Analysis of physics textbook reviewed from the aspects of scientific literacy in the Bandung city

S Sahriani¹ *, A Samsudin², P Sinaga²

¹Master of Physics Education Program, Universitas Pendidikan Indonesia, Jl. Setiabudhi No. 229 Bandung 40154, Indonesia
²Department of Physics Education, Universitas Pendidikan Indonesia, Jl. Setiabudhi No. 229 Bandung 40154, Indonesia

*sahriani@upi.edu

Abstract. The skills that students must possess in 21st century learning are to prepare scientific literacy. This study aims to determine the ability of scientific literacy in the XI grade physics textbook used in Bandung senior high school. This research is a descriptive study that aims to obtain information about developing scientific literacy skills in the three textbooks used. The results showed that the three books did not fully contain the categories of scientific literacy with the average appearance of the categories for the three books of 44% for the knowledge of science, 31% for science as the investigative nature of science, 18% for science as a way of thinking, and 7% for the interaction between science, technology and society. It was concluded that the textbooks used were not optimal in facilitating all aspects of students' scientific literacy in a balanced manner. Therefore, the results of this study can be used as a basis for designing and developing physics textbooks needed to improve students' scientific literacy skills.

1. Introduction

In diverse learning, the existence of textbooks has a vital role during the learning process, the availability of quality textbooks will support student learning success [1, 2]. Textbooks are the main and important learning resources in learning activities to ensure the achievement of curriculum goals and educational goals [3, 4]. Quality textbooks are considered as the main tool in advancing the education of a nation and its national development. Each book chapter is equipped with a student concept map, introduction, student activity sections, both experimental and non-experimental or discussion, practice questions, evaluation summaries, and assignments for students [5].

Education should be able to develop 21st century skills of learners. They need to have good skills to solve problems and face challenges in the 21st century. Scientific literacy is a fundamental thing that is important for students to continue to be developed to build the nation, with the development of scientific literacy, other academic skills and successes will follow [6, 7, 8]. Therefore, it is necessary to have learning that is able to prepare students to gain an adequate understanding of science (known as scientific literacy).

The fact is that the management of education in Indonesia faces many obstacles. In the field of science, student achievement is assessed through the Program for International Students Assessment (PISA). The results of the PISA study indicate that the average score of scientific literacy of students in Indonesia is far below the international average which indicates that the scientific literacy of students in Indonesia is still very low. The low level of scientific literacy is partly due to some PISA examination materials that are not included in the Indonesian science curriculum, but also by the unavailability of
textbooks that meet the demands of the curriculum and competence [9]. Scientific literacy will be a provision for students to face complex global challenges. Physics textbooks need to contain scientific literacy to help students face problems in the real world and global challenges [9, 10, 11]. Books that are designed in accordance with the applicable curriculum will direct the learning process in the right direction according to the demands of the curriculum in improving the aspects of students' scientific literacy. Therefore, textbooks as a derivative form of the curriculum are indirectly required to contain aspects of scientific literacy. In other words, the 2013 curriculum textbooks used in schools must be oriented towards scientific literacy.

Physics is the most basic of the sciences. It deals with the behavior and structure of matter. One of the events that are often found in everyday life is the game “Ma'gasing” which comes from the Bugis language which in Indonesian is generally known as playing top. This game uses the concept of torque and moment of inertia.

Mathematically, torque is written as an equation

\[ \tau = \vec{F} \cdot r \sin \theta \]

Moment of inertia, written as

\[ I = mr^2 \] (2)

According to Wilkinson, the aspect of scientific literacy is close to proportional, namely 42% for the knowledge of science aspect, 19% for investigative nature of science, 19% for the science aspect as a way of thinking, and 20% for the interaction of science, technology, and society [13]. This can be expressed in a 2: 1: 1: 1 ratio for the four aspects respectively. For clarity, an illustration related to this frame of mind is presented in Figure 3.
Several textbooks that have been published have adjusted to the latest developments in science and technology, and have adapted to the existing curriculum guidance. However, it cannot be denied that there are quite a number of textbooks in circulation that are still not suitable and generally have not shown the balance aspect of scientific literacy. In order to review this, analysis of physics textbooks is very much needed as one of the guarantees for improving the quality of education in Indonesia. Research on textbook analysis or textbooks itself has indeed been widely used in Indonesia. However, research on textbook analysis based on scientific literacy content is still rare.

The main problem in this research is "whether the SMA class XI physics textbooks used in schools reflect scientific literacy?" with the following research questions: "what is the scope of scientific literacy in textbooks used in schools in terms of the knowledge of science, investigative nature of science, science as a way of thinking and the interaction of science, technology and society?". This study aims to obtain information related to the level of science literacy content in high school physics textbook class XI odd semester in the city of Bandung.

2. Method

2.1 Sample
The population of this study were all high school physics textbooks used in class XI in Bandung with curriculum 2013 revised edition 2016. Textbooks as a sample and analyzed three textbooks most widely used is based on the survey results, as shown in Table 1.

Table 1. List of Analyzed Class XI High School Physics Textbooks

| Code | Book Title | Author | Publisher |
|------|------------|--------|-----------|
| Book A | Fisika untuk SMA/MA Kelas XI (Kurikulum 2013 Revisi 2016) | Sunardi, et al. | Yrama Widya |
| Book B | Fisika untuk SMA/MA Kelas XI (Kurikulum 2013 Revisi 2016) | Marthen Kanginan | Erlangga |
| Book C | Aktif dan Kreatif Belajar Fisika untuk SMA/MA Kelas XI (Kurikulum 2013 Revisi 2016) | Ketut Kamajaya, et al. | Grafindo Media Pratama |

2.2 Design
The type of research is descriptive research. Methods of collecting the data used is the documentation method in order to obtain the percentage score data for each aspect studied according to the category of scientific literacy [12].

2.3 Instruments
The research instrument used was in the form of an analysis sheet containing indicators of aspects of scientific literacy adopted from Chiappetta et al. [12] as shown in Table 2.

Table 2. Categories of Science Literacy in Textbooks

| Scientific literacy category | Indicator |
|-----------------------------|-----------|
| The knowledge of science    | a. Present facts, concepts, principles and laws. |
|                             | b. Present hypotheses, theories, and models. |
|                             | c. Asks students to recall knowledge or information. |
| The investigative nature of science | a. Requires students to answer a question through the use of materials. |
|                             | b. Requires students to answer a question through the use of charts, tables, etc. |
Scientific literacy category | Indicator
--- | ---
Science as a way of thinking | c. Requires students to make a calculation.  
d. Requires students to reason out an answer.  
e. Engages students in a thought experiment or activity.
|  
|  
|  

Science as a way of thinking | a. Describes how a scientist experimented.  
b. Shows the historical development idea.  
c. Emphasizes the empirical nature and objectivity of science.  
d. Illustrates the use of assumptions.  
e. Shows how science proceeds by inductive and deductive reasoning.  
f. Gives cause and effect relationships.  
g. Discusses evidence and proof.  
h. Presents the scientific method and problem solving.
|  
|  
|  

The interaction of science, technology and society | a. Describes the usefulness of science and technology to society.  
b. Points out the negative effects of science and technology on society.  
c. Discusses social issues related to science or technology, and  
d. Mentions careers and jobs in scientific and technological fields.
|  
|  
|  

2.4 Data Analysis

The data obtained were analyzed descriptively by grouping the data according to the research problem and translated into words. To find out the percentage of occurrence of the scientific literacy category, the following analysis techniques were carried out:

1. Summing up the appearance of scientific literacy indicators in each category for each book analyzed.
2. Calculate the percentage of indicators appearing aspect of scientific literacy using:

\[
\text{Percentage} = \frac{\text{number of indicators per category}}{\text{total indicator number}} \times 100\% \tag{3}
\]

To determine the agreement coefficient, namely tolerance of differences in observations, an observations reliability testing technique is used [12]. Reliability is used to assess the consistency of two appraisers in assessing through a checklist that produces nominal data.

a. Data obtained in the form of scores from researchers and analysts after giving a checklist on the analysis sheet indicators of aspects of scientific literacy.

b. Calculate the percentage of agreement using the formula proposed by Grinnell [14].

\[
KK = \frac{2S}{N_1+N_2} \tag{4}
\]

c. The data is recapitulated in a recapitulation table, with the following categories:

\(<0.40: \text{very bad}; 0.40 - 0.75: \text{good}; >0.75: \text{very good.} \ [12]\)

3. Result and Discussion

The results of the analysis of customization using instruments of aspect scientific literacy, obtained the coefficient of agreement between the two observers, namely for each books A, B, and C are shown in table 3.

| No. | Book | Agreement coefficient | Category |
|-----|------|-----------------------|----------|
| 1.  | Book A | 0.90 | Very good |
| 2.  | Book B | 0.87 | Very good |
| 3.  | Book C | 0.93 | Very good |

Based on table 3, the data analysis of the agreement coefficient research results on observers I and II in each book shows very good results. The book agreement levels A, B, and C are 0.90; 0.87; and 0.93. This is in accordance with the level of agreement in Chiapetta et al. with a value of >0.75 indicating a very good agreement. With the following categories \(<0.40: \text{very bad}; 0.40 - 0.75: \text{good}; >0.75: \text{very good}\) [12].
The results of the number of occurrences and the percentage of four scientific literacy aspects in books A, B, and C are presented in Table 4.

**Table 4.** The number and percentage of four aspects of scientific literacy for each book (books A, B, and C)

| No. | Indicators of scientific literacy                  | Book A | Book B | Book C | Average (%) |
|-----|----------------------------------------------------|--------|--------|--------|-------------|
|     |                                                    | ΣN     | ΣN     | ΣN     | %           |
| 1.  | The knowledge of science                           | 885    | 1429   | 867    | 43.8        |
| 2.  | The investigative nature of science                | 705    | 929    | 642    | 31.4        |
| 3.  | Science as a way of thinking                       | 246    | 744    | 294    | 17.7        |
| 4.  | The interaction of science, technology and society | 114    | 219    | 81     | 7.1         |
|     | **Total**                                          | 1950   | 3421   | 1950   | 100         |

Based on the data in Table 4, the comparison in the three books has a tendency to rank the same level of scientific literacy, namely the largest number and percentage of occurrences in the aspect of the knowledge of science, then the investigative nature of science, science as a way of thinking, and the least in the aspect of the interaction of science, technology, and society. Can be seen that there are different proportions in the three books (A, B, and C) in terms of their numbers and percentages. Of the three books, the highest acquisition of aspects knowledge of science was in book C at 46%. For the aspect of the investigative nature of science, book A is mostly in the amount of 36%. The aspect of science as a way of thinking is in book B by 22%, while the interaction aspect of science, technology and society is in book B by 9%. After the data is obtained, the percentage description for each aspect of scientific literacy can be seen in Figure 4.

**Figure 4.** Percentage of each category of scientific literacy in books A, B, and C

The following is the proportion of the appearance of the four aspects of scientific literacy in books A, B, and C and the average proportion of appearances of scientific literacy indicators in books A, B, and C.
Based on Figure 5, the aspect of scientific literacy abilities in the three books obtained the knowledge of science by an average of 44%, the investigative nature of science with an average of 31%, science as a way of thinking with an average of 18%, and the interaction of science, technology, and society with an average of 7%. In general, the three textbooks analyzed reflect scientific literacy, but the proportion of the emergence of scientific literacy aspects that are presented is not yet balanced. The analysis shows that the knowledge aspect is very dominant compared to the other three aspects. According to Wilkonson, the aspect of scientific literacy is close to a balanced proportion, namely 42% for the knowledge of science aspect, 19% for the investigative nature of science, 19% for the science aspect as a way of thinking, and 20% for the interaction of science, technology and society or with a ratio of 2: 1: 1: 1 in order for the four aspects.

In general, the textbooks analyzed present a lot of scientific knowledge, namely presenting facts, concepts, principles, and laws. Chiapetta [12] in her research analyzing science textbooks also concluded that the textbook focuses on a collection of scientific knowledge only. The results of previous research on teaching materials have been conducted by Fairuz, et al. [15] who found that teaching materials have the same great effect as teachers, even greater because they can be studied anywhere and anytime. Sinaga, et al [10] stated that increasing scientific literacy of high school students can be done by using science books that are developed appropriately, there is a significant increase in scientific literacy in each domain. In line with previous findings, Zakiyah, et al. [16] found that there was a significant increase in scientific literacy between students who were taught using multimodus representation textbooks and students who used teaching materials commonly used in schools. When looking at the facts in the field, students are better at memorizing than science process skills. Most students in Indonesia are very skilled at memorizing knowledge, but are less able to apply it, this is due to the tendency of students to use memorization to master science. Even though physics learning must emphasize providing direct experience to develop competencies so that students can understand the natural surroundings scientifically.

4. Conclusion
Based on the analysis carried out on physics textbooks for class XI SMA in Bandung, it was found that the three books had aspects of scientific literacy, namely: the knowledge of science, the investigative nature of science, science as a way of thinking, and the interaction of science, technology, and society. However, the textbook does not contain balanced aspects of scientific literacy, only one of the aspects of scientific literacy that stands out is the knowledge of science. Therefore, the results of this study can be used as a basis for designing and developing physics textbooks needed to improve students' scientific literacy skills.

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