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The Analysis of Science Literacy Aspects in High School Biological Textbooks (First Grade) on The Biodiversity Material at SMAN 1 Kutacane

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Abstract

Background: *Textbook analysis is very important to assess the quality and suitability of the book. A teacher needs to analyze textbooks so that students can quickly understand the material being taught and read. This study aims to analyze the aspects of scientific literacy presented in the tenth-grade Biology textbooks used at SMAN 1 Kutacane, specifically in the topic of Biodiversity, as contained in two instructional materials: first book, Biology for Public High School/Islamic High School Grade 10 (Merdeka Curriculum, Erlangga publisher), and second book, Biology for Public High School/Islamic High School Grade 10 (Grafindo publisher).* **Methodology:** *The research used a descriptive qualitative content analysis method, measuring and comparing the percentage scores of four dimensions of science literacy: Scientific thinking; science as an investigative process; science as a product of knowledge; and the interaction between science-technology, and society. Data were collected from both textbooks and analyzed by calculating the percentage scores for each dimension.* **Findings:** *The results showed that Textbook I (Erlangga) had a higher percentage score than Textbook II (Grafindo). The highest dimensions in both books were "science as a way of thinking" (Book I: 61.25%; Book II: 52.50%) and "science as an investigative process" (Book I: 62.50%; Book II: 53.12%). The dimension with the lowest score was "science-technology-society interaction" (Book I: 55.00%; Book II: 48.75%). This book analysis provides empirical evidence about the importance of balancing science literacy dimensions and the need to develop textbooks that improve students' comprehensive science literacy.* **Contribution:** *This study provides a comparative insight into how different high school biology textbooks represent dimensions of scientific literacy, offering empirical guidance for improving the balance and depth of literacy components in future textbook development.*

Keywords: *Biodiversity; Science Literacy; Textbook*

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INTRODUCTION

Education is a benchmark for national progress, especially in the technological era, when scientific thinking and problem-solving skills are essential. However, in practice, the science literacy skills of students in Indonesia still show significant weaknesses. According to OECD (2023) PISA 2022 data describe about 34% of Indonesian students reached at least Level 2 in science literacy, far below the OECD average (76%). In addition, the trend in Indonesia's science literacy scores has been relatively stagnant or even declining compared to the previous PISA cycle. This situation confirms that the presentation of science material in schools has not been optimal in strengthening students' science literacy.

Science literacy is defined as a person's ability to understand science, communicate science, and apply scientific knowledge to solve problems, thereby developing a high attitude and sensitivity towards themselves and their surroundings while making choices grounded in scientific principles (Meuthia et al., 2021; Huda, 2017). Science knowledge, science as an investigative approach, science as a way of thinking, and the interaction of science, technology, and society are all included in the category of science literacy (Chiappetta & Fillman, 2017).

Science literacy is measured continuously through PISA, a long-term program designed to develop a comprehensive information system that monitors trends in student knowledge and skills across various countries. Indonesia's participation in the PISA study, which began in 1999, reveals that the country's scientific literacy achievements have not been encouraging. PISA has studied the scientific literacy of students in many developing countries, as it is considered a key to success in science learning. The 2018 PISA results indicate that the scientific literacy achievements of Indonesian students remain unsatisfactory, as they have only reached a level of around 500, not far from their previous score in 2015 (OECD, 2023).

Chiapetta et al., (1991) recommend analyzing the selection of science textbooks based on scientific literacy by considering four categories: improving scientific process skills will increase students' scientific literacy. Scientific literacy is characterized by four categories: (1) Scientific knowledge encompasses facts, concepts, laws, principles, theories, models, and hypotheses that constitute the foundational structure of science; (2) The nature of scientific inquiry is characterized by activities designed to stimulate critical thinking and investigative skills. In this regard, students are engaged in tasks such as observation, measurement, data recording, calculation, experimentation, and drawing conclusions-thereby enabling them to experience the process of scientific discovery firsthand; (3) Science as a mode of thinking describes the cognitive processes through which scientists generate and refine knowledge, emphasizing analytical and reflective reasoning as central components of scientific understanding; (4) The interrelationship between science, technology, and society is depicted through an examination of how scientific advancement both influences and is influenced by social and technological contexts.

According to Adisendjaja (2011), science literacy can be increased if teachers train students to apply process skills in their daily lives. In this regard, mastery of science literacy is a crucial factor that must be considered. This means that learning

activities should not only be oriented towards the mastery of knowledge. However, learning should not be limited to content acquisition but must also emphasize the learning process and the practical application of scientific knowledge. As stated by Asyhari (2015), scientific literacy is defined as the capacity of students to utilize their understanding of science in addressing and resolving problems. The development of scientific literacy is influenced by the extent to which students comprehend their environment. Environmental scientific literacy can be achieved when students are able to interpret natural phenomena and recognize environmental changes that are associated with human activities..

Textbooks are one source of knowledge and a significant determinant of students' educational success in school. Textbooks serve as the primary reference books read by students and are also used by most teachers. The use of textbooks by teachers is primarily driven by two underlying factors. First, the creation of classroom materials is perceived as a demanding and time-consuming process. Second, the limited availability of time—stemming from the professional responsibilities of teachers—restricts their ability to design new instructional materials (Wahyu et al., 2016).

Books are the primary source of information in learning; therefore, a good textbook structure is necessary. Especially in science learning, credible textbooks should influence and contain a balance of science literacy categories. However, existing science textbooks in the field generally do not demonstrate a balance of science literacy categories. One of the reasons for the low level of science literacy in Indonesia is the textbooks used by students. Therefore, an analysis of biology textbooks is necessary because the quality of textbooks is a crucial aspect of learning.

The biodiversity material in Grade X covers the level of biodiversity in Indonesia, the impact of human activities on biodiversity, and conservation efforts. Biodiversity education often focuses on material found in textbooks and overlooks the richness of Indonesia's biodiversity, the impact of human activities on its dynamics, and the necessary conservation efforts. Biodiversity material has learning outcome requirements that students must achieve by the end of the learning process, in accordance with the provisions of the Merdeka Curriculum. The indicator of scientific literacy in biodiversity materials is that students have the expertise to create solutions to various problems based on events around them, both nationally and globally, related to the interpretation of the diversity of living things and their roles. Students can achieve this learning through science literacy skills that train them to solve problems based on scientific knowledge, facts, and considerations, and to provide solutions to problems.

Previous research conducted by Amien (2005) showed that high school students' science literacy was low in terms of understanding and interpreting basic statistics. Maturradiyah (2015) Several factors are believed to contribute to low science literacy among Indonesian children, including the education process, one of which is the use of teaching materials. One of the teaching materials that teachers often use in teaching is textbooks. The textbooks used must be thoroughly tested for quality as a source and medium of learning. One step to develop science literacy skills is through education, particularly through biology lessons.

Kurnia et al. (2014) suggested that the curriculum and educational system, the instructional methods and models chosen by teachers, as well as the availability of learning facilities, resources, and materials, are among the various factors believed to contribute to the low level of science literacy among Indonesian students. One factor related to student learning activities is access to learning resources, such as textbooks.

Textbook analysis is based on studies conducted to examine the elements or structure of the subject matter in detail, providing a basis for discussion or interpretation. The analysis of textbooks is considered essential, as the quality of a textbook can only be determined when it is carefully examined by the teacher before use. Through such analysis, the material presented in the textbook can be more easily comprehended by students, either during instruction or when studying independently. Books as learning resources certainly have advantages and disadvantages.

One of the factors that influences the development of science and the potential of students today is the ability related to mastering science, also referred to as *scientific literacy*. According to Asyhari (2015), Scientific literacy can be characterized as the capacity through which an individual comprehends scientific concepts, communicates scientific information, and applies scientific understanding to problem-solving. Through this ability, a heightened awareness and sensitivity toward oneself and the surrounding environment are developed, enabling decision-making grounded in scientific reasoning. Scientific literacy skills are essential for preparing students to comprehend the ever-evolving fields of science and technology.

Meuthia et al., (2021) state that the weakness of science learning in Indonesia lies mainly in the weak implementation of process skills. Therefore, to improve science literacy in terms of content, context, and process skills, Science learning is expected to be designed and developed by teachers in such a way that it enables students to practice process skills in their everyday lives. Through the implementation of this instructional design, the comprehension of scientific literacy among students can be facilitated more effectively. in other words, students will become aware of the essence of science.

According to Ekohariadi (2009), the low scores obtained in the PISA study indicate that Limited scientific knowledge is generally exhibited by Indonesian students. While the content dimension tends to be understood, weaknesses are often found in the dimensions of context and process skills. However, according to Mariana (2006), The accumulation of content, process, and context dimensions is regarded as the core of science. Within this framework, the content dimension encompasses facts, definitions, concepts, principles, theories, models, and terminology, whereas the process dimension involves the skills required to obtain or identify concepts and principles. The context dimension comprises three elements, namely those relating to individuals, society, and overall school experiences.

Based on research examining aspects of science literacy by Mustari (2020); Yuliyanti & Rusilowati (2014), the results are still unbalanced across the four categories of science literacy indicators recommended by Chiapetta et al., (1991). Furthermore, a study by Variska et al., (2019) states that the results indicate the emergence of unbalanced science literacy indicators, which primarily emphasize the

contextual aspect. The results of research by Lutviana & Laelasari (2023) suggest that the 10th-grade biology textbooks analyzed reflect aspects of science literacy; however, when viewed from the sub-aspects of science literacy, not all are present, and the proportion of science literacy categories presented is unbalanced. Rahmawati & Istiningsih (2022) One of the reasons for the low level of science literacy in Indonesia is the textbooks used by students when learning. Determining suitable and good textbooks in accordance with established standards can develop science literacy skills.

According to Lailatul et al., (2015), a good textbook should complement and contain a balance of science literacy. This research was conducted to determine the extent to which the Grade X biology textbook integrates indicators of scientific literacy associated with the concept of biodiversity. The textbook appeared to place limited emphasis on scientific literacy components. Hence, an evaluation of the scientific literacy content in the 10th-grade high school biology textbook was required, encompassing four major dimensions: science as a body of knowledge, science as a mode of reasoning, science as a method of inquiry, and science in relation to technology and society. Through this assessment, the level of scientific literacy embedded in the biodiversity material of the textbook was identified.

Previous studies have examined scientific literacy in science and biology textbooks (Dewanti et al., 2022; Utviana & Laelasari, 2023; Rahmawati & Istiningsih, 2022), but few have specifically analyzed biodiversity material at the high school level based on the four dimensions of scientific literacy proposed by Chiappetta & Fillman (2007). Therefore, this study aims to analyze the extent to which the 10th-grade high school Biology textbook used at SMAN 1 Kutacane incorporates aspects of science literacy in its biodiversity material.

METHOD

This research was conducted at Senior High School-SMA Negeri 1 Kutacane, using the 10th-grade Biology textbook as the research subject. The material selected for this research was Biodiversity. The researcher analyzed two textbooks used in teaching, including: 1) Biology textbook for Senior High School/MA Grade X Merdeka Curriculum, published by Erlangga; 2) Biology textbook for Senior High School/MA Grade X, published by Grafindo.

The type of research employed was qualitative, utilizing document analysis methods, descriptive statistics, observation, and documentation. This analysis aimed to calculate the percentage of biology textbooks, where each book was analyzed by Observer I (a Biology Teacher) and Observer II (a Biology Lecturer), with each observer consisting of a single person.

In this study, the science literacy assessment, analyzed by three observers, covers four main dimensions of science literacy, as outlined by Chiappetta & Fillman (2007). These four dimensions form the basis for observers to assess the extent to which the Grade 10Th Biology textbook on *Biodiversity* contains elements of science literacy. Based on the results of these calculations, the following assessment criteria were obtained.

Table 1. Assessment criteria for the total percentage score of science literacy in the 10th grade biology textbook (Elim et al., 2024)

Interval	Criteria
81.25 % < X ≤ 100 %	Very Good
62.5 % < X ≤ 81.25 %	Good
43.75 % < X ≤ 62.5 %	Fair
25% < X ≤ 43.75 %	Not Good

Sample or Participant

This study was conducted at SMAN 1 Kutacane, using the 10th-grade biology textbook as the research subject. The material selected for this study was biodiversity. The researcher analyzed two textbooks used in teaching, including: 1) Biology for Senior High School/MA Grade X by Dra. Iryaningtyas, M.Pd and Syiva Sagita, S.Pd, M. Si, published by Erlangga Kurikulum Merdeka; 2) Biology Textbook for Senior High School/MA Grade X by Grafindo Publishers. Three observers conducted data analysis: Observer I (the observer), Observer II (a Biology Lecturer), and Observer III (a Biology Teacher).

RESULTS AND DISCUSSION

The results of the research on science literacy in the 10th-grade biology textbook at SMA Negeri 1 Kutacane revealed that the analyzed textbook contained an unbalanced science literacy. The four dimensions of science literacy are science as the core of knowledge, science as an investigative process, science as a way of thinking, and science as a relationship between technology and society. The textbooks used as research subjects in the study were labeled Book I and Book II. The percentage scores for the dimensions of science literacy can be seen in the following table 2.

Table 2. Percentage of Scientific Literacy Dimension Scores in Book I

No	Literacy Dimension	Book I		
		Observer I (%)	Observer II (%)	Average (%)
1	Science as a body of knowledge (*science as a body of knowledge*)	80	52.5	66.25
2	*Science as a way of thinking*	67.5	55	61.25
3	Science *as a way of investigating*	68.75	56.25	62.5
4	*Science and* its interaction with technology *and society*	62.50	47.5	55.00
∑ score percentage 100		278.75	211.5	245
Average percentage of total score (x)		69.68	52.87	61.25

Table 3. Percentage of Scientific Literacy Scores in Book II

No	Literacy Dimension	Book II		
		Observer I (%)	Observer II (%)	Average (%)
1	Science as a body of knowledge (*science as a body of knowledge*)	60	65	62.5
2	*Science as a way of thinking*	52.5	52.25	52.25
3	Science *as a way of investigating*	50.20	56.25	53.12
4	*Science and* its interaction with technology *and society*	47.50	50.00	48.75
∑score percentage 100		210.00	223.75	216.87
Average percentage of total score (x)		52.5	55.93	54.21

The science literacy dimension score for both books was obtained as a percentage, with Book I scoring 61%, which is categorized as fairly good, and Book II scoring 54%. This is categorized as fairly good because both books analyzed presented a percentage score of ≥ 50% in the section containing the science literacy dimension. The different percentages of the two books were determined according to the assessment indicators for biology textbooks in terms of the science literacy dimension. Additionally, the emergence of the science literacy dimension was more pronounced in Book I than in Book II. For example, Book I contained a QR code that students could scan to visit a website about biodiversity, which they could access simply by pointing their cell phone camera at the QR code, while Book II only provided a website link that students could visit to learn about the respiratory system, which they had to type manually to access.

Analysis of the textbook in terms of the science dimension, as the main body of knowledge, reveals that it accounts for a greater proportion in Book I, specifically 66.25%, compared to Book II, which is 62.5%. Chiappetta & Koballa (2010) state that the theme or dimension of science is the collection of knowledge that most often appears in analyzed textbooks, focusing on science based on the explanations of scientists' ideas, which consist of principles, laws, theories, models, facts, concepts, and assumptions. This indicates that the authors tend to emphasize scientific facts, concepts, principles, and models as a means of imparting information to students. Both books also emphasize the dimension of science as an investigative process, which appears second most frequently after the dimension of science as the body of knowledge. Furthermore, the dimension of science as a way of thinking. In Book I, the percentage is greater than in Book II, specifically 61.25% in Book I and 52.5% in Book II. This dimension shows how scientists think and conduct research.

According to the analysis results, it appears that there are very few situations that encourage students to think critically and at a high level about questions related to the material's content. This situation aligns with Cobanoglu & Sahin (2009), who demonstrated that there are very few situations that encourage students to think at a high level. The biology textbooks analyzed contain errors or misconceptions, and they do not provide questions, inquiries, or approaches that promote critical thinking; instead, the methods used are primarily rote learning. Then, in the realm of

science as an investigative process, it demonstrates how students construct knowledge through the scientific process and its associated methods. This dimension is presented more extensively in the book through experimental activities that students can conduct. Similar to the research by Chiappetta & Filman (2017), this category encompasses direct activities and experiments that students can carry out to support their understanding of concepts.

In both books analyzed, the situations that arise are mostly practical activities; however, some situations encourage students to use scientific inquiry, calculation activities, and problem-solving using scientific processes. Based on the two books, only Book I contains new information from the internet along with a QR code that can be scanned to access links by students. Very little in these two books reflects the dimension of science as a relationship between technology and society. In Book I, the average is 55%, and in Book II, it is 48.5%. This finding aligns with the research by Wahyu et al., (2016), which analyzed 10th-grade biology textbooks in terms of science literacy, yielding a 4% result for the dimension of science as a relationship between technology and society. According to Ariningrum (2013), a good textbook effectively connects each material to scientific research and science, technology, and society by highlighting how science is carried out and its role in life, as well as mentioning careers related to the material, thereby providing students with an overview of related career opportunities. This dimension illustrates how an individual contributes to the advancement of science and technology, and conversely, how science and technology support an individual in solving their problems. In both books, there is a greater emphasis on the benefits of science and technology to society, and less on the careers and negative impacts in the field of science. A good textbook is one that can connect each subject to technology, science, society, and scientific research by illustrating the application of science and how it is carried out (Campbell et al., 2010).

Other aspects that influence the research results are quite adequate. Many schoolbooks published by several publishers cover only science content related to principles, theories, models, factual terms, definitions, and concepts. Meanwhile, the proportion of context and process perspectives is minimal, or even not included at all in textbooks. Therefore, the scientific mechanisms contained in these books are imperfect or very limited. This is supported by research from PISA, which shows that the level of science literacy among students in Indonesia has generally remained low from year to year. Based on this situation, textbooks play a key role in improving students' science literacy, including developing their ability to apply scientific skills, solve problems that arise, and understand the signs of nature that occur around them (Martiasari et al., 2022).

Science literacy is highly relevant in textbooks as a teaching resource; therefore, textbooks used in learning should incorporate science literacy, enabling students to increase their own science literacy. Furthermore, high-quality textbooks have a significant impact on learning success. As the foundation of knowledge, scientific literacy has been the subject of extensive discussion. In the preparation of textbooks, greater attention is generally directed by authors and publishers toward scientific content—such as theories, principles, and factual knowledge—that students

are expected to memorize and comprehend. Meanwhile, the enhancement of students' cognitive and reasoning processes tends to receive less focus. This condition was demonstrated through Abdulkarim (2007) study on textbook analysis and its implications for strengthening high school students' thinking abilities, which revealed that the textbooks currently available fail to encourage reflective thinking or assist learners in developing their critical thinking capacity.

According to Carin & Sund (1993), science is systematic or organized knowledge that is universally applicable and consists of a collection of data from observations and experiments. Activities in science are always related to experiments that require skills and craftsmanship. Simply put, science can also be defined as what scientists do. Thus, science is not only a collection of knowledge about objects or living things, but also concerns how things work, how to think, and how to solve problems. Scientists are always interested in and pay attention to natural events, always wanting to know what, how, and why about a natural phenomenon and its relationships.

CONCLUSION

Based on the study's results, it can be concluded that the 10th-grade high school biology textbook on biodiversity at Senior High School-SMA Negeri 1 Kutacane encompasses all four dimensions of science literacy; however, these dimensions are not balanced. The book from the publisher Erlangga received an average score of 61.25% (in the fairly good category), while Grafindo received 54.21% (also in the fairly good category). The dimension with the highest percentage was "science as an investigative process" (62.5%), while the lowest was "science and its interaction with technology and society" (48.75%). Therefore, it can be concluded that the level of science literacy in the Grade 10 high school biology textbook on biodiversity used at this school is quite good according to the assessment criteria. There is a need to develop textbooks that highlight the relationship between science, technology, and community life, enabling students to develop their science literacy comprehensively.

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