Profile of middle school students on scientific literacy achievements by using scientific literacy assessments (SLA)

Arif Rachmatullah; Sariwulan Diana; Nuryani Y. Rustaman

AIP Conf. Proc. 1708, 080008 (2016)

https://doi.org/10.1063/1.4941194
Profile of Middle School Students on Scientific Literacy Achievements by Using Scientific Literacy Assessments (SLA)

Arif Rachmatullah, Sariwulan Diana, Nuryani Y. Rustaman*

Department of Biology Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia, Jl. Dr Setiabudi No. 229, Bandung, West Java, Indonesia

* Corresponding author: nuryanirustaman@upi.edu

Abstract. Along with the development of science and technology, the basic ability to read, write and count is not enough just to be able to survive in the modern era that surrounds by the products of science and technology. Scientific literacy is an ability that might be added as basic ability for human in the modern era. Recently, Fives et al. developed a new scientific literacy assessment for students, named as SLA (Scientific Literacy Assessment). A pilot study on the achievements of scientific literacy of middle school students in Sumedang using SLA was conducted to investigate the profile scientific literacy achievement of 223 middle school students in Sumedang, and compare the outcomes between genders (159 girls and 64 boys) and school accreditation (A and B) using a quantitative method with descriptive research-school survey. Based on the results, the average achievement of scientific literacy Sumedang middle school students is 45.21 and classified as the low category. The five components of scientific literacy, which is only one component in the medium category, namely science motivation and beliefs, and the four other components are in the low and very low category. Boys have higher scientific literacy, but the differences not statistically significant. Student’s scientific literacy in an accredited school is higher than B, and the differences are statistically significant. Recommendation for further are: involve more research subjects, add more number of questions for each indicator, and conduct an independent research for each component.

INTRODUCTION

The development of science and technology has become one of the heated conversations in all over the world, including Indonesia [1]. The rapid advance of science and technology is one of the impacts of globalization, causing the mindset of society is increasingly critical to the need of their life. One of the aspects of life that relate to science and technology development is education, especially science education [1]. Earlier human study science, easier they can compete in the globalization era. In the era of science and technology, requiring sensitivity of problems in daily life, the basic ability to read, to write and to count is not enough yet to be able to survive in the era. So, other ability need for human to survive in globalization era, the ability, that human needs, the ability that includes scientific literacy.

Scientific literacy is the goal of basic science education [2]. There are so many definitions about scientific literacy, but in short we can call as ‘be aware of science’ [3,4]. In the wider definition many people and researchers define scientific literacy, but the definitions are not all equal [5]. Reich defines scientific literacy as wider science disciplines especially relating with science application in daily life [6]. Miller defines it as understanding level of science and technology needed in society [7]. DeBoer defines scientific literacy as a method to provide understanding of science and scientific product development, despite one will be a scientist or not [8]. And the recent definition that we used is from PISA (The Program for International Student Assessment), PISA defined scientific literacy into four definitions, one of the definitions is scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues [9].
Because of so many definitions about scientific literacy, recently Fives et al. [10] summarized the definition of scientific literacy from 1974-2010 into five components of scientific literacy. The components are the role of science, scientific thinking and doing, science and society, mathematics in science and science motivation and beliefs. Each of these components gets its indicator. Besides that, Fives et al. developed an assessment to measure systematic literacy for middle school student, the assessment called Scientific Literacy Assessment (SLA). According to Fives et al., assessments of scientific literacy, that widely used, are concentrated on specific sciences contents, especially PISA. SLA is more concentrated on the understanding of science, especially scientific method as an approach not only to the problems that are connected not only with science disciplines, but also the problems of non-science in everyday life. Thus, SLA is more concentrated on the ability of contextual science process with the general content contained therein.

With the development of new assessment and different from PISA which has been widely used, this pilot study goal is to uncover whether the achievement of scientific literacy using the SLA will close the achievement of scientific literacy from PISA. Therefore, we need a research survey in an area with a smaller scope before on a wider scope. Sumedang selected as an area of research because many middle schools in three affected class studies with Indonesia University of Education (UIP). Thus, indirectly research also revealed the achievements of scientific literacy profiles of students (especially middle school) in Sumedang based SLA and also whether the impact of class study and thus increasing the quality of teachers, especially in terms of the assessment are used. Moreover, according to the OECD [11] one of the factors that affect scientific literacy achievement is gender and school quality. Therefore, this study also reveals the differences of scientific literacy achievement between gender and between school qualities in term of school accreditation.

RESEARCH METHODS

Quantitative method with descriptive-school survey is utilized to investigate middle school student scientific literacy profile in Sumedang, Indonesia. In Sumedang, there are total 70 middle schools under the Education Department. Eight samples of school are randomly chose. The eight schools are four schools in accreditation A and four schools in accreditation B. The schools have been chosen from four different school areas that established by Sumedang Government in Education. So, in one area there is one school in accreditation A and one school in accreditation of B. There are 223 participants with 159 girls and 64 boys used as subject researches.

The instrument that used in this research is SLA that has been translated into bahasa. The translated SLA has been checked by teacher from bilingual school and lecturer in biology education at Indonesia University of Education. SLA divides into two section, section one form in 26 multiple choice or called as SLA-Demonstated (SLA-D) that put the test on cognitive components in scientific literacy (i.e. role of science, scientific thinking and doing, science and society and mathematics in science), and the section two form in 25 Likert-scale statements or called as SLA-Motivation and Beliefs (SLA-MB) that examine affective components of scientific literacy (science motivation and beliefs). In fact, the result of science motivation and beliefs converted to percent form so it could be combined with other components to conclude the total average of scientific literacy. The time for participant to finish the instrument is 50 minutes. To interpret the score of each component and total component of scientific literacy is adapted from Arikunto’s interpretation score [11]. Statistical analysis one way ANOVA was used to uncover gender and school accreditation s differences score.

RESULTS AND DISCUSSION

Based on the result of Table 1, it can be seen that the middle school student in Sumedang achieved 45.21 in scientific literacy that categorized into low category. The result has not much varied with the achievements of scientific literacy scores of Indonesian students in the PISA tests in 2000, 2003 and 2006. In 2000, 2003, and 2006 Indonesia got score of 45.6, 46.4 and 47.1 [12]. The results of each component that showed on the Table 1, all the component are on the low category, in fact two components of scientific literacy, which are scientific thinking and doing and mathematics in science, are in very low category that achieved 31.31 and 30.79. Just affective component, science motivation and beliefs, reached score that categorized in medium-high category. So the average result of scientific literacy achievements obtained much supported by the affective component scores. This can be seen from the lower score of the achievements of other components of scientific literacy scores compared with the achievements of science motivation and beliefs.
TABLE 1. Sumedang Students Achievement based on SLA test

<table>
<thead>
<tr>
<th>No</th>
<th>School</th>
<th>Scientific Literacy Components (%)</th>
<th>Role of Science</th>
<th>Scientific Thinking and Doing</th>
<th>Science and Society</th>
<th>Mathematics in Science</th>
<th>Science Motivation and Beliefs</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>School A1</td>
<td>46.47</td>
<td>42.22</td>
<td>56.67</td>
<td>41.67</td>
<td>69.60</td>
<td>51.36</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>School A2</td>
<td>46.15</td>
<td>21.37</td>
<td>41.76</td>
<td>25.00</td>
<td>64.43</td>
<td>40.14</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>School A3</td>
<td>56.82</td>
<td>30.30</td>
<td>54.11</td>
<td>38.38</td>
<td>65.53</td>
<td>49.03</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>School A4</td>
<td>52.42</td>
<td>28.32</td>
<td>52.07</td>
<td>29.03</td>
<td>69.57</td>
<td>46.28</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>School B1</td>
<td>49.19</td>
<td>33.33</td>
<td>48.85</td>
<td>25.27</td>
<td>66.43</td>
<td>44.61</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>School B2</td>
<td>43.52</td>
<td>28.40</td>
<td>47.62</td>
<td>31.48</td>
<td>66.28</td>
<td>43.46</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>School B3</td>
<td>47.83</td>
<td>35.75</td>
<td>37.89</td>
<td>28.99</td>
<td>65.95</td>
<td>43.28</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>School B4</td>
<td>48.86</td>
<td>30.81</td>
<td>44.16</td>
<td>26.52</td>
<td>67.38</td>
<td>43.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>48.91</td>
<td>31.31</td>
<td>47.89</td>
<td>30.79</td>
<td>67.15</td>
<td>45.21</td>
<td></td>
</tr>
</tbody>
</table>

Based on Figure 1, it can be seen briefly that two components achieve lower than others. Scientific thinking and doing is one component of the two components that belong to the lowest category. The low achievement of scientific thinking and doing is supported by the results of Suciati et al. [13] which showed that high school students has scientific thinking and doing achievement at least a low level compared with other components. The low achievement of these components is according to Darliana due to still weak implementation of scientific process approach [14].

FIGURE 1. Differences Between Scientific Literacy Component Achievements

Based on Figure 2, the distribution of student scientific literacy dominated in the low category with the accumulation 81% (Low 51% and Very Low 30%). The number of students who remain in a lower category as confirmed by interviews to representative students from each category, about 63% of them considers the problems, that the questions are difficult. The reason, they consider the text or the description on many questions is too long, so they cannot catch the essence of the description of the question. The statement is consistent with the statement Rustaman [15], one of the factors that affect scientific literacy achievement is the ability to read. The reasons expressed by the students indicate that reading ability of middle school students in Sumedang is still weak. The possible implications of a lack of interest in reading literacy are low. Low interest in reading allows students to be lazy to read and become less conscientious because in a hurry to read. This also supports with the results of student interviews. Low interest in reading, especially reading about the whole concept on the description or on the form of scientific process questions seems not familiarized by science teachers. This is supported by the assessment created by teachers, which is almost 95% of the questions that are made, accumulated on memorizing (C1), while the demands on scientific literacy is a content which form problem solving (C3) and analysis (C4). One of scientific literacy core is the ability to identify problems. Therefore to improve the achievement of student’s scientific literacy should be faced with the problems of daily life [16]. According to interview results, 63% of students claim that the teacher in class still rarely gave the problem analysis of any graphs or tables. However, the ability to interpret results in table forms and graphic forms is part of the indicators to be human or scientifically literate students. Memorizing content is more disliked by students. Most of the students prefer the identification of problems as in SLA. Based on the interview, one of the other reasons of student’s low scientific literacy as there are some science terms or concepts that has not been understood.
by the students. In fact, if viewed and analyzed existing concepts in SLA, all concepts that are expected to be studied by students of class IX in both the 2006 curriculum and the curriculum of 2013. This indicates the possibility of student comprehension of the content presented by the teacher might be still low.

The theme of gender equality is widely promoted, so it is making OECD always discussed the results of scientific literacy by comparing the score of boy and girl students. Therefore, this study will discuss a comparison among gender as a form of student profile in Sumedang. The results that boys and girls achieved showed in the Table 2. Based on Table 2, score of scientific literacy boys is higher than girls. These results are same with the results in PISA 2006, which shows boy’s achievement is higher than girls [17]. One aspect that causes boys’ scientific ability is higher than girls are attitude and culture [17]. Hyde & Linn argues that the high activity and aggressiveness of boys make it higher, as makes it difficult for girls to have better activity and active than boys [18]. Statistical comparison (ANOVA) using SPSS, showed that the achievement of students’ scientific literacy of boys and girls in Sumedang is not differ significantly. It is also consistent with the findings in the PISA2006 that the achievement between girls and boys are not significantly different [17]. The lack of significant differences between boys and girls gives the sense that basically every human being that both girls and boys have the same capacity, especially in terms of this ability in science. Thus it is adequate if the slogan of gender equality in various fields of life promoted as much as possible, so that each gender, especially girls who always viewed not equivalent with boys can realize their dreams and desires.

Besides gender, one of the aspects that affect the scientific literacy as has been mentioned before is school quality. In terms of school quality, in this study refers to the comparison of scientific literacy of students in schools accredited A and B, which the accreditation based on completeness of facilities and infrastructure in schools [19].

<table>
<thead>
<tr>
<th>Accreditation</th>
<th>Role of Science</th>
<th>Scientific Thinking and Doing</th>
<th>Science and Society</th>
<th>Mathematics in Science</th>
<th>Science Motivation and Beliefs</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50,83</td>
<td>30,83</td>
<td>51,55</td>
<td>33,89</td>
<td>67,79</td>
<td>46,98</td>
</tr>
<tr>
<td>B</td>
<td>47,33</td>
<td>32,05</td>
<td>45,08</td>
<td>27,99</td>
<td>66,49</td>
<td>43,78</td>
</tr>
</tbody>
</table>

Based on the result that showed in Table 3, scientific literacy score of student in accredited A is higher than in B. Statistical comparison (ANOVA) using SPSS, showed that the achievement of students’ scientific literacy in accredited A is higher statistically significant than in B. This indicates that schools with accreditation A not only better in infrastructure, but rather quality of students was better than students in schools accredited B or lower accreditation. In addition, the results obtained can be dismissed presumption in society that mention of accreditation of every school is based solely on screening documents, especially school infrastructure, while the quality of their students are less of a priority. Complete facilities and infrastructure in schools improve quality of student learning that impact on student
achievement. The results obtained according to the statement of Munger, that the type of school (in this case the difference of accreditation) is one of the factors that influence the achievement of scientific literacy [20].

The results are not same with the result that reached by the school. Most of schools with accreditation A based on Table 1 are higher than school in accreditation B, except school A2. School A2 has lower achievement and does not fit with the prediction, that schools with accreditation A will be higher than the accreditation B. Perhaps School A2 results are affected to the condition of the students at the time when they are doing the SLA test. Based on the observation of the author, at the time doing on SLA, school A2 conditions less conducive and outside the classroom is too noisy. Thus, the possibility of students cannot be concentrated in the test. In fact, scientific literacy problems need a high concentration to solve the problem.

CONCLUSION

Middle school students in Sumedang achieve scientific literacy categorized into low category and the result is not different with achieved in PISA. Scientific literacy component that categorized into high category is only scientific motivation and beliefs. Role of science and science and society categorized into low category, and scientific thinking and doing and mathematics in science categorized into very low category.

Boys have higher scientific literacy that girls, but the differences are not statistically significant. Students in the A accredited school have higher scientific literacy that in B, and the differences is statistically significant.

REFERENCES

15. Y.H. Adisendjaja (private communication).
16. N. Rustaman (private communication).