

# Teacher's Understanding of Science Literation in Learning Chemistry

Stefanus Kristiyanto<sup>1, a)</sup>, Ashadi<sup>1</sup>, Sri Yamtinah<sup>1</sup>, Sulistyono Saputro<sup>1</sup>, Sri Mulyani<sup>1</sup>

<sup>1</sup>*Master Program in Chemistry Education, Sebelas Maret University, Surakarta-57126*

<sup>a)</sup>Corresponding author: [stefanuskristiyanto@gmail.com](mailto:stefanuskristiyanto@gmail.com)

**Abstract.** The ability of science literacy is one of the essential skills that chemistry teachers must have in the current educational era. The latest result of the Program for International Student Assessment (PISA) ranks Indonesia to be the 10<sup>th</sup> lowest. The data show that the ability of science literacy of chemistry teachers is also still low. The aims of the study are to describe the literacy ability of science teacher. This research is a quantitative descriptive research with a population consisting of all chemistry teachers in Boyolali District. The samples in this research were 25 chemistry teachers. The data collection techniques consisted of interviews and questionnaires. The research instruments used in this study were interview protocol and questionnaire. Based on the result of preliminary research on the science literacy ability of chemistry teachers, 53% of chemistry teachers understand the science literacy and 47% of chemistry teachers understand the science literacy but never implement it in the learning process and evaluation. If the chemistry teacher understands the science literacy but does not implement it in the learning process and evaluation, then the process of building science-literate-society will be hampered.

## INTRODUCTION

The world of the 21<sup>st</sup> century is characterized by a rapid, complex and global change in the fields of knowledge, technology, and information. The changes are aimed at improving the quality of modern social life, such as its benefits in the areas of health, communication, and nanotechnology. Despite the benefit which is felt by the community, the negative impacts of the changes are also emerging, such as the occurrence of global warming, energy crisis, and environmental damage. It is inevitable that 21<sup>st</sup>-century society needs an understanding of scientific facts and the relationship between science, technology, and society [10]. People who are knowledgeable and able to apply their knowledge to solve real-life problems are called literate societies [2]. Therefore, the achievement of science-literate society has become the demand of this era. Scientific Literacy is one of 16 essential skills in the 21st century identified by the World Economic Forum [17].

Related to the importance of science literacy, educating people to have science literacy is a major goal in any science education reform [4]. Many educational organizations today accept and publish the standards and guidelines related to content, pedagogy, and assessment for science literacy [7]. In addition, several attempts have been made to define theoretically about biological and chemical literacy [1] [8] [12].

One of the efforts to develop science literacy is by developing chemical literacy. Gilbert and Treagust claim that many aspects of chemical literacy have direct implementation in everyday life, thus enabling people to become better citizens and allowing them to understand the report and to discuss chemistry and chemicals, and can overcome various environmental issues in everyday life such as greenhouse effect, ozone depletion, acid rain, and so on [10].

According to Schwartz, Ben-Zwi & Hofstein, the aspects of chemical literacy competencies include as the followings [12].

1. Explaining the phenomenon by using the chemistry concept, that is, recognizing the importance of chemical knowledge in explaining the daily phenomena, also understanding the theories, models, and concepts of chemistry. The subject roots in the theory that has a broad and deep application.
2. Using chemistry understanding in problem-solving that is using his or her understanding of chemistry in daily life, as a consumer of new products and technologies, in making decisions and participating in social debates on chemistry issues. Understanding how chemistry and chemistry-based technologies related to one another. Chemistry produces an explanation of nature, while chemistry-based technology changes the world. The models and concepts produced by the two fields are strongly connected, so they will affect each other.
3. Analyzing the strategies and benefits of chemistry applications, namely understanding the relationship between innovation in chemical processes and social life appreciating the impact of chemistry and chemistry-based technology on society understanding the nature of the prevailing chemistry phenomena. Producing changes or variations on a better phenomenon by changing the world we see or seeing from different angles.

The measurement of science literacy including chemistry literacy is to find out the learner's chemistry understanding in explaining natural phenomena and human behavior result and the learner's skill in applying the understanding of chemistry for decision making and problem-solving [6]. Science Literacy is the main area of PISA (Program for International Student Assessment) 2006, which was previously a minor domain in PISA 2000 and 2003. The scores of the science literacy of Indonesian learners are 393, 395, 395 points for 2000, 2003 and 2006, respectively. The average score of all participant countries is 500 with a standard deviation of 100. The low score means that Indonesian learners have limited scientific knowledge. The low science literacy scores reflect the general phenomenon of poor Indonesian students' learning achievement [5]. The results of the PISA study in 2015 show that Indonesia can only rank 69 out of 76 countries. The score of science literacy is actually increased from 382 points in 2012 to 403 points in 2015. But this score is still quite far from the total average value of 495 [9].

The low score of science literacy is not only achieved by the learners, but also by teacher training students. Sujana's research shows that only 21 students (51.22%) of the Elementary School Teacher Education (PGSD) students have reached chemistry literacy, and the elementary school teachers are only 6 people (30%) [15].

The Deputy of Secretary General of The Federation of Indonesian Teachers Union (FSGI) Satriwan Salim said that many teachers are lazy to read. This is one of the reasons why Indonesia's literacy rate is low [16]. "The teachers themselves are lazy to read, so how can the students practice it?" The lack of book facilities is the reason for the laziness in reading. Consequently, it becomes a bad example for students. The access to teacher and student literacy is still far from ideal. To overcome these two problems, the FSGI recommends the Ministry of Education and Culture to promote literacy programs for teachers. The ministry was also requested to provide the qualified books for teachers and students [16].

This research is, therefore aimed to describe the science literacy ability of chemistry teachers. The good science literacy of chemistry teachers will be supposed to positively correlate with the science literacy of learners.

## **METHODS**

### **Types of research**

This research is descriptive research with quantitative approach.

### **Time and Place of research**

The research was conducted in November until December 2017. The study was conducted on high school chemistry teachers in Boyolali District.

### **Research subject**

The research subject is a source of data in a research from which the information can be obtained [14]. The subject of quantitative research should be representative. Creswell describes the representatives as the individual selection of population samples in such a way that the selected individual represents the population as a whole [3]. A population is a group of individuals who share the same characteristics. The sample in this research is high school chemistry teacher in Boyolali regency which was 25 people.

### **Procedure**

Descriptive research is aimed to describe the population characteristics based on the data collected from the sample [13]. This study describes the science literacy ability of science teachers. In this research, the data was obtained from the questionnaire distributed to the teacher after attending the 2013 Curriculum implementation training in High School Chemistry Teacher Association (MGMP) in Boyolali District. The obtained data were analyzed quantitatively by using descriptive statistics with the average calculation of research results, presented in the form of a percentage (%) and then described in the form of tables and graphs to draw the conclusions.

The interviews were conducted to some of the officials of High School Chemistry Teacher Association (MGMP) in Boyolali by using interview guidelines. The interview results were used only to reinforce MGMP board's perception of literacy science ability of chemistry teachers.

### **Techniques and Data Collecting Instruments**

The data collection techniques in this study were interview and questionnaire. Interviews were used to find out the problems to be researched, and also if the researcher needs to find out the facts of the respondents deeply [14]. The interviews were conducted on 3 MGMP Chemistry officials related to the science literacy ability of science teacher in the learning process at school. The questionnaire is a written statement used to obtain the information from the respondent as a report about the person or things he/she know [13]. The questionnaire was distributed to 25 chemistry teachers who have been trained in the implementation of Curriculum 2013 in High School Chemistry Teacher Association (MGMP) in Boyolali District.

The instruments used in this study were interview guideline and questionnaire. The interview guideline contains questions to the chemistry teacher related to the science literacy ability of chemistry teachers in the learning process while the questionnaire contains how the teacher understands the science literacy and its benefits in chemistry learning.

The questionnaire measures three aspects of chemical science literacy: explaining phenomena using chemistry concepts, using chemistry understanding in solving problems, and analyzing the strategies and benefits of chemistry applications. Each aspect was classified into 5 statements so the total questionnaire contained 15 statements to be answered by the teachers.

The scale of the questionnaire used was Likert scale with four alternative answers [13]. This scale was arranged in a form of statement and followed by a response option that indicates the level. Response options were SS (strongly agree), S (agree), TS (disagree), and STS (strongly disagree). Likert-size option scoring depends on the nature of the statement. For a positive statement the answer score is SS = 4; S = 3; TS = 2; STS = 1. For negative statements is the opposite, ie SS = 1; S = 2; TS = 3; STS = 4.

### **Data analysis technique**

The data analysis techniques used to determine the science literacy ability of science teacher was based on teacher questionnaire results and supported by interviews with the board of MGMP. The stages of data analysis conducted in this study are the followings.

1. Calculating the score obtained from the questionnaire calculation.
2. Determining the average score of teacher chemistry literacy ability.

3. Determine the percentage of science literacy competence, by using Table 1.

Table 1. Science Literacy Ability Category

| Score    | Ability Category |
|----------|------------------|
| 76 – 100 | High             |
| 50 – 75  | Medium           |
| < 50     | Low              |

4. Analyzing the results of the interviews obtained.

## RESULTS AND DISCUSSION

The teacher literacy data in each aspect is presented in Table 2.

Table 2. Percentage of Science Literacy Capability of Each Aspect

| No. | Aspect   | Percentage |
|-----|--|------------|
| 1   | Explaining the phenomenon by using the concept of science      | 56.30%     |
| 2   | Using an understanding of science in solving problems.         | 50.80%     |
| 3   | Analysing the strategies and benefits of science applications. | 51.90%     |
|     | Average  | 53.00%     |

The average ability of science literacy as a whole was found to be 53.00%. This result shows the ability of chemistry teacher scientific literacy is still in the medium category. Furthermore, the scores data obtained were analyzed by using descriptive statistical analysis technique. Based on the analysis, it is revealed that the average ability of chemistry teacher in each indicator of each aspect is as follows.

a. Describing the phenomenon by using the chemistry concept

The first aspect consists is based on these indicators: (1) recognizing the importance of chemistry knowledge in explaining daily phenomena, and (2) knowing the theory, models, and concepts of chemistry in daily phenomena. The five items in the aspect statement are summarized in Table 3.

Table 3. First Aspect Statement Item

|    |  |
|----|--|
| 1. | I can understand how the phenomenon relates to chemistry in daily life                           |
| 2. | I can explain the relationship between the phenomenon and the concept of chemistry               |
| 3. | I can understand how the phenomenon can occur based on the chemistry that has been learned       |
| 4. | I can understand the theory of how a phenomenon can occur that is related to the chemical matter |
| 5. | I can understand how the concept of chemistry can play an important role in a phenomenon         |

The results of the research on each of these statements are presented in Figure 1. The results of the analysis on the first aspect showed that as many as 59.30% of chemistry teachers understand how the chemistry concept can play an important role in a phenomenon, while 54.80% of chemistry teachers understand how the phenomena relate to the chemistry concept. This indicates that the chemistry teacher is more dominant in understanding the theory of a phenomenon.

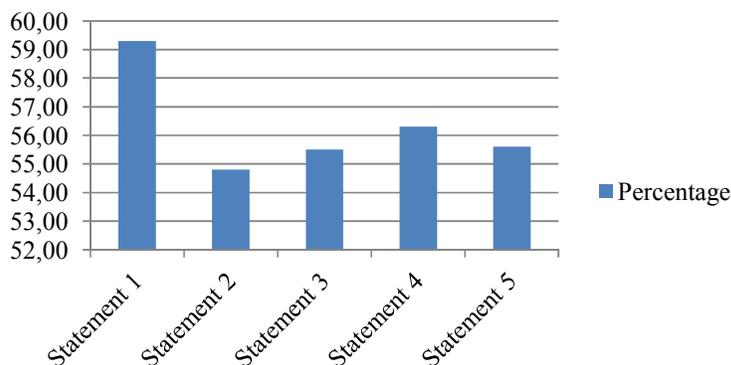


Fig 1. Science Literacy ability of Each aspect Statement based on Explanation of the Phenomenon by Using the Chemistry Concept.

b. Using a chemistry understanding of problem-solving.

The second aspect is based on these indicators: (1) using an understanding of chemistry in daily life, (2) as a consumer of new products and technologies in decision making, (3) understanding how chemistry and chemistry-based technologies relate to each other, and (4) understanding models and concepts generated by both fields have a strong relationship so that they affect each other. The indicators are broken down into five items in Table 4.

Table 4. Second Aspect of Statement Item

|    |  |
|----|--|
| 1. | I always use chemistry concepts in solving problems in life                                    |
| 2. | I understand how chemistry is applied in daily life  |
| 3. | I am interested in new products and technologies related to chemistry                          |
| 4. | I am interested in the issues related to chemistry   |
| 5. | I understand how chemistry and chemistry-based technologies are interconnected with each other |

The results of the research on each item statement based on the indicator, presented in Figure 2.

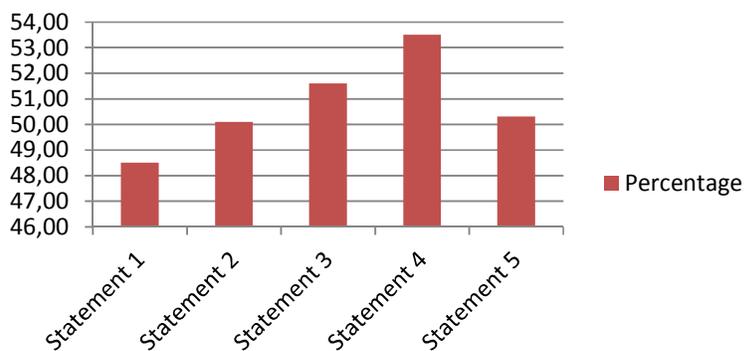


Fig 2. Chemistry Literacy ability of Each Statement based on Aspect of Using Chemistry Understanding In Solving Problems

The results of the analysis on the second aspect indicate that in using chemistry understanding to solve problems, chemistry teachers cannot always use science which is related chemistry materials to solve life problems, as indicated by 48.50% percentage.

c. Analysing the strategies and benefits of chemistry applications.

The third aspect is based on these indicators: (1) understanding the relationship between innovation in chemistry, sociological and cultural processes (the importance of applications such as medicines, fertilizers, and polymers), (2)

appreciating the impacts of chemistry and chemistry-based technology in society, and (3) understanding the nature of applicable chemical phenomena. The indicators are broken down into five items in Table 5.

Table 5. Third Aspect of Statement Item

|    |  |
|----|--|
| 1. | I understand the benefits of the chemistry in daily life               |
| 2. | I understand how the application of chemistry in daily life            |
| 3. | I understand the nature of the chemistry phenomena prevailing in life  |
| 4. | I understand the process of chemistry in the application of daily life |
| 5. | I understand the effects of chemistry related to daily life            |

The results of the research on each of the third aspect statement items are presented in Figure 3.

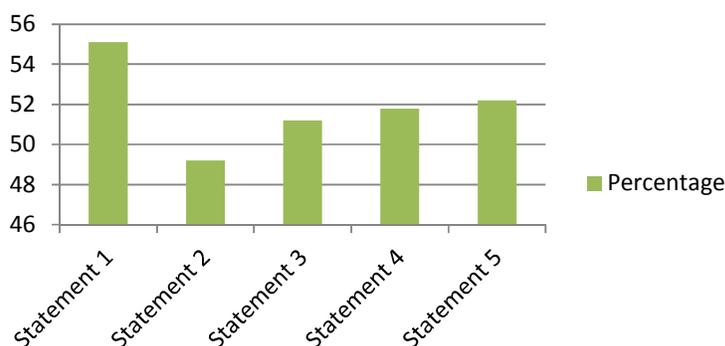


Fig 3. Chemistry Literacy ability of Each Statement based on Aspect of Analyzing the Strategies and Benefits of a Chemistry Application.

The results of the analysis in the third aspect show that in analyzing the strategies and benefits of chemistry applications, chemistry teachers are still lacking in how the application of chemistry learning materials in daily life, that is indicated by a 55%.

In general, it can be reviewed that the percentage of science literacy ability of science teacher is 53.00%. The results of this study indicate that the science literacy ability of science teacher is in the medium category. This indicates that the chemistry teacher has not been sufficiently accustomed to learning activities that use scientific steps, and has not been able to master the science materialistically. That is, in the teaching and learning activities of chemistry teachers are still required to master chemistry materials. The 53.00% of chemistry teachers with the ability of science literacy in the medium category was 47.00% never apply science literacy in the learning process and evaluation. This means that chemistry teachers rarely connect and apply the understanding of phenomena in their daily environment in the learning process and learning evaluation. This causes the process of science-literate society building will be hampered.

Likewise, from the interviews with MGMP Chemistry board, the low science literacy ability of science teacher is caused by several factors, such as insufficiency of education and teacher training. The government is still allocating the small amount in the budgets for education and teacher training scholarships. The condition is aggravated by the lack of teacher training activities. The chemistry teacher has facilitated only one training annually. The teachers who get lack of adequate education and training will tend to implement their learning unexceptionally. In learning evaluation, the teacher also tends to be more interested in constructing the simple essay test items. The test items constructed do not contain aspects of science literacy, because the teachers consider that constructing the test items that contains aspects of science literacy is difficult. Only a few learning topics which are developed into questions to measure the literacy of science.

Chemistry teachers should be trained to develop students' literacy skills. They are expected to perform chemistry learning activities that begin with observing activities and linking learning materials to the phenomena that occur in daily life. Through this activity, the learners are encouraged to be able to build knowledge and connect

natural phenomena that occur with learning materials learned in school. The learning process has to train the science skills so that learners are accustomed to doing things related to activities such as: explaining phenomena scientifically, using chemistry understanding in solving problems and analyzing the benefits of chemistry applications. Similarly, in the learning evaluation activities, the chemistry teachers have to use evaluation instruments that are oriented towards improving the ability of science literacy. In chemistry, there are many topics which can be related and applied to daily life. Also, it can be developed into test items which can improve science literacy skills. It should be remembered that the development of questions which are used to measure the science literacy needs to be adjusted to the criteria for making science literacy questions of the Program for International Student Assessment (PISA), so that the science literacy ability of the learners in Indonesia increases.

## CONCLUSION

### Conclusion

Based on the result of the research, it can be concluded that the science literacy ability of high school chemistry teacher in Boyolali District is moderate.

### Suggestion

This research was still conducted in the preliminary research stage, so the authors expect the other researchers to continue this research until the final stage using the broader subject of research.

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Published by Faculty Of Mathematics And Natural Sciences  
Yogyakarta State University, ISBN 978-602-74529-3-0

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