

Research Article

Cite this article: Siwi, D. A., Sajidan., Siswandari., & Gunarhadi. (2025). Representation of Scientific Literacy in Elementary School Science Textbooks: A Critical Discourse Analysis. *Educational Process: International Journal*, 18, e2025443. <https://doi.org/10.22521/edupij.2025.18.443>

Received June 21, 2025

Accepted August 18, 2025

Keywords: Scientific literacy, science textbooks, elementary school

Author for correspondence:

Dwi Anggraeni Siwi

✉ dwiangraenisiwi@student.uns.ac.id

✉ Universitas Sebelas Maret, Indonesia

**OPEN ACCESS**

© The Author(s), 2025. This is an Open Access article, distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction, provided the original article is properly cited.

Representation of Scientific Literacy in Elementary School Science Textbooks: A Critical Discourse Analysis

Dwi Anggraeni Siwi[✉], Sajidan[✉], Siswandari[✉], Gunarhadi[✉]

Abstract

Background/purpose. Scientific literacy plays a crucial role in fostering inquiry and scientific understanding. This article examines the integration of scientific literacy in elementary school science textbooks through an inquiry-based pedagogical approach, employing a semiotic perspective. This study aims to assess the implementation of science literacy-based learning through the presentation of fourth-grade elementary science textbooks that are widely used in current education.

Materials/methods. This study used a qualitative descriptive method with a descriptive design. The data source was a fourth-grade science textbook by Amalia Fitri. Data collection techniques included documentation, reading analysis, and citation techniques. Data analysis involved breaking down information by identifying patterns, categories, and fundamental units of description.

Results. This study shows: (1) the content of science knowledge as a body of knowledge only appears at the beginning of each chapter as an introduction to learning objectives; (2) the content of investigation has the highest percentage, marked by students being given broader opportunities to be actively involved in learning; (3) the content of science as a way of thinking describes how a scientist experiments, presents the historical development of an idea, emphasizes the empirical and objective nature of science, and describes human imagination and creativity; and (4) the content about the interaction between science, technology, and society includes statements that discuss social issues.

Conclusion. The textbook analysis indicates that the aspects of science as a way of investigating and science as a way of thinking are more dominant compared to the other aspects.

1. Introduction

In primary education, teachers face the challenge of introducing scientific literacy as part of fostering attitudes and awareness of scientific literacy from an early age (Fishman, Yang, & Mandell, 2021). Introducing and instilling scientific literacy in school children is essential to help them act as scientifically aware citizens with a scientific mindset. This awareness and mindset are crucial for understanding and responding to scientific phenomena in daily life or their social environment. Thus, the role of scientific literacy cultivation among school children is vital for developing scientific thinking at a young age, which can be manifested in their everyday lives (Chen & Cai, 2020).

Commonly, scientific literacy is defined as the ability to engage with scientific issues and ideas as informed citizens (Mork et al., 2022). Nigro (2022) further elaborates that scientific literacy aims to evaluate the application of scientific knowledge to real-life situations from the students' perspectives. Therefore, instilling scientific literacy in schools should be a primary focus for teachers as agents of scientific literacy (Mukhopadhyay, 2014). Epistemologically, scientific literacy is not merely about the natural human curiosity but also emphasizes the values of care and respect for existing scientific knowledge (Oliver & Adkins, 2020). It encourages inquiry-based thinking and investigative enthusiasm. Schools, therefore, play a critical role in providing opportunities to instill scientific literacy in students from an early age, fostering individuals who are not only intellectually capable but also emotionally mature (Tommasi, Petricca, Cozzolino, & Casadio, 2020:8). Without this, learning would merely result in the acceptance of dogma and would never lead to the development of an appropriate orientation toward scientific endeavors (Yu et al., 2022).

Empirical evidence suggests that scientific literacy must be developed in students to achieve comprehensive learning goals, rather than focusing solely on cognitive skill development in primary education (BouJaoude & Nouredine, 2020). Teachers should create opportunities to nurture students' natural curiosity and learning abilities. In managing classroom learning, teachers must provide students with an understanding of the concepts presented in the textbooks used in their teaching (Lee & Wan, 2022). Science lessons should be valued not only for their content but also for the values imparted during the learning process (Garthwaite et al., 2014).

In education and science classrooms, textbooks play a key role in shaping students' conceptions and literacy regarding scientific knowledge (Zhu & Tang, 2023). With strong scientific literacy instilled in students, it is expected that these attitudes will persist in their daily lives (Biologi, 2018). Scientific literacy is developed through student activities in science learning, such as discussions, experiments, simulations, and field projects (Sari et al., 2018).

These learning processes are inherently tied to learning resources, particularly textbooks. Science textbooks should facilitate process skills, serving as a guide to help students develop basic scientific literacy (BouJaoude & Nouredine, 2020). To support science literacy-based learning, teaching materials must enable its implementation. While many elementary-level textbooks from various publishers are currently available, it is necessary to examine whether these textbooks adequately facilitate science literacy-based learning. The development of scientific literacy in primary education must align with students' cognitive development stages (Andersen, 2018).

Previous studies have highlighted that teachers often rely heavily on textbooks, despite common misconceptions that reading comprehension is merely the process of understanding individual words in a text (Slough et al., 2010). Other research has analyzed student textbooks from a critical thinking perspective in integrative thematic contexts (Gumilar et al., 2022). Both studies attempted to dissect the subject matter solely, focusing on content analysis and not critical analysis. Critical discourse analysis, however, can provide insight into the representations found in textbooks. Given this context, a solution to address this problem is through critical discourse analysis, which analyzes the extent to which textbooks meet the components of scientific literacy. The purpose of this study was to evaluate

the implementation of scientific literacy-based learning using a widely used fourth-grade science textbook in elementary schools.

2. Literature Review

2.1. Scientific Literacy

Scientific literacy refers to the ability to engage with scientific issues and ideas as a thoughtful citizen (Bellová et al., 2021). It equips individuals with the capacity to make informed decisions in daily life by evaluating scientific information and concepts. From this perspective, it can be concluded that scientific literacy enables individuals to solve everyday problems through a scientific lens (Lelliott, 2014). According to PISA (2015), scientific literacy consists of four interrelated aspects: context involving issues at the personal, local/national, or global level, both current and historical, that require an understanding of science and technology; knowledge that includes an understanding of the facts, concepts, and theories that form the basis of scientific knowledge; competencies that include the ability to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and facts scientifically; and attitudes that refer to a set of attitudes toward science, demonstrated through interest in science and technology, appreciation of scientific approaches to inquiry, and awareness and perception of environmental issues (Ustun et al., 2022).

2.2. Textbooks

Textbooks hold a central position as a learning resource, providing materials necessary to achieve curriculum-mandated learning objectives (Kim et al., 2011). They serve as a critical source of knowledge for students, particularly given the integral role of reading and writing in educational activities (BouJaoude & Nouredine, 2020). Reading involves the process of understanding and utilizing language, especially in its written form.

Textbooks are designed to meet specific criteria for learning activities and are systematically organized for assimilation (Ritchie et al., 2011). As a tool, they help students comprehend and learn from the material they read while also fostering their understanding of the world. Consequently, textbooks are structured to support educational programs and assist teachers in planning, selecting tasks, and implementing lessons (Carrejo & Reinhartz, 2014). Textbooks play a vital role in determining the success of learning processes (Stylianidou et al., 2002). Students use them for independent practice, and their presentation influences how students engage with and utilize the material. Therefore, textbooks must foster attitudes aligned with the desired competencies and stimulate students' interest in learning (Román & Busch, 2016).

Previous research on science textbooks has provided valuable insights into their use in science education. Studies have evaluated the role of science textbooks in classroom learning contexts, employing methods such as observations, interviews, and surveys to assess their effectiveness in supporting science instruction.

2.3. Critical Discourse from a Social Semiotics Perspective

Analysis can be interpreted as an effort to break down a unit into separate components, dividing it into sub-parts, distinguishing between similar elements, and identifying differences within a unified structure (Slough et al., 2010). Analysis serves as an activity to uncover new findings regarding the object of study or observation by identifying accurate evidence related to the object (X. Chen, 2017).

Critical discourse is an analytical approach that involves a thorough understanding of texts and the social contexts in which they are situated (Zhu & Tang, 2023). From the perspective of social semiotics, critical discourse focuses on understanding how signs and symbols are utilized in social communication, particularly in textbooks, to reveal the meaning embedded in written content (Oliver & Adkins, 2020).

Social semiotics is an approach used to study how symbols and signs are employed in social contexts to convey meaning and influence human interaction (Semiotika et al., 2023). In the context of elementary science textbooks, the social semiotics approach can be employed to analyze how symbols and signs are utilized to convey scientific information to students. The elements that can be analyzed using a social semiotics approach in elementary science textbooks include:

First, the images and illustrations used in science textbooks. Visual symbols and signs, such as pictures, diagrams, and graphs, are used to visualize scientific concepts. Social semiotic research examines how these symbols are used to help students understand concepts and how effectively they convey learning material.

Second, language and terminology: Social semiotic analysis can also assess the use of language in science textbooks. The way words and phrases are used to describe scientific concepts can significantly impact student comprehension. Social semiotic research can determine whether the language used is suitable for students' levels of understanding and whether language variations affect their comprehension.

Third, gender representation and stereotypes in science textbooks can reflect gender roles and stereotypes in the context of science. Social semiotic analysis can reveal whether the textbooks perpetuate specific gender stereotypes or encourage students to develop diverse interests and participation in science regardless of gender.

Fourth, information organization involves analyzing how science textbooks structure and organize information. The arrangement of information, including text, subheadings, bullet points, and page layout, can influence how students organize and comprehend the material presented.

Sixth, regarding activities and assignments. Social semiotic analysis can examine how the assignments and activities presented in science textbooks help students understand and apply scientific concepts. Social semiotics can evaluate whether these assignments and activities encourage critical thinking, develop observational skills, and connect scientific concepts to students' everyday lives.

By employing a social semiotics approach, we can uncover how symbols and signs in elementary science textbooks contribute to the learning process. Social semiotics analysis helps identify the strengths and weaknesses in the representation of science within textbooks. Critical discourse in social semiotics involves an in-depth examination of the signs and symbols used in texts or social communication, analyzing the meanings embedded in signs such as words, images, logos, and other symbols.

3. Methodology

3.1. Research Method

This study employed a qualitative research approach with critical discourse analysis (Waugh et al., 2016). The researchers described all elements reflecting aspects of scientific literacy. The data generated in this study consisted of verbal data, highlighting the manifestation of scientific literacy aspects in fourth-grade science textbooks, with a focus on analysis and evaluation. The data used in this study consisted of sentences and evaluation models contained in the textbooks. Therefore, the critical discourse analysis design employed was Norman Fairclough's approach, which views texts as part of social practices that convey discursive goals through representation, ideology, power, and values (Gölbaşı, 2017). The critical discourse analysis method was chosen as the analytical tool because textbooks are educational texts that contain various forms of discursive meaning that integrate all aspects of scientific literacy (Rogers et al., 2016).

The primary data source was the Grade IV science textbook authored by Amalia Fitri et al., published by the Curriculum and Book Center, Research and Development Agency, Ministry of Education and Culture in 2021. This textbook was selected because it constructs relevant concepts, fosters critical thinking, integrates interactions between science, technology, and society, and includes activities for conducting experiments and investigations using scientific methods. These features helped students retain knowledge and develop practical skills in applying it. Overall, the textbook integrated all aspects of scientific literacy.

3.2. Research instruments

The primary instrument used in this research was the researcher, serving as the primary instrument (Becker, 2019; Freitas et al., 2020). Data collection techniques included documentation, reading, and quoting (Busetto et al., 2020; Moser & Korstjens, 2018). The researcher analyzed each statement on the pages under study, matched it against the scientific literacy indicators on a checklist, and calculated the percentage of occurrences of each scientific literacy category within the textbook.

3.3. Data analysis techniques

Data analysis involves breaking down information by identifying patterns, categories, and fundamental units of description to uncover themes and formulate working hypotheses as suggested by the data (Lähnemann et al., 2020; Moleong, 2017). Based on this perspective, the data analysis in this study was conducted through several steps. First, the data were identified by selecting parts of the Grade IV science textbook that aligned with the research focus, specifically analysis and evaluation. The analysis involved summarizing and providing concise descriptions of findings related to the manifestations of scientific literacy aspects in the textbooks based on the transcription of data.

Second, the data is presented through Focus Group Discussions (FGDs) consisting of elementary school teachers in Sukoharjo Regency, Indonesia. Participants were selected using a purposive sampling technique. The instrument used in the discussion was a checklist related to the analysis and evaluation of aspects of scientific literacy in the fourth-grade science textbook by Amalia Fitri et al. Aspects analyzed in the eight chapters of the textbook include science as a body of knowledge, science as a method of investigation, science as a way of thinking, and the interaction between science, technology, and society. Finally, the researcher interpreted the qualitative data collected from the checklist, which had been grouped by each aspect of scientific literacy, in the form of linguistic descriptions and drew conclusions from these findings. The elements or units of text analyzed using a social semiotic approach in elementary science textbooks included pictures, illustrations, paragraphs, questions, tables and their descriptions, information organization, and activities and tasks.

4. Results

Textbook analysis plays a crucial role in enhancing the quality of educational outcomes. This study aimed to gather information on the aspects of scientific literacy in Grade IV textbooks used under the Kurikulum Merdeka. The aspects analyzed included science as a body of knowledge, science as a method of investigation, science as a way of thinking, and the interaction between science, technology, and society. The textbook analyzed consisted of eight chapters: 1) Plants, Sources of Life on Earth, 2) States of Matter and Their Changes, 3) Forces Around Us, 4) Transforming Forms of Energy, 5) Stories About My Region, 6) Indonesia: Rich in Culture, 7) How Do We Meet All Our Needs?, 8) Building a Civilized Society.

The findings revealed differences in the presentation of each aspect of scientific literacy. The following is a discussion of each scientific literacy aspect.

4.1. Science as a Body of Knowledge

Elementary school textbooks aim to introduce children to structured scientific thinking and foster their interest in understanding the world around them. Science as a body of knowledge refers to scientific concepts that are considered the "product" of science. Based on the analysis, this aspect accounted for 20% of the scientific literacy content. It primarily appeared at the beginning of each chapter, serving as an introduction to the learning objectives, compared to the other scientific literacy aspects. Each chapter of the textbook began with facts, concepts, and hypotheses, aligning with the characteristics of the Merdeka Curriculum, which emphasizes essential content and the development of student competencies at their respective stages.

4.2. Science as a Way of Investigating

"Science as a way of investigating" highlights the use of the scientific method to explore and understand natural phenomena. Through structured scientific methods, individuals can address questions about the universe and seek answers backed by empirical evidence. This aspect accounted for the highest percentage of content, reaching 40%. It was evident that each chapter actively engaged students in hands-on learning, allowing them to verify facts and concepts through experiments and project implementation.

For instance, in Chapter 1 (p. 8), students were guided to observe the function of a plant stem using celery stalks colored with food dye. Additionally, they conducted an experiment on photosynthesis and concluded the chapter with a project to grow fast-growing plants like mung beans, spinach, and water spinach. In Chapter 2, which covered states of matter and their changes, students investigated the concept of mass using a balance scale and analyzed the properties of solids, liquids, and gases with nearby objects. In Chapter 3 (p. 71), students tested object motion on inclined surfaces, explored magnetism and its poles (p. 75), and conducted an experiment on static objects using rubber bands (p. 89). In Chapter 4 (p. 97), students conducted various experiments to gain a better understanding of energy transformations, including a hands-on activity that demonstrated potential energy using a candle. In Chapter 5 (p. 139), students were encouraged to share stories about the natural wealth in their respective regions. In Chapter 6, students explored the diversity of local wisdom and traditions passed down in their areas. Finally, in Chapter 7, students analyzed primary, secondary, and tertiary human needs essential for survival. In Chapter 8, students engage in practical activities, such as creating a lemon battery and a water wheel. This indicates that the textbook emphasizes science as a process rather than merely as a product. The authors have paid significant attention to fostering science as a process in its presentation. The indicators of science as a way of investigating are evident in every chapter of the textbook and include the following:

The first is observation and experimentation. Students are encouraged to engage in direct observation or use tools to observe phenomena and conduct experiments to test hypotheses and gain a deeper understanding of natural events. The second is the application of scientific concepts and principles. Students apply the scientific concepts and principles they have learned in real-world contexts. They are guided to design solutions to existing problems, enhancing their ability to connect science to practical applications. The third is active engagement. Instead of passively receiving information, students actively engage in developing their understanding through investigation and exploration. This hands-on approach strengthens their grasp of scientific concepts. The fourth is problem-solving. Students are engaged in problem-solving, which includes identifying problems, formulating hypotheses, designing experiments, and evaluating proposed solutions. The fifth is critical thinking skills. This textbook encourages the development of critical thinking skills, including the ability to evaluate evidence, analyze experimental results, and construct arguments based on data.

4.3. Science as a Way of Thinking

Science as a way of thinking refers to a rational and methodological approach to understanding the universe and the phenomena within it. This involves the use of logic, observation, experimentation, and modeling to investigate and explain natural occurrences. As we know, science is a human activity characterized by the thinking processes that take place in the minds of those involved in it. The textbook has successfully guided students toward fostering a strong sense of curiosity, imagination, and critical thinking during their investigations to comprehend and explain natural phenomena.

Statements and activities within the Grade IV science textbook indicate a strong emphasis on science as a way of thinking, with this aspect contributing a significant percentage of 25%. For instance, in Chapter 1, titled "Plants that Store Food in Their Roots," students are guided to analyze types of food derived from roots and to understand how fibrous roots grow into food sources. Additionally, on page 13, students are encouraged to analyze the relationship between plants, humans, and animals in the process of photosynthesis. In Chapter 2, students are challenged to analyze and gather information about a case study, specifically exploring methods to separate camphor from a mixture of sand. Similarly, in Chapter 3 (page 69), students are directed to observe and analyze various activities performed by people around them using their muscles. Another example is found on page 85 of Chapter 3, where students explore fundamental questions such as, "Why do objects fall? Why can't we float in the air?". On page 104, students are tasked with creating a journal documenting their daily activities, identifying the types of energy used and the transformations involved. This activity connects directly to the material presented in the textbook, particularly in chapters discussing the adaptations of living organisms that enable their survival.

In writing this textbook, the authors have effectively considered scenarios that encourage students to engage in higher-order thinking, both through the questions posed and the content provided. This aligns with the fundamental characteristics of science education, which include conducting experiments related to natural phenomena frequently encountered by students in their daily lives, thereby demanding more critical and analytical thinking. This suggests that the textbook analyzed has successfully depicted how scientists conduct experiments, demonstrated the historical development of ideas, emphasized the empirical and objective nature of scientific knowledge, illustrated human imagination and creativity, portrayed the characteristics of scientists, and showcased various ways to understand the universe. The aspect of science as a way of thinking is an essential component in the development of scientific literacy.

4.4. Interaction of Science, Technology, and Society

Science, technology, and society are three inseparable components where science forms the basis of technological development, technology supports scientific advancements, and the application of technology meets societal needs for daily life. Thus, technological advancements are always linked to society. The interaction between science, technology, and society (STS) is an educational approach that explores the application of science in the context of everyday human life. This approach, often referred to as the Science-Technology-Society (STS) framework, integrates science with technological issues that are present in society. Using this approach, students are encouraged to apply scientific principles to create simple technological works or develop solutions to mitigate the negative impacts of emerging technological products.

The importance of the interaction between science, technology, and society in education is highlighted in the textbook in Chapters 5 (Stories about My Region), 6 (Indonesia's Rich Culture), 7 (How to Fulfill All Our Needs), and 8 (Building a Civilized Society). Each of these chapters contains

statements discussing social issues related to science or technology. However, in other chapters, this aspect is presented to a lesser extent, even though, in reality, the progress of science and technology continuously evolves and influences society. For instance, in Chapter 5, on page 150, students are directed to discuss the natural landscape of their regions, including types of plant and animal resources, as well as historical relics with the potential to serve as resources. In Chapter 6, on page 152, students are guided to describe cultural diversity and local wisdom in their respective regions.

5. Discussion

Based on the analysis, all aspects of scientific literacy are presented in science textbooks. However, the results indicate an imbalance in the proportions of each aspect of scientific literacy. Textbooks emphasize the presentation of material that encourages understanding and analysis, but place less emphasis on directing students to create something related to technology. Science textbooks focus on scientific concepts as products of science that serve as intermediaries for learning objectives. These textbooks also begin with an explanation of facts, concepts, and hypotheses, consistent with the characteristics of the independent curriculum. This aligns with previous findings that thematic science textbooks tend to prioritize the presentation of material tailored to students' abilities, thus focusing on memorization (Dewi & Putra, 2022).

This science textbook makes a significant contribution to student competency development by guiding them to acquire the desired knowledge and competencies. This finding aligns with data from previous researchers on elementary school science textbooks. The textbook contains complex scientific knowledge to support students' scientific literacy (Sesrita, 2020). The theory of science textbooks, as per the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 8 of 2016. Science textbooks serve as the primary learning resource, guiding students through direct activities that support their learning (Doğru et al., 2021). Process skills in science learning in elementary schools are also supported by the availability of textbooks, as these books facilitate students' understanding of the material and help them follow basic science processes.

Science indicators are acquired through several methods. Observation and experimentation are the primary methods driving the science acquisition process. This is because observation involves hypothesis testing and in-depth exploration of natural phenomena. Observation and experimentation are integral to scientific investigation. Investigation is a strategy that encompasses a series of learning activities that engage all students' abilities through systematic, critical, logical, and analytical inquiry. Science process skills are further developed through this investigative process. This method is highly suitable for science learning, as it fosters satisfaction and enjoyment in children, particularly when they explore objects. Science learning, well-managed by teachers, provides students with opportunities to observe, analyze, and draw conclusions from their observations. This finding aligns with another research, which states that the development of students' scientific literacy extends beyond the concepts they learn, but rather through the complex learning process they undertake (Sideri & Skoumios, 2019).

Next, applying scientific concepts and principles is also a way to directly utilize these scientific concepts and principles. Designed solutions to emerging problems are applied practically to connect science. Active engagement is also a way for students to acquire science knowledge and develop their understanding. Active student involvement is a path to problem-solving through the process of identifying problems, formulating hypotheses, designing experiments, and evaluating established solutions. This aligns with the characteristics of the Independent Curriculum, which designs learning to support a project-based approach. In this approach, students are actively involved in exploring and investigating specific topics through relevant and contextual projects (Farrow et al., 2024; Tierney et al., 2022). Indirectly, students are encouraged to maximize their critical thinking skills, as evidenced by their ability to evaluate evidence, analyze experimental results, and construct arguments based

on data. This finding also aligns with expert theory that science learning is generally conducted through investigation, as science inquiry emphasizes the activity of seeking and finding answers to identified problems (Chakraborty & Kidman, 2022).

This textbook has successfully guided students in cultivating curiosity, imagination, and strong critical thinking skills during their investigations to understand and explain natural phenomena. The textbooks analyzed describe the experimental process, demonstrate the development of ideas, emphasize the empirical and objective nature of scientific knowledge, illustrate human imagination and creativity, describe the characteristics of scientists, and show various ways to understand the universe. The description of this book aligns with the scientific theory that human activity inherently involves the ability to think and connect the universe through observation and hypothesis (Gu et al., 2021). Problem-solving in science textbooks is often linked to solving examples related to everyday life. Therefore, students can reason critically, reflectively, and creatively as an intellectual process, forming concepts, applying existing information, and evaluating it.

Science, as a way of thinking, plays a crucial role in the development of scientific literacy (Alberts, 2022). This is because it demonstrates the causal relationships between observed phenomena. Science textbooks should present statements that foster the development of students' critical thinking skills (Simpson et al., 2021). This ideal of a science textbook is exemplified in this book. It fully integrates the values of scientific literacy. This means that every student receiving science education is equipped with scientific literacy to prepare them for future demands driven by advances in science and technology. However, in practice, the material presented is limited to illustrations of the benefits of science and technology, the negative impacts of science, discussions of social and cultural impacts, interactions with the public and peers, and scientific ethics—but only to a limited extent. Based on these aspects of scientific literacy, it is clear that the ultimate goal is to create a learning environment that engages students and encourages them to enjoy the learning process, leading to active participation in learning activities.

This textbook connects each topic to scientific research, as well as science, technology, and society. The role of science in life is highlighted through social and career issues related to the material, providing students with insights into related careers. The development of science leads users to implement innovative learning approaches, one of which is Science, Technology, and Society (STM). This STM approach consists of three inseparable components. Science serves as the foundation for developing technology. Technology supports scientific progress. The implementation of technology meets the needs of society in everyday life (Safrizal et al., 2020). The interaction of Science, Technology, and Society (STM) is an approach that is linked to everyday life in society. This finding is interesting because the indicators of interaction between science, technology, and society result in maximum interaction. This finding aligns with previous findings that the Science-Technology-Society (STM) approach has proven effective in integrating science and technology within society (Efendi, 2021). Previous researchers found the same thing, stating that science knowledge indicators appeared most frequently because books focused on providing information categorized as scientific knowledge (Li & Ma, 2024).

6. Conclusion

Research on the presentation of scientific literacy aspects in science textbooks concluded that the content of scientific knowledge as a body of knowledge appears only at the beginning of each chapter as an introduction to learning objectives, compared to other aspects of scientific literacy. Investigative content in science, namely "science as a way of investigating," has the highest percentage, characterized by students being given broader opportunities to actively engage in learning to validate facts and concepts through experiments and project implementation. The "science as a way of thinking" content in the textbook describes how a scientist experiments, presents

the historical development of an idea, emphasizes the empirical and objective nature of science, and illustrates human imagination and creativity. Meanwhile, the content on the interaction between science, technology, and society includes statements that discuss social issues related to science or technology. An overall analysis of the textbook shows that it integrates all aspects of scientific literacy. This reflects the general inclusion of scientific literacy. However, the proportion of scientific literacy themes presented is not balanced. The emergence of indicators in this book can be recommended for teachers and students who need teaching materials as a source of information in the application of science in everyday life.

7. Suggestion

This study is expected to provide valuable insights to curriculum developers, teachers, and textbook publishers in designing and developing science learning materials that are more effective and relevant for students. Based on the findings of this study, several recommendations are proposed. First, for future researchers, further exploration of scientific literacy aspects in textbooks is recommended, particularly by determining the relationship between the science textbooks and students' actual scientific literacy levels. Second, for science teachers and curriculum developers, additional instructional resources should be provided to fulfill better the proportions of scientific literacy aspects that are currently underrepresented.

Declarations

Author Contributions. The author is solely responsible for the conception, writing, and revision of this manuscript.

Conflicts of Interest. The authors declare no conflict of interest.

Data Availability Statement. The data supporting the findings of this study are available from the corresponding author upon reasonable request. All datasets were collected and stored in compliance with institutional research ethics and privacy guidelines.

Acknowledgments. We would like to thank the authors and publishers of the fourth-grade science textbooks who have allowed researchers to analyze and discuss the presentation of aspects of scientific literacy in the books.

References

- Alberts, B. (2022). Why science education is more important than most scientists think. *FEBS Letters*, 596(2), 149–159.
- Andersen, K. N. (2018). Evaluation of school tasks in the light of sustainability education: textbook research in science education in Luxembourgish primary schools. *Environmental Education Research*, 24(9), 1301–1319. <https://doi.org/10.1080/13504622.2017.1384798>
- Becker, K. M. (2019). Beyond researcher as instrument: Researcher with instrument: musicking in qualitative data collection. *Qualitative Research Journal*, 19(4), 426–437. <https://doi.org/10.1108/QRJ-02-2019-0021>
- Bellová, R., Balážová, M., & Tomčík, P. (2021). Are attitudes towards science and technology related to critical areas in science education? *Research in Science and Technological Education*, 00(00), 1–16. <https://doi.org/10.1080/02635143.2021.1991298>
- Biologi, D. P. (2018). *Jurnal Biolokus Jurnal Biolokus*. 1(1), 1–10.
- BouJaoude, S., & Nouredine, R. (2020). Analysis of Science Textbooks as Cultural Supportive Tools: The Case of Arab Countries. *International Journal of Science Education*, 42(7), 1108–1123. <https://doi.org/10.1080/09500693.2020.1748252>

- Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, 2(1). <https://doi.org/10.1186/s42466-020-00059-z>
- Carrejo, D. J., & Reinhartz, J. (2014). Teachers fostering the co-development of science literacy and language literacy with English language learners. *Teacher Development*, 18(3), 334–348. <https://doi.org/10.1080/13664530.2014.914564>
- Chakraborty, D., & Kidman, G. (2022). Inquiry Process Skills in Primary Science Textbooks: Authors and Publishers' Intentions. *Research in Science Education*, 52, 1419–1433. <https://doi.org/10.1007/s11165-021-09996-4>
- Chen, T., & Cai, J. (2020). An elementary mathematics teacher learning to teach using problem posing: A case of the distributive property of multiplication over addition. *International Journal of Educational Research*, 102, 101420. <https://doi.org/https://doi.org/10.1016/j.ijer.2019.03.004>
- Chen, X. (2017). A comparative study of visual representations in conventional, digitized and interactive high school science textbooks. *Journal of Visual Literacy*, 36(2), 104–122. <https://doi.org/10.1080/1051144X.2017.1386388>
- Dewi, N. L. W. A., & Putra, I. K. D. A. S. (2022). Analisis Aspek Literasi Sains Pada Buku Tematik Pembelajaran Ipa Kelas Vi Di Sd Negeri 2 Cempaga Tahun 2022. *ORBITA: Jurnal Pendidikan Dan Ilmu Fisika*, 8(2), 339. <https://doi.org/10.31764/orbita.v8i2.11478>
- Doğru, M., Kirbaci, G. Y., & Çelik, M. (2021). An Analysis of Representation of Nature of Science in Science Textbooks. *Socialinis Ugdyimas*, 55(1), 85–97. <https://doi.org/10.15823/su.2021.55.6> Socialinis
- Efendi, N. dkk. (2021). Studi literatur literasi sains di sekolah dasar. *Dharma PGSD*, 1(2), 57–64.
- Farrow, J. M., Kavanagh, S. S., Samudra, P., & Pupik Dean, C. (2024). The promise of the project to student-centered learning: Connections between elements, curricular design, and practices of project based learning. *Teaching and Teacher Education*, 152(September), 104776. <https://doi.org/10.1016/j.tate.2024.104776>
- Fishman, J., Yang, C., & Mandell, D. (2021). Attitude theory and measurement in implementation science: a secondary review of empirical studies and opportunities for advancement. *Implementation Science*, 16(1), 1–10. <https://doi.org/10.1186/s13012-021-01153-9>
- Freitas, F., Leite, C. V., de Souza, F. N., & Costa, A. P. (2020). How the “Help” Feature Can Boost the Self-learning Process of CAQDAS: The webQDA Case Study. In *Advances in Intelligent Systems and Computing* (Vol. 1068). https://doi.org/10.1007/978-3-030-31787-4_14
- Garthwaite, K., France, B., & Ward, G. (2014). The Complexity of Scientific Literacy: The development and use of a data analysis matrix. *International Journal of Science Education*, 36(10), 1568–1587. <https://doi.org/10.1080/09500693.2013.870363>
- Gölbaşı, S. (2017). Critical Approach in Social Research: Fairclough's Critical Discourse Analysis. *The Online Journal of Communication and Media*, 3(4), 5–18.
- Gu, F., Chung, M. H., Chignell, M., Valaee, S., Zhou, B., & Liu, X. (2021). A survey on deep learning for human activity recognition. *ACM Computing Surveys (CSUR)*, 54(8), 1–34.
- Gumilar, S., Hadiano, D., Amalia, I. F., & Ismail, A. (2022). The portrayal of women in Indonesian national physics textbooks: a textual analysis. *International Journal of Science Education*, 44(3), 416–433. <https://doi.org/10.1080/09500693.2022.2032462>
- Kim, T.-H., Kong, D.-Y., & Lim, J.-D. (2011). Analysis on Types and Contents of Photos Relating to Geodiversity Suggested in Science Textbooks for Middle School. *Journal of Korean Nature*, 4(3),

185–190. <https://doi.org/10.7229/jkn.2011.4.3.185>

- Lähnemann, D., Köster, J., Szczurek, E., McCarthy, D. J., Hicks, S. C., Robinson, M. D., Vallejos, C. A., Campbell, K. R., Beerenwinkel, N., Mahfouz, A., Pinello, L., Skums, P., Stamatakis, A., Attolini, C. S. O., Aparicio, S., Baaijens, J., Balvert, M., Barbanson, B. de, Cappuccio, A., ... Schönhuth, A. (2020). Eleven grand challenges in single-cell data science. In *Genome Biology* (Vol. 21, Issue 1). Genome Biology. <https://doi.org/10.1186/s13059-020-1926-6>
- Lee, Y. J., & Wan, D. (2022). Disciplinary emphasis and coherence of integrated science textbooks: a case study from mainland China. *International Journal of Science Education*, 44(1), 156–177. <https://doi.org/10.1080/09500693.2021.2021312>
- Lelliott, A. (2014). Scientific literacy and the South African school curriculum. *African Journal of Research in Mathematics, Science and Technology Education*, 18(3), 311–323. <https://doi.org/10.1080/10288457.2014.967935>
- Li, R. Y., & Ma, Y. Y. (2024). Knowledge and Attitudes toward Biotechnology in STEM Education as an Indicator of Scientific Literacy. *Journal of Baltic Science Education*, 23(1), 76–89.
- Moleong, J. (2017). *METODOLOGI PENELITIAN KUALITATIF*. PT Remaja Rosdakarya.
- Mork, S. M., Haug, B. S., Sørborg, Ø., Parameswaran Ruben, S., & Erduran, S. (2022). Humanising the nature of science: an analysis of the science curriculum in Norway. *International Journal of Science Education*, 44(10), 1601–1618. <https://doi.org/10.1080/09500693.2022.2088876>
- Moser, A., & Korstjens, I. (2018). Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. *European Journal of General Practice*, 24(1), 9–18. <https://doi.org/10.1080/13814788.2017.1375091>
- Mukhopadhyay, D. R. (2014). Scientific attitude – some psychometric considerations. *IOSR Journal of Humanities and Social Science*, 19(1), 98–100. <https://doi.org/10.9790/0837-191798100>
- Oliver, M. C., & Adkins, M. J. (2020). “Hot-headed” students? Scientific literacy, perceptions and awareness of climate change in 15-year olds across 54 countries. *Energy Research and Social Science*, 70(June), 101641. <https://doi.org/10.1016/j.erss.2020.101641>
- Ritchie, S. M., Tomas, L., & Tones, M. (2011). Writing stories to enhance scientific literacy. *International Journal of Science Education*, 33(5), 685–707. <https://doi.org/10.1080/09500691003728039>
- Rogers, R., Schaenen, I., Schott, C., O'Brien, K., Trigos-Carrillo, L., Starkey, K., & Chasteen, C. C. (2016). Critical Discourse Analysis in Education: A Review of the Literature, 2004 to 2012. *Review of Educational Research*, 86(4), 1192–1226. <https://doi.org/10.3102/0034654316628993>
- Román, D., & Busch, K. C. (2016). Textbooks of doubt: using systemic functional analysis to explore the framing of climate change in middle-school science textbooks. *Environmental Education Research*, 22(8), 1158–1180. <https://doi.org/10.1080/13504622.2015.1091878>
- Safrizal, S., Zaroha, L., & Yulia, R. (2020). Kemampuan Literasi Sains Siswa Sekolah Dasar di Sekolah Adiwiyata (Studi Dekriptif di SD Adiwiyata X Kota Padang). *Journal of Natural Science and Integration*, 3(2), 215. <https://doi.org/10.24014/jnsi.v3i2.9987>
- Sari, P. M., Sudargo, F., & Priyandoko, D. (2018). Correlation among science process skill, concept comprehension, and scientific attitude on regulation system materials. *Journal of Physics: Conference Series*, 948(1). <https://doi.org/10.1088/1742-6596/948/1/012008>
- Semiotika, A., Halliday, S. M. A. K., Ghoky, N., Salju, J. G., Manokwari, K., & Barat, P. (2023). *Social Semiotic Analysis M . A . K . Halliday Novel Ghoky Aku Papua By Johan Gandeogoay Insum*

Malawat dan Hengki Universitas Papua PENDAHULUAN Terminologi semiotika mengacu pada studi tentang tanda dan bagaimana tanda menyampaikan makna . Dalam konteks “ b. 12(2), 443–456.

- Sesrita, A. (2020). SITTAH: Journal of Primary Education, Vol. 1 No. 2, Oktober 2020. *Journal of Primary Education*, 1(2), 139–148.
- Sideri, A., & Skoumios, M. (2019). Science Process Skills in the Greek Primary School Science. *Science Education Internationa*, 32(3), 231–236. <https://doi.org/10.33828/sei.v32.i3.6>
- Simpson, D. Y., Beatty, A. E., & Ballen, C. J. (2021). Teaching between the lines: Representation in science textbooks. *Trends in Ecology & Evolution*, 36(1), 4–8.
- Slough, S. W., McTigue, E. M., Kim, S., & Jennings, S. K. (2010). Science textbooks’ use of graphical representation: A descriptive analysis of four sixth grade science texts. *Reading Psychology*, 31(3), 301–325. <https://doi.org/10.1080/02702710903256502>
- Stylianidou, F., Ormerod, F., & Ogborn, J. (2002). Analysis of science textbook pictures about energy and pupils’ readings of them. *International Journal of Science Education*, 24(3), 257–283. <https://doi.org/10.1080/09500690110078905>
- Tierney, G., Urban, R., Olabuenaga, G., & Paulger, C. (2022). Designing Project-Based Learning Curricula: Leveraging curriculum development for deeper and more equitable learning. In *Lucas Education Research*.
- Tommasi, M., Petricca, P., Cozzolino, G., & Casadio, C. (2020). Attitudes towards scientific knowledge: social dispositions and personality traits. *Synthese*. <https://doi.org/10.1007/s11229-020-02632-0>
- Ustun, U., Cansiz, M., Ozdemir, E., & Cansiz, N. (2022). Student and school-level factors to predict science literacy for two top-performing countries in PISA 2015: Finland and Singapore. *International Journal of Science Education*, 44(4), 579–603. <https://doi.org/10.1080/09500693.2022.2037167>
- Wagh, L. R., Catalano, T., Masaeed, K. Al, G., T. H. D. and P., & Renigar. (2016). Critical Discourse Analysis: Definition, Approaches, Relation to Pragmatics, Critique, and Trends. *Springer International Publishing Switzerland*, 71–135. <https://doi.org/10.1007/978-3-319-12616-6>
- Yu, J., Li, C., & Li, G. (2022). Alignment between biology curriculum standards and five textbook editions: a content analysis. *International Journal of Science Education*, 44(14), 1–20. <https://doi.org/10.1080/09500693.2022.2119621>
- Zhu, Y., & Tang, A. (2023). An analysis of the nature of science represented in Chinese middle school chemistry textbooks. *International Journal of Science Education*, 1–18. <https://doi.org/10.1080/09500693.2022.2160939>

About the Contributor(s)

Dwi Anggraeni Siwi, is a student in the Doctor of Educational Science Study Program, the Faculty of Teacher Training and Education, Universitas Sebelas Maret. The focus of research is in the fields of elementary education and educational science. Several articles have been published on the topic: An Ethnoscience Study in IPAS Learning to Foster Global Diversity Through the Making of Traditional Food Rempeyek Kacang and Strengthening Ethnoscience to Foster Love for the Motherland of Indonesia Migrant Workers in Kuala Lumpur, Malaysia.

Email: dwianggraenisiwi@student.uns.ac.id

ORCID: <https://orcid.org/0000-0001-6673-1365>

Sajidan is a Professor in the field of Genetics and Biotechnology at Universitas Sebelas Maret (UNS). He is also known as a lecturer in the Master's Program in Biology Education at the Faculty of Teacher Training and Education (FKIP), UNS. Several articles have been published on the topic: Developing E-module based on hypothetical inquiry learning to improve students' critical thinking skills

Email: sajidan_fkip@staff.uns.ac.id

ORCID: <https://orcid.org/0000-0001-6306-6849>

Siswandari, is a Professor of Education specializing in Statistics courses. She is actively in research in the field of entrepreneurship. More specifically, she is engaged in research related to the Entrepreneurship Development Center (PPKWU) and the Development of Accounting and Finance Education. Several articles have been published on the topic: Green Entrepreneurial Intention: The Role of Entrepreneurship Education and Entrepreneurial Self Efficacy

Email: siswandari@staff.uns.ac.id

ORCID: <https://orcid.org/0000-0003-4537-7939>

Gunarhadi, is a Professor of Special Education at Universitas Sebelas Maret (UNS). He is also involved in the Disability Studies Center (Pusat Studi Difabilitas/PSD) at UNS. Several articles have been published on the topic: Analysis of Science Misconceptions for Class VI Elementary School Using The Certainty of Response Index Method, and An Analysis Of The Application Of Problem Based Learning (Pbl) Model In Mathematics For Elementary School Students

Email: gunarhadi@staff.uns.ac.id

ORCID: <https://orcid.org/0000-0002-1329-6280>

Publisher's Note: *The opinions, statements, and data presented in all publications are solely those of the individual author(s) and contributors and do not reflect the views of Universitepark, EDUPIJ, and/or the editor(s). Universitepark, the Journal, and/or the editor(s) accept no responsibility for any harm or damage to persons or property arising from the use of ideas, methods, instructions, or products mentioned in the content.*
