.13%). Students' scientific literacy skills in public schools (43.47%) were higher than in private schools (26.89%). Meanwhile scientific literacy skills of male students

(38.48%) were lower than female students (43.68%). Subsequently, the post hoc test of Mann-Whitney of students' scientific literacy skills based on school area, school status and gender were displayed in Table 4.

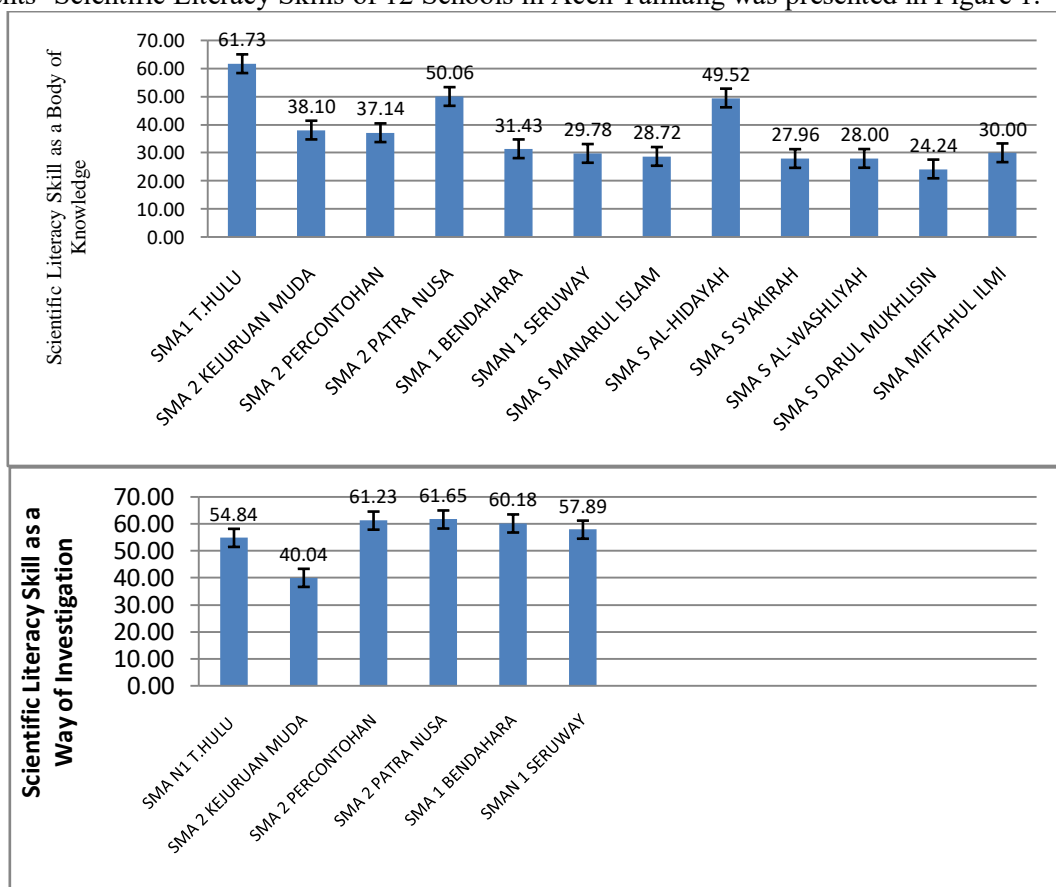
Table 4. Scientific Literacy Skills of Biology for the Eleventh Grade Students in Aceh Tamiang on the Difference of School Area, School Status and Gender Tested by Mann Whitney

No	Dimension	Values of Mann Whitney		P	Values of Mann Whitney		P	Values of Mann Whitney		P
		School Area			School Status			Gender		
		Village	Town		Public	Private		Male	Female	
1.	Science as a Body of Knowledge	164.08	138.18	0.010	174.76	112.57	0.000	130.78	171.35	0.000
2.	Science as a Way of Investigation	164.03	138.23	0.008	208.50	58.00	0.000	133.79	168.10	0.000
3.	Science as a Way of Thinking	184.38	119.56	0.000	168.98	121.91	0.000	108.64	193.08	0.000
4.	Interaction of Science, Environment, Technology and Society	164.91	137.36	0.002	169.36	120.88	0.000	145.21	156.67	0.206

Based on Table 4 aforementioned, it could be stated that students' scientific literacy skills based on school area, school status and gender for the dimension of science as a body of knowledge, science as a way of investigation, and science as way of thinking were significantly different.

Meanwhile, for the dimension of interaction of science, environment, technology and society was significantly different based on school area and school status, but not significantly different based on gender (P= 0.206).

Students' Scientific Literacy Skills of 12 Schools in Aceh Tamiang was presented in Figure 1.



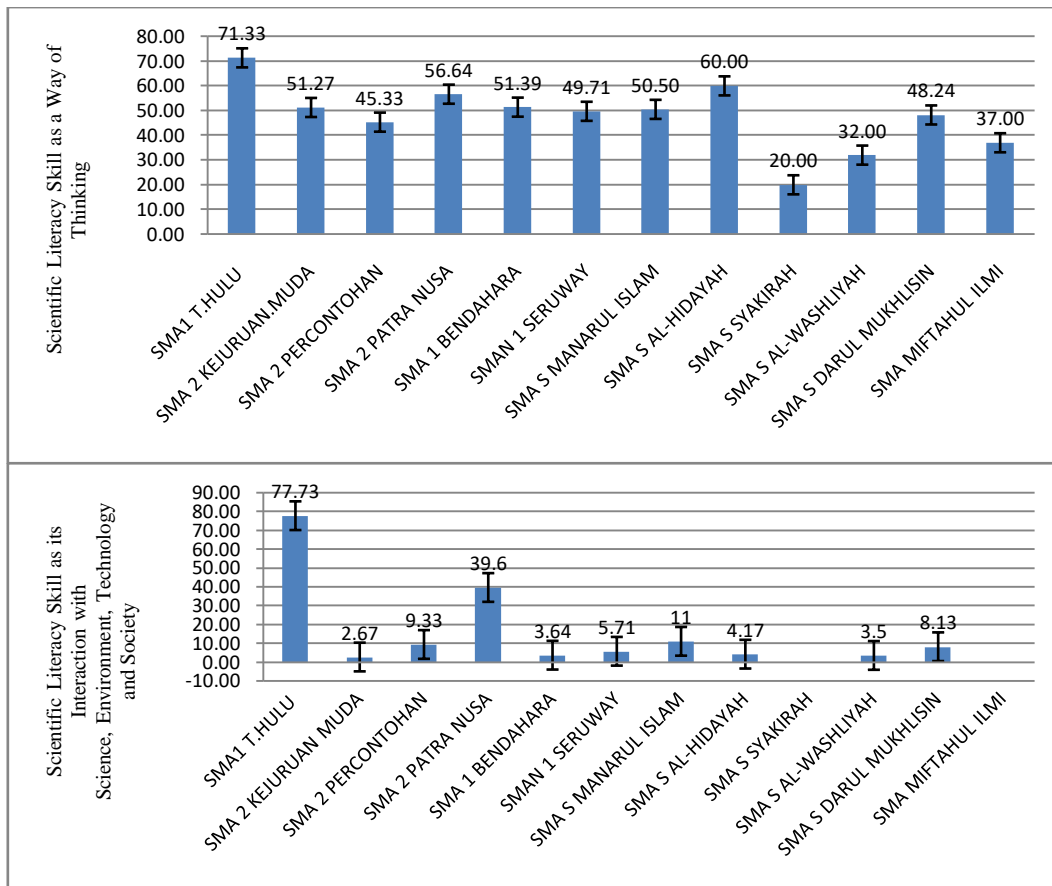


Figure 1. The Average of Students' Scientific Literacy Skills in Aceh Tamiang on the Dimensions of Science as a Body of Knowledge, Science as a Way of Investigation, Science as a Way of Thinking, and Interaction of Science, Environment, Technology and Society.

Based on Figure 1 aforementioned, it could be confirmed that the highest scientific literacy skills of biology for the dimension of science as a body of knowledge, science as a way of thinking and interaction of science, environment, technology and society were in SMA Negeri 1 Tamiang Hulu, meanwhile the highest scientific literacy skill for the dimension of science as a way of investigation was in SMA Negeri 2 Patra Nusa Banyak Payed. The lowest scientific literacy skill for the dimension of science as a body of knowledge was in SMA Swasta Darul Mukhlisin, meanwhile the dimension of science as a way of investigation and interaction of science, environment, technology and society were in SMA Negeri 2 Kejuruan Muda, and the lowest scientific literacy skill for the dimension of science as a way of thinking was in SMA Swasta Syakirah.

3.2 DISCUSSION

From the results of the study, it was concluded that scientific literacy skills of the eleventh grade students belong to the low category as well. Generally, these results showed that most of students did not have the characteristics of scientifically-literate person, they were not capable of connecting or interrelating concepts in their daily lives.

There were several things that cause students' scientific literacy skills were low, based on the observation obtained that there were no sufficient learning classrooms, neither infrastructures nor medium to make experiments or practices in the laboratory. These were in accordance with the previous study from Wulandari (2013), [7] suggested that the implementation of practice-based learning could enhance students' process science skills. On some aspects of science process skills could be retained very well, namely skills of observation, prediction and interpretation. Books that were used as

learning sources have not been sufficient and it was in line with the study from Nurlaili (2011) ^[5] who stated that a book as the guide for students still possessed low scientific literacy abilities with the theme of science as a body of knowledge for the X textbook was 27.2% as well as the Y textbook was 10.9%, the science as a way of thinking for the X textbook was 2.5% as well as the Y textbook was 1.1% and the interaction of science, environment, technology and society for the X textbook was 0.2% as well as the Y textbook was 0.9%, all of these three aspects were categorized to be “not good”.

According to Rustaman *et al* (2003), ^[8] science process skill is a skill that involves cognitive or intellectual, manual and social skills. A cognitive skill is getting involved because of students have conducted their scientific literacy skills by using their own minds. A manual skill is obviously getting involved in the process skills because they are engaged in using materials and devices, measuring, arranging or assembling tools. A social skill is getting involved in the process skill because they interact with others in executing other teaching and learning activities, for instance discussing the result of observation. Process skills need to be developed through direct experiences as the learning experience. Through the direct experience, someone can vivify those processes or activities being occurred.

Students' critical thinking skills can really influence their scientific literacy skills, another factor that causes students' critical thinking skills are low due to they are less practiced and difficult to solve the tests that present the phenomenal aspects. Critical thinking skill is an essential skill that should be developed through education, because it is one of the keys to solve problems in line with challenges that students have faced in the 21st century, students should be more independent, critically and creatively thinking person, and also they are daring to take any risks (Kalelioglu, 2014). ^[9] If students were

trained continuously to be able to think critically, so they would really understand and comprehend the learning materials. Critical thinking skill had a positive relationship with learning outcome, it means that a student who had a good critical thinking would have a very good learning outcome as well (Cayo *et al.*, 1991). ^[10]

Similar with the study conducted by Zuriyani (2013) ^[11] who stated that most of Indonesia's students had limited science knowledge that could only be applied in several familiar situations. As familiar as students could get, the bigger possibility of science knowledge and comprehension they would get very well. Students' recognition or comprehension about learning materials before they learn about it, it would be easy for them to add up the knowledge and the better their comprehension about materials as well. Students have already found out the concepts, facts, theories, laws but they were not capable of connecting and applying them in the daily life.

The decline of students' scientific literacy skills in Aceh Tamiang could occur because students were accustomed with the test characteristics related in this study which involves other certain issues as context. As Dinar (2013) ^[12] suggested that it needs to improve the existence of scientific literacy test questions in order to transform their own educational basis to be more scientifically literate in the near future.

In addition to involve the context, the test instruments in this main study have also used texts as the introduction of tests that made students require to read and understand the texts and test questions completely. The decrease of reading interest as well reading ability could affect students' scientific literacy skills. The results of study analysis from Hadi and Mulyatiningsih's (2009) ^[13] on the results of PISA 2000, 2003, 2006 has showed that students' science skills were influenced significantly and consistently by their own reading, mathematics, learning cultures, learning sources, educational facilities and the availability of internet connection as well. If

the reading skill was improved well, their mathematics and science skill would be also improved in the mean time.

3.2.1 Science as a Body of Knowledge

The percentage of science as a body of knowledge was 37.42%, it showed that students' scientific literacy skills in Aceh Tamiang was categorized to be "low". Students could answer questions that present facts, concepts and laws. Biology is one of the science which is not only focused on memorization and recall, but it also contains product and process as well. The biology learning, either in schools or colleges not only the theory, but importantly it involves with practices or experiment activities. It can be obtained with the science process skill-based learning, hence students are expected to obtain more meaningful and deepen comprehension about themselves and their own surroundings (BSNP, 2006) ^[14]

Science is a knowledge or horde of concepts, principles, laws and theories that will be accumulated shaping the science contents by itself. If we observe facts in the field, Indonesia's students are very keen in recall, but less competent in applying their own knowledge. This is probably linked with the tendency to use recall as the medium to master knowledge, but not a thinking ability. It seems to be clear that science education in Indonesia really emphasizes on abstract conceptualization and not develops on active experimentation, whereas both of them should be balanced proportionally (Dinar, 2013). ^[12]

3.2.2 Science as a Way of Investigation

The percentage of science as a way of investigation was 55.97%, it showed that students' scientific literacy skills in Aceh Tamiang was categorized to be "low". Students were just capable of observing, drawing and recording but not understanding about how to determine hypotheses, to predict the results, to process data and to interpret the results and also to

communicate them in front of the classroom.

Science is formed from the sustainable investigation process that really needs skills in the implementation, so the science process skills are very important and necessarily needs to be developed through any direct experience as the learning experience during the learning process (Prihartiningsih, 2016). ^[15] Science process skill involves cognitive or intellectual, manual and social skills so the science (biology) learning will be more meaningful. Furthermore, learning with the approach of science process skills enable students to learn or even discover the concepts that are the main purpose of learning science and also to develop the basic science skill, science attitude and critical behaviour as well (Zubaidah, 2016). ^[16]

According to Haryono (2006), ^[17] science process skill-based learning model is a learning structure that integrates science process skill into the series of teaching and learning process to refer students on the knowledge-constructed process independently. The learning process is designed as good as possible until students can discover facts, build concepts, theories, and particular attitudes through science process independently.

According to Sufinah (2013), ^[18] this study can be mentioned quite successful with a good result if there are four assessed aspects in the learning process, namely aspects of observation, classification, identification and conclusion.

3.2.3 Science as a Way of Thinking

Based on the results of the study, it was clearly found out that science as a way of thinking was 50.55% and it could be concluded that students' scientific literacy skills was categorized to be "low". Students were not capable of answering questions about problem solving and recall, because they were just capable of answering questions about memorization and remembering only.

In line with the study of Prihartiningsih (2016) [15] suggested that approximately 75,63% of students has low and decreasing critical thinking skills. Furthermore, teachers need to renew and develop students' critical thinking abilities on the topic of classification of living things through discovery-based learning model. Science is human's activity marked by the existence of thinking processes. The activities conducted by those scientists related with reason, portray human's curiosity and their willingness to understand natural phenomena. Realizing the science category as a way of thinking is the most important aspect in enhancing scientific literacy.

A teacher should keep increasing students' critical thinking skills as early as possible. It was supported by Richmond (2007) [19] suggested that a long process and training was required to be able to change someone's critical thinking. Thinking critically could be trained well; however the learning pattern was very essential to develop. Liliarsari (2010) [20] suggested that three basic abilities of critical thinking skills initially given to students, that were (1) understanding arguments and beliefs of someone else; (2) evaluating those arguments and beliefs critically; and (3) developing and retaining those arguments that have made.

3.2.4 Interaction with Science, Environment, Technology and Society

Based on the results of this study, it was obviously known that science as its interaction with science, environment, technology and society was 18,48% and it could be concluded that students' scientific literacy skills in Aceh Tamiang on the dimension of science as its interaction with science, environment, technology and society was "extremely low".

Science, Environment, Technology and Society is a knowledge which is completely linked one to another, where science becomes the basic core on the development of technology, and this

technology is the implication of science used to fulfill what society really needs. The interaction between science, environment, technology and society are relatable very close each other (Chiapetta, 1993). [6]

The decline of students' scientific literacy skills with the use of these instruments, it was probably caused by the difference of learning targets applied in schools (although Curriculum 2013 has been implemented) by targeting the scientific literacy. The science learning in every school includes the assessment was more limited to materials/contents of science, meanwhile the target in PISA was focused on the way of thinking scientifically (reasoning) in the real life (Fives *et al.*, 2014). [21]

By employing the scientific literacy questions on the tests of PISA, the precision of reading and ability in understanding the content was very necessarily required. The content on these instruments was presented on graphics that requires reasoning. In fact students who possess high academic achievement, however has no quite high scientific literacy as well. Thus, people's scientific literacy skills could grow fast and those skills could be higher in any particular aspects but could be even lower in other aspects (Shwatz *et al.*, 2006). [22]

4. CONCLUSION

From the results of research and data analysis aforementioned, it could be concluded that scientific literacy skills of Biology for the eleventh grade students were 40.61% belongs to the low category. Scientific literacy skills of Biology for the dimension of science as a body of knowledge, science as a way of investigation and science as a way of thinking were 37.42%, 55.97% and 50.55%, respectively, and all of them belong to the low category. Meanwhile, scientific literacy skills of Biology for the dimension of interaction of science, environment, technology and society were 18.48% and it belongs to the extremely low category.

Recommendation

Based on the results of the study, several efforts could be done to enhance students' scientific literacy skills in Biology, namely the quality of teachers should be enhanced by giving training and positive occasions; especially direct training about the biology practices so teachers can directly apply them at school. By giving a lot of qualified materials to all the teachers, they could deliver the learning materials more meaningfully. The authority should fulfill the sufficient infrastructures and tools/media for students to learn and make practices more effectively. All relevant learning media and sources were very important, such as handbooks for students to learn at school.

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AUTHORS' BIOGRAPHY



Fitriani, S.Pd, is a student of the Postgraduate Program of Biology Education at Universitas Negeri Medan (State University of Medan), Medan, North Sumatera, Postal Code 20221, Indonesia. She obtained her Bachelor Degree in Biology Education from Universitas Negeri Medan (State University of Medan), and her Master Degree in Biology Education from Universitas Negeri Medan (State University of Medan), Medan, Indonesia.



Dr. Fauziyah Harahap, M.Si, is a lecturer in the Graduate Program of Biology and Postgraduate Program of Biology Education at Universitas Negeri Medan (State University of Medan), Medan, North Sumatera, Postal Code 20221, Indonesia. She obtained her Bachelor Degree in Biology Education from IKIP (Teachers and Education Science Institute), Medan, Indonesia, her Master Degree in Biology Program from Universitas Gadjah Mada (University of Gadjah Mada), Yogyakarta, Indonesia and her Doctoral Degree in Biology Program from Institut Pertanian Bogor (Agriculture Institute of Bogor), Bogor, Indonesia. (*Corresponding Author*)



Prof. Dr. rer.nat. Binari Manurung, is a professor in Bioecology of the Biology Department in the Graduate and Postgraduate Program of Universitas Negeri Medan (State University of Medan), Medan, North Sumatera, Postal Code 20221, Indonesia. He obtained his Bachelor Degree in Biology Education from IKIP (Teachers and Education Science Institute), Medan, Indonesia, his Master Degree in Biology from ITB (Bandung Institute of Technology), Bandung, Indonesia and his Doctoral Degree in Biology from Martin-Luther University of Halle-Wittenberg, Halle (Saale), Germany

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