

Analysis of Grade X Physics Textbooks on the Basic Measurement Material from the Nature of Science Perspective

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Abstract. Issues related to the quality of textbooks are often a topic of discussion in science. However, in various education systems, some textbooks have effectively incorporated the nature of science, while others are still lacking in this aspect. It is well-known that the nature of science serves as a crucial foundation that should be applied in science education, especially in physics. This is because the nature of science plays a role as the basis to guide a more holistic learning approach and an exploratory process in understanding knowledge about the natural world. Hence, a study was conducted to analyze physics textbooks to analyze the percentage of nature of science content and describe the proportion of nature of science aspects in high school physics textbooks. The research employed a mixed methods approach, combining qualitative and quantitative research. The quantitative research section involved the development of the theory, including observations and data collection for accuracy. The quantitative research portion explained how to obtain percentage data for the ten aspects of the nature of science under investigation. The study results showed that the textbook published by Grafindo, referred to as Book B, presented the most aspects of the nature of science compared to the other two textbooks. Quotations in Book B were presented explicitly, although some quotations were presented implicitly. Books A and C were found to be less inclusive of the nature of science aspects in the measurement material. The proportion of the appearance of the nature of science in Book A was 33%, in Book B, it was 53%, and in Book C, it was 27%. Overall, all three evaluated textbooks explicitly conveyed aspects of the nature of science. The implications of this research highlight the importance of incorporating the nature of science aspects in science learning materials to enhance understanding of the nature of science, as the nature of science is a complex concept and serves as a fundamental foundation for studying science.

Keywords: Science Education; Textbooks; The Nature of Science

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INTRODUCTION

Textbooks are crucial in influencing students' understanding of teaching and learning. Teachers use textbooks to organize teaching materials, deliver instructional content, and create student assignments (Magdalena et al., 2020). Textbooks are vital for teachers because high-quality teaching materials can

enhance students' learning outcomes. Quality textbooks provide knowledge, guidance, and relevant direction in supporting students' success in the curriculum implementation process.

According to the National Education Standards Agency, a textbook is considered high quality if it meets four aspects of suitability, including content,

presentation, language, and graphics (Pratiwi & Widyaningrum, 2021). Using good-quality textbooks can lead to improved learning outcomes.

As known, the nature of science plays a vital role in science education. Science education goes beyond factual knowledge and concepts; it involves the methods and processes scientists use to discover facts and theories, which are then generalized. The nature of science is used to help students understand scientific knowledge correctly. It can also be an effective tool in developing various aspects of science education, making it easier for students to grasp scientific content (Imran & Wibowo, 2018).

The nature of science is the core of knowledge, involving complex concepts encompassing philosophy, sociology, and the history of knowledge. The essence of scientific knowledge consists of three main dimensions: science as an end product, science as a process step, and science as a scientific thinking attitude. Additionally, the nature of science provides a suitable way for students to understand scientific content better and develop various aspects of science education (Tursinawati, 2016).

Several related studies have analyzed the nature of science in science textbooks at the secondary school level. One study (Nur'aini et al., 2017) focused on analyzing a chemistry textbook's thermodynamics section based on scientific literacy content, including an investigation of science's nature. This aligns with the present research analyzing the aspects of the nature of science in a Grade X physics textbook. The analysis of the chemistry textbook revealed a relatively balanced representation of knowledge and the investigation of the nature of science. However, the balance between scientific thinking and the interaction between science, technology, and society was not optimal. Research has also been

conducted regarding the analysis of teaching materials explicitly representing the nature of science in the topic of the Earth's layers. This study incorporated seven aspects of the nature of science into teaching and curriculum development. Based on the results of the study, it can be concluded that the goals of science learning highly need the explicitness of the nature of science in teaching materials (Artifasari et al., 2021).

By researching the analysis of textbooks, it is possible to improve the quality of education in Indonesia and determine whether textbooks adequately represent the nature of science to influence students' understanding of science in science or science education (Oviana, 2015). Textbooks serve as instructional materials used by educators to provide information to students. Students use textbooks to understand the meaning and purpose of the learning material, making the learning process more accessible. Therefore, textbooks are one of the factors that impact students' understanding, particularly in scientific knowledge (Utami & Dessty, 2021).

The research related to the analysis of teaching materials in the explicitness of the nature of science on Earth's layers involved using seven aspects of the nature of science in the research, which were integrated into teaching and curriculum development. This research employed a descriptive research method, with data collection carried out through a literature review to analyze the need to explicitness the nature of science in teaching materials on the topic of Earth's layers. Based on the results of the study, it can be concluded that the explicitness or application of the nature of science in teaching materials is highly necessary for the goals of science education (Artifasari et al., 2021). In the analysis of the physics textbook for grade X, which was examined in terms of the nature of

science, ten aspects of the nature of science were used and integrated into the learning materials. Additionally, this research employed a mixed methods research method, with the quantitative research portion focused on obtaining percentage data for the ten aspects of the nature of science under investigation. This involved observations to gather accurate data and information. Then, the quantitative research section explained how to obtain percentage data for the ten aspects of the nature of science being studied.

One of the topics in physics education commonly encountered in everyday life and serves as an early chapter in high school physics is the subject of measurement. Additionally, in this topic, aspects of the nature of science can enhance students' understanding of these scientific aspects. Based on this explanation, it is clear that the fundamental topic of basic measurement is related to understanding the nature of science, which aligns with the curriculum standards.

Research related to textbook analysis is needed to assess the quality of science used as informative sources of knowledge aligned with the nature of science and appealing to students. Therefore, this study is conducted to evaluate the quality of physics textbooks used by students as learning resources in schools, specifically in Palembang. The research is titled "Analysis of Grade X Physics Textbooks on the Basic Measurement Material from the Perspective of the Nature of Science."

The significance of this research lies in understanding and evaluating the quality of science textbooks used as knowledge sources by students. This research aims to ensure that the textbooks not only meet the criteria for being informative in line with the nature of science but also possess qualities that motivate students in their physics education. Through this research, it is

hoped that the quality of textbooks can be improved, allowing students to understand better the underlying essence of the science being taught. As a result, the urgency of this research is to enhance the effectiveness of physics education in Palembang, particularly in the area of basic measurement, through evaluating and improving the textbooks used. Basic measurement material was chosen as the subject of this research because measurement is essentially the systematic process of assigning numerical values to an object. Measurement plays a crucial role in developing science and technology for presenting information (Sari et al., 2019). Furthermore, measurement material encompasses essential competencies in physical quantities, accuracy, precision, significant figures, and scientific notation, providing students with foundational knowledge for further learning in physics (Sari & Rozi, 2019).

METHOD

The research related to the analysis of physics textbooks applies a mixed methods research methodology, which integrates two types of research: qualitative and quantitative. The qualitative research aspect involved the development of the theory, which includes observation and scrutiny of every paragraph, table, and figure based on the criteria of the nature of science to determine whether the material explanations in the paragraphs or presented images align with the nature of science. This process results in data and information relevant to the textbook content analysis, specifically focusing on the subject of physics measurement. The analysis was conducted following the instrument used in this study, an observation sheet with aspects and indicators of the nature of science adopted from a journal (Panjaitan & Siadari, 2021), used as a reference for

conducting content analysis in the physics textbook.

In the next step, data analysis is carried out on excerpts from sample textbooks using a scoring rubric adapted from a previous study (Abd-El-Khalick et al., 2008). This process included calculating the percentage of each aspect of the nature of science within the analyzed textbooks. This represents the quantitative research aspect that elaborates on obtaining data related to the percentage and proportion of the ten aspects of the nature of science under investigation.

The population of focus in this study is the textbooks used in three high schools in Palembang. The research included textbooks from three different types of schools: State High School, Private High School, and Islamic High School. Using textbooks from various types of schools, the research aims to provide a more comprehensive perspective on the quality of physics textbooks in Palembang and to what extent these textbooks reflect the nature of science and appeal to students from different backgrounds. Therefore, selecting these three textbooks as samples is relevant and representative in this study. The textbooks sampled in this study are from State High School 3 Palembang, Muhammadiyah High School 1 Palembang, and Islamic High School 3 Palembang. The research employed a purposive sampling method. The research procedure for textbook analysis is divided into three stages:

1. The preparation stage began with gathering information from various sources regarding various fundamental aspects of science that would be the focus of the research. These aspects included empirical, inferential, creative, theoretical, tentative, scientific method, scientific theory, scientific law, social, and the application of science in social and cultural

contexts. The next step involved conducting preliminary or pre-research by analyzing a specific chapter in one of the textbooks relevant to one of the identified fundamental aspects of science.

2. The implementation stage involved conducting a survey of the physics textbooks for grade X in high schools based on the 2013 curriculum. The selected textbooks in this research were chosen based on several considerations using the purposive sampling technique, where books were chosen from three different types of schools, which are known to be exemplary: State High School 3 Palembang, Private High School, namely Muhammadiyah High School 1 Palembang, and Islamic High School, selected from Islamic High School 3 Palembang. These schools represent various schools in Palembang. The textbooks selected for this study were Textbook A from Arya Duta (from Islamic High School 3 Palembang), Textbook B from Grafindo (from State High School 3 Palembang), and Textbook C from Intan Pariwara (from Muhammadiyah High School 1 Palembang). Subsequently, a sampling process was carried out to select relevant data, and this data was collected by extracting quotations from sentences or paragraphs containing fundamental elements of science. A scoring rubric was then completed for each collected data. The next step was to verify the data by consulting the analysis results with the research advisor or individuals with expertise in the field. This step aimed to ensure the accuracy and correctness of the analysis results conducted by the researchers.
3. The final stage involved the data analysis process generated from this

research. It included calculating the scores accumulated in the assessment rubric, counting the quotations representing each aspect from the three textbooks, and measuring the appearance percentage for each aspect within the textbooks. To assess the agreement among assessors, the interrater reliability method was employed by calculating the Kappa Coefficient. The final results from all these steps would aid in formulating conclusions based on the findings of this research.

In this research, data were collected using the documentation method. The study focused on examining every paragraph on the pages of grade X high school physics textbooks, specifically on chapters related to basic measurements. The analysis process involved in-depth reading and understanding of the text and observation and comprehension of text components within the book. The research tool used consisted of an observation sheet outlining various aspects and indicators related to the nature of science, adopted from a journal (Panjaitan & Siadari, 2021). Each quotation in the analyzed chapter was categorized and scored according to the categories: correct and explicit, correct but implicit, incorrect and explicit, and incorrect but implicit. After each quote is categorized using an assessment rubric, the appearance of each aspect of the

nature of science in the book is expressed in percentage form.

The final step was to test the research reliability, and the results would be evaluated by assessing the research's reliability using the triangulation method through examination by the members. Based on the agreement reached between the observers and the researchers, the level of reliability would then be calculated. The formula for the Kappa Coefficient is as follows:

$$KK = \frac{P_A - P_C}{1 - P_C} \tag{1}$$

Information:

PA = probability of agreement between observers

PC = observed agreement distribution for each category in the contingency table

$$P_A = \frac{n_a}{n_0} \tag{2}$$

Information:

n_a = number of the same statements

n₀ = number of agreements that are observed

The range of values for the reliable kappa coefficient is between 0.61 and 1.00. Therefore, if the results between two observers fall within this range, it can be concluded that the agreement is considered reliable or valid (Sumarno, 2020). Table 1 shows the interpretation of reliability from the kappa coefficient values.

Table 1 Interpretation of Reliability

Kappa Coefficient	Interpretation
<0,00	Very Poor
0,00-0,20	Poor
0,21-0,41	Fair
0,41-0,61	Moderate
0,61-0,80	Good
0,80-1,00	Very Good

(Triana & Oktavianto, 2013)

RESULTS AND DISCUSSION

The research on textbook analysis was conducted to determine the proportion of the appearance of aspects of the nature of science and the percentage of the nature of science content in high school Grade X physics textbooks (Firdaus et al., 2014). In this study, a mixed methods approach was employed. The qualitative research part involved an explanation of the analysis of textbooks based on the nature of science. Quotations from the material, images, and tables were analyzed according to the provided instrument and were scored or assessed according to a scoring rubric. The results of this research indicated that the three textbooks had varying proportions regarding the ten aspects of the nature of science. Additionally, the research revealed issues with Grade X high school physics textbooks, particularly concerning the lack of explicitness of the

nature of science and an imbalance in the presentation of the nature of science. This could potentially reduce students' understanding of the subject matter.

Therefore, this research emphasizes the importance of implementing all ten aspects of the nature of science in textbooks (Irsyan et al., 2013). The aim is to provide a more comprehensive understanding of the nature of science to students. Consequently, textbooks can be more effective in helping students understand scientific concepts well. A deep understanding of the nature of science will positively impact effective science learning, ultimately achieving the intended goals of the science learning process (Oviana, 2015). The research investigated and evaluated three grade-level textbooks in the quotation evaluation group, where Book A had five quotations, Book B had 13 quotations, and Book C had three quotations.

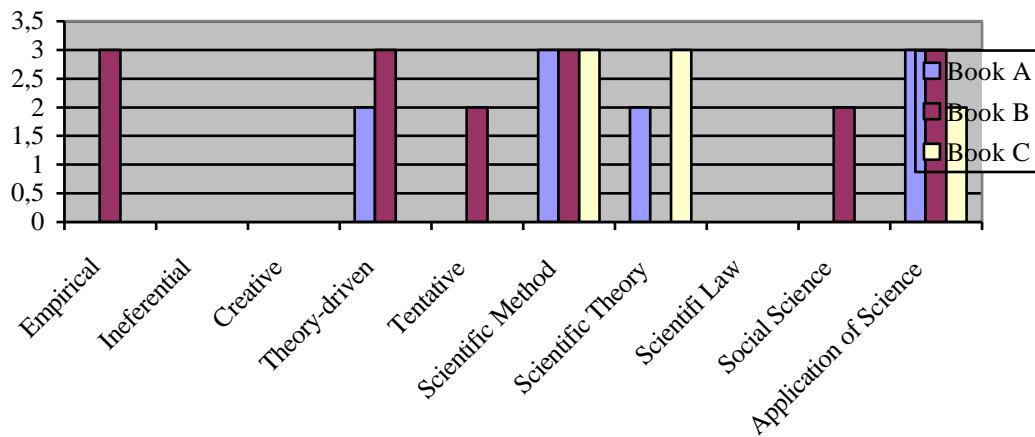


Figure 1 Physics high school grade x textbook scores

The research results indicated that Book B presents more aspects of the nature of science, as well as sentences or material explanations that are stated clearly. However, there are also some quotations conveyed implicitly. In contrast, Book A presents more statements related to the aspects of the scientific method and the social and cultural application in science. At the same time, Book C brings out more

quotations regarding the scientific method and scientific theory. Thus, from the conducted research, it is observed that Book B highlights more aspects of the nature of science in the measurement material.

There are still specific implicit quotations even though some aspects of the nature of science mentioned in Book B's measurement chapter are presented explicitly. The aspects of the scientific

method and the social and cultural application in science are rated very good, based on their frequent appearance and classification in the assessment. Therefore, for all three books, these two aspects meet the criteria. The book provides clear and understandable explanations and guidance for conducting experiments regarding the scientific method. The research findings

show that the scientific method aspect is most prominently featured in Book B, with clear and understandable presentation.

The dominant scores of the aspects of the nature of science that appear in the three books with different percentage results are presented in Figure 2.

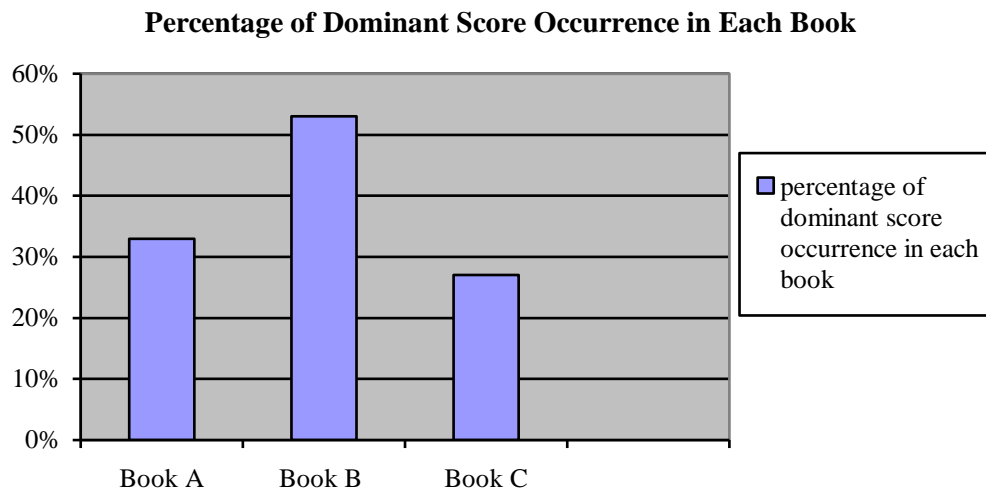


Figure 2 The Percentage of Occurrence of The Dominant Score in Each Class X Book

The data shows the percentage of dominant score appearances in each book. Book B has the highest percentage because it presents 6 out of the ten aspects of science, Book A presents four aspects of science, and Book C presents three aspects of the nature of science. The analysis is based on the examined chapter's consistency and presentation style (either explicitly or implicitly). The data shows the analysis findings regarding the compatibility of quotations with the indicators used in the research (Nurmutia et al., 2013).

The ten aspects of the nature of science used as a reference for content analysis in the physics textbooks (Panjaitan & Siadari, 2021) are:

1. Empirical aspects indicate scientific knowledge obtained through observation and evidence.
2. Inferential aspects involve statements about scientific phenomena that cannot be directly observed.
3. Creative aspects demonstrate that scientific knowledge is generated using imagination.
4. Theory-driven aspects show that existing theories influence the development of scientific knowledge.
5. Tentative aspects, which indicate that scientific knowledge can change.
6. Scientific method aspects involve observing, measuring, comparing, testing, speculating, making hypotheses, creating ideas or concepts, and creating theories and explanations.
7. Scientific theory aspects which provide explanations and

conclusions about natural phenomena.

8. Scientific law aspects that explain the relationships between observed phenomena.
9. Social sciences aspects which show how society contributes to the development of science.
10. Application of science in socio-cultural contexts, which involves using scientific knowledge to create technology that supports human life.

Science textbooks that encompass the ten aspects of the nature of science ideally should meet several criteria and specific characteristics. Some crucial aspects present in science textbooks that integrate the ten aspects of the nature of science are as follows:

1. Integration of the aspects of the essence.
2. Holistic approach: Science textbooks should adopt a holistic approach that promotes a deeper understanding of natural science beyond mere factual knowledge.
3. Scientific processes: Learning materials should encompass scientific processes like observation, experimentation, and scientific reasoning to enable students to engage in scientific exploration.
4. Real-world relevance: Textbooks should relate scientific concepts to real-world applications, allowing students to see the connection between theory and practice.
5. Contemporary context: Learning materials should reflect recent scientific discoveries and developments, helping students understand how science evolves.
6. Critical thinking skills: Science textbooks should encourage the development of critical thinking skills in students.

7. Activities and exercises: Textbooks should include activities and exercises designed to test students' understanding and enable them to apply the concepts they have learned.
8. Student engagement: Textbooks should be designed to engage students in learning, for example, through reflective questions, assignments, or projects.
9. Easy-to-understand language: Learning materials should be written in language that is easy for students to understand.
10. Illustrations and graphics: Relevant illustrations, images, and graphics can help students better understand scientific concepts.
11. Evaluation and assessment: Textbooks should ideally include evaluation questions and assessments to help teachers measure students' comprehension.

The analysis results reveal deficiencies in the Grade X high school physics textbooks, notably a lack of emphasis on the nature of science and an unbalanced presentation of it. Therefore, it's important to implement the ten aspects of the nature of science in textbooks to convey the true meaning of science to students. The advantages can be found in the explicit presentation of quotations that are easy for readers to understand, even though some quotations are still conveyed implicitly. It is hoped that students will be more motivated to learn and understand what science is, how it works, etc. This understanding of the nature of science serves as the first step for students to think scientifically by creatively and critically coming up with new ideas through digital content, allowing them to acquire scientific knowledge or concepts accurately (Tursinawati & Widodo, 2019) and learning at schools after the COVID-19 pandemic trained students in

generic science skills to be good. Thus, it can be concluded that learning generic science skills for class X students at SMAN 1 Daha Utara has a high category after the COVID-19 pandemic.

CONCLUSION

In conclusion, based on the analysis conducted on the physics textbooks designed for Grade X high school students in Palembang, the aspects of the nature of science, such as the scientific essence, creative aspect, and inferential aspect, are not included in the measurement chapter of the Grade X high school physics textbooks. The research revealed that Book A (published by Arya Duta) has a proportion of 33%, Book B (published by Grafindo) has a proportion of 53%, and the last book, Book C (published by Intan Pariwara), has a proportion of 27%. While these three books generally make certain aspects of scientific nature clear, some features are still conveyed implicitly. Including the nature of science in learning materials can support students in understanding the process and application of science in everyday life, providing a more comprehensive and holistic understanding of the nature of science.

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