

ANALYSIS OF GRADE XI SCIENCE TEXTBOOKS IN HIGH SCHOOL BASED ON ASPECTS OF SCIENTIFIC LITERACY

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ABSTRACT

Textbook plays a crucial role in enhancing students' scientific literacy skills. This study aims to evaluate the level of scientific literacy in the biology textbook for Grade XI based on four aspects: scientific knowledge, nature of scientific inquiry, science as a way of thinking, and the interaction between science, technology, and society. Three biology textbooks for Grade XI used in the Medan Tembung district, North Sumatra, were randomly selected, namely Bumi Aksara, PT Tiga Serangkai, and Grafindo Media Pratama. The results of the study indicate that the proportions of scientific literacy aspects in these three textbooks are unbalanced. The aspect of scientific knowledge shows a good percentage (81.42% for Bumi Aksara, 72.90% for PT Tiga Serangkai, and 70.88% for Grafindo). However, the aspects of the nature of scientific inquiry, science as a way of thinking, and the interaction between science, technology, and society have poor percentages for all evaluated textbooks. Therefore, the appropriate selection of textbooks by teachers is crucial in improving students' scientific literacy skills.

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INTRODUCTION

Scientific literacy is the ability possessed by individuals to use knowledge, communicate, understand, and apply scientific skills to solve problems and draw conclusions based on evidence (OECD, 2016). This ability is highly necessary for the entire Indonesian society, including students (Kemendikbud, 2017). It facilitates students' adaptation to the development of science and technology, enabling them to meet the demands of the times as problem solvers, creative individuals, competitive, innovative, collaborative, and possessing character (Nurfaidah, 2017).

The Programme for International Student Assessment (PISA) study reveals that the scientific literacy skills of students in Indonesia are still ranked low (OECD, 2019). The research findings of Putri (2021) also explain the low level of scientific literacy skills among Indonesian students. Students have not been able to comprehend scientific concepts, processes, and apply acquired knowledge in daily life (Sutrisna, 2021). This is supported by field observations where students are more capable of memorization rather than developing scientific process skills to acquire knowledge (Yulianti, 2014).

There are several factors contributing to the low level of scientific literacy in Indonesia, one of which is the selection of learning resources (Wahyu et al., 2016). Learning resources commonly used by students are in print form, namely textbooks (Kurnia et al., 2014). A good textbook should fulfill four aspects of scientific literacy, namely scientific knowledge, inquiry into the nature of science, science as a way of thinking, and the interaction between science, technology, and society (Chiapetta, 1993; Chiapetta & Adams, 2018; Sadler & Zeidler, 2021).

Analysis of science textbooks has been conducted by several researchers, such as Udeani (2013), who revealed that the aspects of science as a thinking process and science as the relationship between technology and society have not been fulfilled. Wahyu et al. (2016), Kurnia et al. (2014), and Adisendjaja (2007) showed that the four categories of scientific literacy have not demonstrated a balanced proportion. The study by Ginting and Suriani (2018) indicated that the dimensions of scientific literacy are imbalanced, and three dimensions of science are categorized as inadequate. The selection of appropriate textbooks needs to be done by teachers, but based on interviews with biology teachers, it is known that the provision of textbooks comes from the School Operational Assistance (BOS). Therefore,

teachers do not have the freedom to choose the textbooks used for the school.

Based on the observations conducted in high schools in the Medan Tembung sub-district, North Sumatra province, it was found that seven different textbooks were used in those schools. The most commonly used book is published by Grafindo Media Pratama and authored by Yusa and Manickam Bala Subra Maniam. It is suspected that the circulating books in schools, especially in the Medan Tembung sub-district, have an imbalanced proportion of scientific literacy aspects. This suspicion is reinforced by the preliminary study results on Grafindo Media Pratama publisher regarding the cell topic.

The analysis of biology textbooks needs to be conducted to obtain information and knowledge about scientific literacy in those books. Previous researchers have only analyzed specific topics, which do not represent the overall quality of the books. Therefore, this study aims to analyze all the main topics found in the senior high school biology textbook for the eleventh-grade science stream based on scientific literacy aspects.

METHOD

This study is a descriptive research. The population in this study consists of seven eleventh-grade high school biology textbooks used in schools in the Medan Tembung sub-district. The sampling technique used in this study is Simple Random Sampling with the Independent Choice of Digits approach. The sample used in this study is the eleventh-grade biology textbooks that cover 11 main topics from three different authors: Slamet Prawiroharto, Sri Hidayati, and Sudjoko published by Bumi Aksara (book 1); Sri Pujiyanto and Rejeki Siti Femiah published by PT Tiga Serangkai Pustaka Mandiri (book 2); Yusa, Manickam Bala Subra Maniam published by Grafindo Media Pratama (book 3). The instrument used in this study is an assessment sheet of scientific literacy aspects based on modifications from Chiapetta et al (1991) and Wulandari (2019), as shown in Table 1.

Tabel 1. Aspects and indicators of scientific literacy

Scientific literacy aspects	Indicators
Science Knowledge	- Presenting facts, concepts, principles, laws, hypotheses, theories and models of science
Investigation of the Nature of Science	- Presenting questions from the material that has been presented. - Presenting questions that require students to answer using pictures, tables and so on. - Presenting questions that require students to make calculations (calculations). - Presenting questions that encourage students to give and explore reasons for an answer.
Science As a Way of Thinking	- There is a description of how scientists experiment. - Presents the historical development of an idea. - Emphasizes the empirical nature and objectivity of science. - Shows a causal relationship. - Discuss facts and evidence. - Presenting the scientific method and problem solving.
The Interaction Between Science, Technology and Society	- Presenting the positive impact of science and the negative impact of science on society. - Describe the relationship between science, society and technology such as social issues related to science. - Mention careers or jobs in the field of science and technology.

There are several stages to analyzing data on biology books for class XI high school, namely (1) calculating and summing the occurrence of scientific literacy indicators for each aspect in each book analyzed; (2) Calculating the percentage of occurrence of scientific literacy indicators for each aspect using a formula based on Adisenjaja (2007). (3) The interpretation of the level of scientific literacy uses the criteria based on Ali (1992), namely 90-100% (very good), 80-89% (good), 70-79% (fairly good), 60-69% (poor) and smaller than 60 (not good).

RESULTS AND DISCUSSION

In the cell material, book 2 demonstrates higher scores for the aspects of science as a way of thinking and interactions between science, technology, and society compared to the other books. However, book 2 also has the highest score for the aspect of scientific knowledge, while book 1 has the highest score for investigating the nature of science.

In the plant tissue material, book 1 exhibits higher scores for the aspects of scientific knowledge and the interaction between science, technology, and society compared to the other books. On the other hand, book 2 has the highest score for the aspect of science as a way of thinking, and book 3 has the highest score for investigating the nature of science.

In the animal tissue material, book 1 demonstrates higher scores for the aspects of

scientific knowledge and investigating the nature of science compared to the other books. However, book 2 has the highest score for the aspect of science as a way of thinking, and book 3 has the highest score for investigating the nature of science.

Regarding the motion systems and regulatory systems material, the pattern remains consistent, with book 2 having higher scores for three aspects of scientific literacy compared to the other books, except for the aspect of science as a way of thinking, where book 1 has the highest score.

In the circulation system material, book 1 demonstrates higher scores for the aspects of scientific knowledge and interactions between science, technology, and society compared to the other books. Meanwhile, the other two aspects are found in book 3.

On the digestive system material, book 1 exhibits higher scores for three aspects of scientific literacy compared to the other books, except for the aspect of interaction between science, technology, and society, where the highest score is found in book 3.

For the respiratory system material, book 3 has higher scores for science as a way of thinking and the interaction between science, technology, and society compared to the other books. However, the highest score for the aspect of scientific knowledge is found in book 1, and the aspect of investigating the nature of science is found in book 2.

In the excretory system material, book 1 demonstrates higher scores for science as a way of thinking and the interaction between science, technology, and society compared to the other books. However, the highest score for the aspect of scientific knowledge is found in book 3, and the aspect of investigating the nature of science is found in book 2.

Regarding the reproductive system material, book 2 has higher scores for two aspects, scientific knowledge and investigating the nature of science, compared to the other books. However, aspects of science as a way of thinking and interactions between science, technology, and society are covered in book 1.

On the body's defense system material, book 2 exhibits higher scores for three aspects of scientific literacy compared to the other books, except for the aspect of interaction between science, technology, and society, where the highest score is in book 3.

The distribution pattern of the four aspects of scientific literacy varies both between books and within the same book. Even in the animal tissue material of book 2, aspects of interaction between science, technology, and society are not included. The results of the analysis of scientific literacy aspects in the three books are presented in table 2.

The dominance of scientific knowledge is evident in all three books compared to other aspects of scientific literacy. These books provide an abundance of facts, concepts, principles, theories, pictures, and new information, aiming to enhance students' understanding. Adisendjaja (2007) also reported similar findings, indicating that the percentage of scientific knowledge as a body of knowledge was 82%. Additionally, Kaya et al. (2012) discovered that the extent and depth of scientific knowledge presented in educational materials can influence students' attitudes towards science. However, Lailatul et al. (2005) cautioned that an overemphasis on scientific knowledge may hinder students' ability to apply their knowledge effectively.

The study reveals that the aspects of investigating the nature of science in the three books were not considered satisfactory criteria. Hamida et al. (2020) noted that this aspect often follows the presentation of scientific knowledge. The percentage of investigating the nature of science in this study ranged from 9% to 17%. The materials presented in the three books primarily focus on encouraging students to explore, discover, and construct answers, emphasizing the process of obtaining answers. This aligns with Shymansky's constructivist learning theory, as

described by Suparlan (2019), which emphasizes students' active engagement in constructing their own knowledge, exploring the meaning of learning, and utilizing existing frameworks to develop new concepts and ideas. However, the three books rarely include questions or assignments that require students to answer using tables, diagrams, charts, or pictures. Consequently, the opportunities for students to build their knowledge and refine new concepts and ideas through these visual aids are limited. The practice questions predominantly consist of textual multiple-choice and essay formats.

The study revealed that the criteria for investigating the nature of science in the three books were considered inadequate. According to Hamida et al. (2020), this aspect often appears after the aspect of scientific knowledge. The investigation of the nature of science aspect in this study ranged from 9% to 17%. The material presented in the three books primarily focuses on the indicator of encouraging students to explore, discover, and construct answers, as well as understanding how those answers are obtained. This aligns with Suparlan's (2019) constructivism learning theory, which emphasizes students' active engagement in constructing their own knowledge, exploring the meaning of learning, and utilizing existing frameworks to enhance new concepts and ideas. However, the three books rarely include questions or assignments that require students to answer using tables, diagrams, charts, or pictures. Instead, the practice questions mostly consist of textual multiple-choice and essay formats.

In this study, it was revealed that the aspect of scientific thinking, including the criteria, was considered inadequate, ranging from 6.68% to 9.42%. According to Dewi and Putra (2022), this aspect is rarely displayed in textbooks. Although in small quantities, the presented material in the three books can evoke students' curiosity and imagination about natural phenomena. Aqil (2017) argues that science as a way of thinking should be seen as an activity to gain understanding about nature and its properties. If textbooks tend to be oriented towards such indicators, students will be trained to always be curious and imagine natural phenomena beyond their surroundings. Additionally, the three books rarely include the indicator "the book presents the historical development of a scientific idea and how scientists conduct experiments."

In this study, it was also found that the aspect of the interaction between science, technology, and society accounted for a percentage that was considered inadequate in all three books, ranging from 2.23% to 4.65%. The three books present

material explaining the positive impact of the use of science and technology on society. The indicator "the book presents how scientific concepts are applied in technology within society" appears more frequently in book 3. However, this aspect is typically presented to a lesser extent. This finding aligns with Udeani's (2013) research, which indicated a range of percentages for the aspect of

science, technology, and society as 2.6% to 2.9%. This aspect is particularly intriguing for students as it includes indicators that depict events commonly encountered in daily life, especially in the field of biology (Wahyu et al., 2016). It is crucial for a biology textbook to include this aspect so that students can apply their knowledge to address everyday problems.

Table 2. Results of the Assessment of Scientific Literacy Aspects for Each Subject in Class XI Biology Books

Topics	Scientific Literacy											
	Scientific knowledge (%)			Investigation of scientific nature (%)			Science as a way of thinking (%)			The Interaction Between Science, Technology and Society (%)		
	1	2	3	1	2	3	1	2	3	1	2	3
Cell	13,08	10,39	6,46	6,69	13,61	14,64	11,11	21,59	4,97	8,57	20,00	4,41
Plant Tissue	9,93	5,37	5,01	5,26	5,23	7,64	6,17	7,95	6,46	5,71	4,00	2,94
Animal Tissue	4,36	5,37	5,49	3,82	5,75	10,19	6,17	4,54	5,97	11,42	0,00	5,88
Motion System	6,89	11,00	6,55	5,26	11,51	8,28	8,64	5,68	7,69	14,28	28,00	17,64
Cardiovascular	9,63	6,84	7,61	6,22	9,42	12,10	13,58	13,63	22,77	11,42	8,00	5,88
Digestive System	14,30	8,55	11,86	16,04	7,85	9,55	11,11	7,95	10,94	5,71	8,00	11,76
Respiratory System	8,51	6,60	6,75	3,34	7,85	3,82	11,11	12,05	13,93	5,71	4,00	8,82
Excretion System	5,88	5,50	9,06	2,39	8,37	5,73	9,87	6,81	9,45	20,00	4,00	14,70
Regulation System	14,50	19,07	18,61	4,78	10,99	8,91	14,81	9,09	12,93	5,71	12,00	4,41
Reproduction system	8,37	9,29	4,14	3,82	9,94	4,54	6,17	4,54	2,98	8,57	8,00	4,41
Immune System	5,27	11,98	9,45	4,30	9,42	8,91	1,23	5,68	5,47	2,85	4,00	17,64

Notes: (1) Script Book Publishers written by Slamet Prawiroharto, Sri Hidayati and Sudjoko; (2) Publisher PT Tiga Serangkai Pustaka Mandiri written by Sri Pujiyanto and Rejeki Siti Femiah; and (3) Yusa's Grafindo Publisher, Manickam Bala Subra Maniam

Table 3. Recapitulation of Scientific Literacy Aspects in the Three Books

Book	Scientific Literacy Aspect (%)			
	1	2	3	4
1	81,42 (good)	9,00 (poor)	6,68 (poor)	2,89 (poor)
2	72,90 (moderate)	17,02 (poor)	7,84 (poor)	2,23 (poor)
3	70,88 (moderate)	10,73 (poor)	13,74 (poor)	4,05 (poor)

Information:

- (Book 1) Bumi Aksara Publisher; (Book 2) Publisher PT Tiga Serangkai Pustaka Mandiri; and (Book 3) Grafindo Publisher.
- Knowledge of science (1), Investigation of the nature of science (2), Science as a way of thinking (3), Interaction between science, technology and society (4).

Based on the findings of this study, the Grafindo publisher's book presents material systematically, with detailed explanations that follow current developments. This book stands out in providing the latest web links, thereby expanding students' knowledge and insights, even though the proportion of scientific literacy aspects is not balanced.

Scientific literacy aspects in textbooks should be presented with a balanced proportion for each aspect, including scientific knowledge, the nature of scientific inquiry, scientific thinking, and the interaction between science, technology, and society. According to Wilkinson (1999), a balanced distribution of scientific literacy aspects consists of 42% for scientific knowledge, 19% for the nature of scientific inquiry, 19% for scientific thinking, and

20% for the interaction between science, technology, and society. Achieving balance in each of these aspects can enhance students' scientific literacy skills and improve the quality of their science education. However, an imbalance in the proportion of these aspects can have an impact on students' scientific literacy abilities. Scientific literacy plays a vital role in developing students' scientific competence and preparing them to face various challenges in their daily lives (Martiasari et al., 2022).

CONCLUSION

Based on the obtained research results, it was concluded that the analyzed biology books for Class XI IPA had an unbalanced percentage of scientific literacy. Book 1 had the highest

percentage of scientific knowledge aspects, amounting to 81.42%. Book 2 had the highest percentage of aspects related to investigating the nature of science, which was 17.02%. Book 3 had the highest percentage of aspects related to science as a way of thinking, which was 13.74%. Additionally, Book 3 also had the highest percentage of the aspect of interaction between science, technology, and society, which was 4.05%.

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