JPII 5 (2) (2016) 299-303

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

IDENTIFY SCIENTIFIC LITERACY FROM THE SCIENCE TEACHERS' PERSPECTIVE

B. Rubini*, D. Ardianto, I. D. Pursitasari, I. Permana

Science Education Program, Postgraduate Program
Pakuan University, Bogor, Indonesia

DOI: 10.15294/jpii.v5i2.7689

Accepted: August 16th 2016. Approved: September 14th 2016. Published: October 2016

ABSTRACT

Scientific literacy is considered as a benchmark of high and low quality of science education in a country. This study aims to identify the scientific literacy of teachers and learning science relation to the issues from the perspective of a science teacher. This descriptive study involved 25 science teachers who are members of MGMP IPA in Bogor. The instrument used in this study consisted of scientific literacy tests and interviews. The results showed that 20% of teachers have scientific literacy ability in the low category, 65% in the moderate category and 15% in the high category. The problems of teaching science based on teacher perspective are 1. having difficulty to teach Integrated Science; 2. having limited knowledge related to learning models of Integrated Science; 3. lack of motivation in teaching integrated science consistently. The results of these studies form the basis that the professional trainings for junior high science teacher need to be conducted in a sustainable manner and related with the needs of their proficiency.

Keywords: Scientific Literacy, Science Learning

INTRODUCTION

Scientific literacy is defined as the ability to use scientific knowledge, identify questions and draw conclusions based on the evidence, in order to understand and make decisions regarding the nature and its changes through human activity (Rustaman, 2003). Scientific literacy is strongly associated with a person's ability to read and write, as well as the use of language fluently, effectively, and criticallly (Alwasilah, 2012). Scientific literacy is related to the public in preparing for the future to make a decision on the issue of personal and collective socioscientific. Scientific literacy is considered as the root of the progressive change science education (Sadler & Zadler 2005, 2009).

Results of The Program for International Student Assessment (PISA) in 2000, showed that Indonesia ranked 38 of 41 countries participating in the literacy skills of science, in 2003 Indonesia ranked 38 of 40 countries, while PISA 2006 Indonesia ranked 50 of 57 countries, and in 2009 Indonesia ranked 60 of 65 countries. Meanwhile, PISA 2012 Indonesia occupied 64 place from 65 countries participating in the ability of science literacy. Indonesian Students gained scientific literacy scores in 2000, 2003, 2006, 2009, 2012, they were respectively 393, 395, 393, 383, 382 with an average score of all participant countries of 500 (Balitbang, 2012).

Related research of scientific literacy conducted by Rubini & Ardianto (2014) about the achievements of scientific literacy in Bogor junior high school students showed that the same acquisition with the achievements of the students' scientific literacy in national. Data showed the achievements of students' scientific literacy in

***Alamat korespondensi:**
E-mail: bibinrubini@unpak.ac.id

Bogor was quite low, with an average of 30% for all aspects, consisting of 29% for the content, 30% for the process, and 31% for the context. Aspects of the context for the application of science have proved that almost students were not able to link the learned scientific knowledge with the phenomena that occur in the world, because they did not gain the experience to be linked. In line with Sadler et al. research, (In Sobard and Rannikmae 2011), it reveals that the lack of scientific literacy of students due to the difficulty of students to evaluate evidence and make decision, as well as less critical in responding to issues related to people's lives.

Related research on the development of students' scientific literacy has been done by many practitioners of science education. The studies have been done previously related to the application of the model/method/strategy of potential science learning in improving scientific literacy of students. Research conducted by Ardianto & Rubini (2015) that examined the application of guided discovery and problem based learning models in science learning process towards junior high school students' scientific literacy ability. Results showed that guided discovery and problem based learning models can improve students' scientific literacy skills but its improvement was in the medium category (41%). The findings are consistent with Brickman et al. (2009), Alfiery et al. (2010) and Nbina (2103) researches that state that science learning based on constructivism (inquiry, discovery, PBL, practicum) can improve students' scientific literacy in the medium category.

Some researches previously described indicate that the model/method/strategy of science learning has been trialed and can overcome the problem of low scientific literacy ability of students, however the improvement of students' scientific literacy is not satisfactory (gain of 0.4 in average category). The problem about the low scientific literacy ability of students can not only be solved by applying the model/method/strategy of science learning based on constructivism. The classroom environment and climate is an important component to the students' literacy skills. Likewise, the school infrastructure, human resources, organization and management bring a very significant influence to students' achievement literacy. Other factors affecting the ability of students' scientific literacy is teacher. Therefore, this study aims to identify the scientific literacy and problem in science learning in the perspective of science teachers regarded as essential component in addressing the issue of students' scientific literacy skills.

METHODS

This research used descriptive method that aims to describe a situation in its natural condition comprehensively and exactly (Fraenkel et al. 2012). Researcher did not give treatment, but measuring, analyzing, and describing the aspects that are analyzed in natural conditions. This research involved 25 science teachers who joined the MGMP (teacher association) of science in Bogor. Instruments consisted of scientific literacy tests adopted from PISA 2013 and interview guidelines for teacher to find out the weaknesses of teachers in teaching science. The data were analyzed descriptively, the teachers' scientific literacy scores were analyzed by using the following mathematical equation.

$$\text{Nilai} = \sum \frac{X}{K} \times 100\% \quad \text{..................................(1)}$$

Where,
$\sum X$: obtained score
$\sum Xt$: maximum score

Teachers' scientific literacy is measured by using the criteria of :

Table 1. Teachers' scientific literacy category

Criteria	Kategori
Teachers' Score > $\bar{X}$ + SD	High
$\bar{X}$ – SD ≤ Teachers' Score ≥ $\bar{X}$ + SD	Moderate
Teachers' Score < $\bar{X}$ – SD	Low

(Suharsimi Arikunto in Febrian Andi Marta, 2010)

RESULTS AND DISCUSSIONS

Teachers' scientific literacy test was conducted for 25 junior high science teachers who have taught science and have experienced in teaching science in the last 5 years. However, the educational background of those teachers is not from integrated science major. 92% of teachers who joined the teacher qualification test were majoring in Physics, Biology or Chemistry. While, 8% of science teachers more qualified S1 were majoring in computer and engineering fields. The result of the scientific literacy competency test data is presented in Figure 1.1

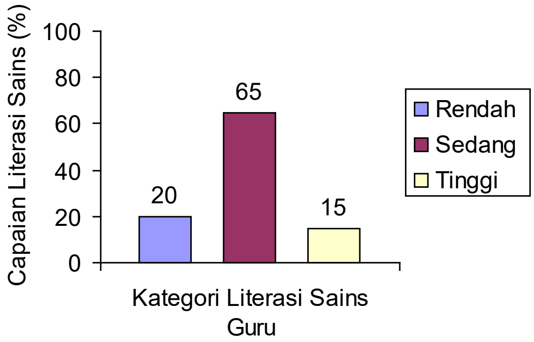

Figure 2. Profile of Junior High School Teachers' Scientific in Bogor.

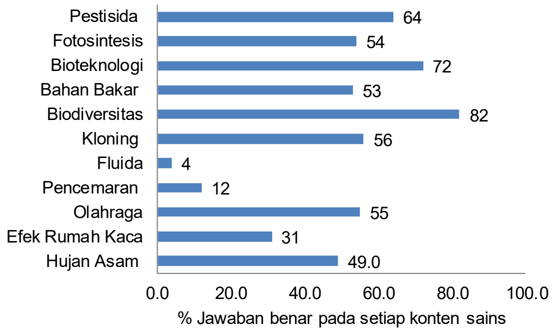

Figure 3. Diagram of the correct answers percentage of science content

Figure 2 indicates that even though some teachers have low level mastery of science, but the overall mastery of science teachers shows the middle category. Teachers' scientific literacy in the low categories was 20%, in the medium category was 65%, and in the high category was 15%. These data indicate that there were still major problems in science learning process in junior high school. With a relatively easy test material, all teachers are supposed to be able to solve it. But this fact encourages the research team to investigate the core problem.

Test material of scientific literacy is also used to identify science teachers' understanding of content and science process skill teachers indicated by significant achievements in scientific literacy process of each indicator. Science content in this consisted of 11 contents of acid rain, greenhouse effect, exercise, pollution, fluid, cloning, biodiversity, fuel, biotechnology, photosynthesis, and pesticides. Data analysis of the correct answers percentage of science content can be seen in Figure 3. While the ability of science process skill identified in this research consisting of three indicators adjusted to the PISA 2013 scientific literacy indicators. Those indicators are; 1. identifying scientific issues, 2. explaining scientific phenomena and 3. using scientific evidence. Data analysis of the correct answers percentage of each indicator on science process skill can be seen in Table 2.

Figure 3 shows that teachers obtained the highest percentage of correct answers on biodiversity content is 82% and the lowest correct answer on the fluid content of 4%. This study proves that the educational background of teachers greatly affects the understanding of science content. The study involved 23 science teachers with educational expertise of Physics, Biology or Chemistry, 15 of them were majoring in Biology. Biodiversity content is relatively close to Biology material, so it might affect their performance in the test because it would be easier for them to answer the questions since their conceptual structure has been built up through their daily teaching experience. Vosniadoun and Loannides (1998) also state that the conceptual structure derived from everyday experiences continually restructured will make the existing concept reach consistent conceptual as scientist conceptual. The results also show if the material does not match with their expertise, the percentage of correct answers will be relatively low. This can be seen in the percentage of correct answers on fluid content of 4%, so it was only 10 teachers who answered correctly to that content.

Figure 3 also shows that the teachers' knowledge level of content related to environmental issues is still low. The environmental issues are represented by the content of acid rain, pollution and the greenhouse effect. The achievement of those contents is below 50%, meaning that only 12 teachers were able to answer correctly

Table 2. Teachers' achievement of each science process indicator

Dimension process of scientific literacy	Number of Items	Total number of items	% Correct answer
Identifying scientific issues	3, 7, 8, 10, 11, 13, 14, 17, 21, 23, 25	11	47
Explaining scientific phenomena	1, 6, 9, 15, 18, 19, 20,	7	41
Using scientific evidence	2, 4, 5, 12, 16, 21, 24	7	75
Average			54

associated with contents related to environmental issues. The finding is reinforced by the facts obtained through interviews with teachers who stated that they felt confused and had misconceptions about environmental issues such as global warming, destruction of ozone layer, acid rain, radioactive pollution and others.

The result of this research is reinforced by Spiropoulou et al. (2007) that states 188 teachers in Greece had limited knowledge when they were asked to discuss environmental issues. Another research also reveals that students and teachers had limited understanding about environmental issues and alternative conceptions about it. One of the main difficulties is when explaining the greenhouse effect and global warming (Acikalin, 2013). Some researches also support that on students (Koulaidis and Christidou, 1999; Rebich and Gautier, 2005) and pre-service teacher (Groves and Pugh, 1999; Kahlid, 2001) that still had a misconception of greenhouse effect concept.

Based on the data in table 1.1, it shows that only 47% of teachers answered correctly to the indicator of identifying scientific issues. For the indicator of explaining scientific phenomena (7 questions), the percentage of teachers who answered correctly is only 41% whereas for using scientific evidence (7 questions) is 75%. Overall average percentage of correct answer in the aspects of the scientific literacy process is about 54%. Scientific literacy material used to measure the indicators by explaining the phenomena is short constructed responses and open-constructed response type and the majority of teachers cannot answer it correctly. It shows that they tend to use memorization as strategy to acquire knowledge and instead of the ability to think.

The result also shows that teachers have low science process ability in explaining scientific phenomena indicator with the average percentage of 41%. It indicates that teachers do not have the habit to think critically and have reasoning according to their knowledge. Though Osborne et al. (2001) shows that the reasoning ability and argument in explaining scientific phenomena can be stimulated and trained through a process of argumentation in a debate over the socio scientific issue. The process of argumentation would foster self-openness, which is a requisite for obtaining a high reasoning power. In line with (Newton et al., 1999, in Yang and Tsai, 2010), they state that the individuals involved in the argument will form the basis for building knowledge because it is through the evaluation of the claim and also the process of observation or evidence that scientific estimation can be knowledge general.

Klahr et al. (Varma, 2014) also reveals that the habit of students to reveal evidence, reason, and other supporting factors that are correct and logical can be trained mainly through inquiry activity. Inquiry is a proper process to develop individual ability to explain scientific phenomena (reasoning). Chen and She (2014) mentions that the reasoning ability of individuals involve the whole inquiry process, such as asking questions scientifically, controlling variables, planning a way to answer questions, designing an experiment to test the hypothesis, analyzing data, and interpreting the results (Chen & She, 2014) ,

The results of interviews with some teachers reveal that some key issues that should be concerned are background of the specific expertise field of causing difficulties in managing integrated learning. They generally master only biology, but not physics or chemistry, and vice versa. Currently, the government has made electronic school books labeled as integrated. However, the implementation is limited especially related to examples. Generally, teachers do not comprehend integrated learning models even though they have joined some trainings in integrating science learning, the implementation is still limited. A lack of motivation from school to organize an integrated learning makes them implementing it inconsistently.

CONCLUSION

This study gives us a picture that not only students have scientific literacy problem but teachers who act major component in the learning process also performed unsatisfactory. Their content mastery is strongly related with the educational background. Their ability in explaining scientific phenomena related to the material that connects to the concept of environmental problems is still low. It indicates teachers do not get used to think critically and have reasoning according to their knowledge. The results also reveal that the problems based on their perspective are 1. having difficulty to teach Integrated Science; 2. having limited knowledge related to learning models of Integrated Science; 3. lack of motivation in teaching integrated science consistently. The results of these studies form the basis that the professional trainings for junior high science teacher need to be conducted in a sustainable manner and related with the needs of their proficiency.

ACKNOWLEDGEMENT

We would like to thank to Directorate

of Research and Community Service through Assignment Agreement of Implementation of Competitive Grants Year 2016 Number 03 / LP-UP / KPHB / VII / 2016.

REFERENCES

Acikalin, F. S. (2013). Middle school students' conceptions of environmental issues. *International Journal of New Trends in Art, Sports & Science Education*. 2(4): 23-27

Alfieri, L., Brooks, P.J. & Aldrich, J.N. (2010). Does Discovery-Based Instruction Enhance Learning?. *Journal of educational Psycology*. (103)1:1-18.

Alwasilah, A.C. (2012). *Pokoknya Rekayasa Literasi*. Bandung: Kiblat.

Ardianto, D dan Rubini, B. (2016). Komparasi Literasi Sains Siswa Pada Pembelajaran IPA Terpadu dengan Model Guided Discovery dan Problem Based Learning. *Jurnal Pendidikan IPA Indonesia.*

Balitbang. (2012). *Survei Internasional PISA.* Jakarta: Pusat Penelitian Pendidikan Balitbag Kemendikbud.

Brickman, P., Gormally, C., Armstrong N dan Hallar, B. (2009). Effects of Inquiry-Based Learning on Students'science Literacy Skills dnd Confidence. *International Journal for the Scholarship of Teaching and Learning.* (3)2

Chen, C. T dan She, H. C. (2014). The Effectiveness of Scientific Inquiry with/ without Integration of Scientific Reasoning. *International Journal of Science and Mathematics Education*.

Fraenkel, J.R., Wallen, N.E. dan Hyun, H.H. (2012). *How to Design and Evaluate Research in Education*. New York: McGraw-Hill.

Groves, F.H dan Pugh, A.F. (1999). Elementary Pre-Service Teacher Perceptions of the Greenhouse Effect. *Journal of Science Education & Technology.* 9: 75-81

Kahlid, T. (2011). Pre-service Teacher's Misconceptoins Regarding Three Environmental Issues. *Canadian Journal of Environmental Educations*. 6: 102-120

Koulaidis, V & Christidou, V. (1999). Model of Students' Thinking Concerning the Greenhouse Effect and Teaching Implementations. *Science Education*. 83(5): 559-576

Marta, Febrian Andi. 2010. Analisis Literasi Sains Siswa SMP dalam Pembelajaran IPA Terpadu pada Tema Efek Rumah Kaca. *Tesis*. Bandung: FPMIPA Universitas Pendidikan Indonesia

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

Osborne, J., et al. (2001). Enhancing the quality of argument in school science. *School Science Review.* 83 (301)

Rebich, S dan Gautier, C. (2005). Concept Mapping to Reveal Prior Knowledge and Conceptual Change in a Mock Summit Course on Global Climate Change. *Journal of Geoscience Education*. 53(4): 355-365

Rubini,B dan Ardianto, D. (2014). Analisis Literasi Sains Sisiwa di Kota Bogor. *Laporan Penelitian*. Bogor: Pascasarjana Universitas Pakuan

Rustaman, N.Y. (2003). *Literasi Sains Anak Indonesia 2000 dan 2003*. Bandung: Universitas Pendidikan Indonesia.

Sadler, T.D dan Zeidler, D.L. (2009). Scientific Literacy, PISA, dan Socioscientific Discourse: Asessment for Progressive Aims of Science Education. *Journal of science Teaching*.1-13

Sadler, T.D dan Zeidler, D.L. (2005). The significance of content knowledge for informal reasoning regarding response to a sosiocientific issues: Applying genetics knowledge to to genentic engineering issues. *Journal of Science Education*. 89(1): 71-93

Soobard, R dan Rannikmae, M. (2011). Assessing student's level of scientific literacy using interdisciplinary scenarios. *Science Education International*. 22 (2): 133-144

Spiropolou, D., Antonakaki, T., Kontaxaki, S & Bouras, S. (2007). Primary Teachers' Literacy and Attitudes on Education for Sustainable Development. *Journal of Science Education Technology.* 16: 443-450

Varma, K. (2014). Supporting Scientific Experimentation and Reasoning in Young Elementary School Students. *Journal of Science Education and Technology*. 23: 381–397.

Vosniadou, S dan Ioannides, C. (1998). From conceptual development to science education: a psychological point of view. *International Journal of Science Education*. 20(10): 1213-1230

Yang, F.Y. & Tsai, C.C. (2010). Reasoning about science-related uncertain issues and epistemological perspectives among children. *Instructional Science*. 38: 325–354.