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Comparison Analysis of Junior High School Science Textbooks in Indonesia and Singapore View from Nature of Science (NoS) Aspects

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Abstract: Scientific literacy can prepare quality human resources who can develop the ability to think logically and creatively, solve problems, be critical, master technology and be adaptive in the face of change and face the times. A vital component to improving students' scientific literacy is understanding the Nature of Science (NoS), which must be emphasized in science learning. The purpose of this study is to obtain a comparison of content and explain aspects of NoS in science textbooks in Indonesia and Singapore. The research approach used is descriptive qualitative with content analysis design. This research focuses on science books for Junior High School Class IX Semester 1 Curriculum 2013 Revised Edition 2018, Integrated Science Books for Junior High School Class IX Curriculum 2013 Revised Edition 2018, and Lower Secondary Science Matters Textbook Volume B 2nd Edition 2013. The data collection techniques are by reviewing documents with non-test instruments in the form of observation guidelines for assessing textbooks based on the NoS aspect developed by Abd-El-Khalick et al., (2008). The data analysis technique uses the fixed comparison method by Moleong (2014). The results obtained are that the textbooks from the two countries have represented several relevant aspects of NoS. Still, the theoretically-driven elements have not been found in the three books, and the existing components have not been well described. Science textbooks in Singapore get a higher score than science textbooks in Indonesia. Still, the availability of the NoS aspect of science textbooks in Indonesia is more than that of science textbooks in Singapore.

Keywords: Content analysis; Science textbooks; Nature of Science

Introduction

The role of scientific literacy in science education is to prepare quality human resources, namely human resources who can develop logical and creative thinking skills, solve problems, be critical, master technology and be adaptive in facing a change and facing the times (Nofiana and Julianto, 2018). Introducing scientific literacy skills as early as possible can help reduce gaps and prepare students for the next life (Kähler et al., 2020). Scientific literacy can help individuals identify misinformation in everyday life (Sharon and Bharam, 2020). Student teacher candidates consider it very necessary to apply scientific literacy in learning (Muliani et al., 2021). Scientific literacy in education in Indonesia has begun to be accommodated in the 2006 Curriculum or the Education Unit Level Curriculum (known with KTSP). It is more clearly visible in the 2013 Curriculum (Narut and Supardi, 2019). Science learning will be more meaningful for students, if students have good literacy skills (Pertiwi et al., 2018; Ristina et al., 2019). On the other hand, the implementation of scientific literacy can demonstrate the application of evidence-based practices to improve student outcomes (Sanetti and Collier-Meek, 2019).

A vital component to improving students' scientific literacy is understanding the Nature of Science (NOS), which must be emphasized in science learning (Rahayu, 2012). NoS-based science learning will produce students

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with high science literacy skills because NOS and scientific literacy are related in their aspects (Vitasari, 2018). Moreover, more attention should be given to the contemporary Nature of Science views and its consistent teaching (Moutinho et al., 2015). Teachers also need to understand the NoS aspect because there is an intervention from PCK on NoS (Demirdöğen et al., 2016).

One of the assessments to measure scientific literacy ability is an assessment through the Program for International Student Assessment (PISA) test. The PISA test results in the Indonesian science performance category are still unsatisfactory. Indonesia's PISA ranking in 2015 was low at 62 out of 70 countries, with an average score of 403 (Tohir, 2019). Indonesia's 2018 PISA ranking is ranked nine from the bottom, or 71 of 79 countries, with 396 (OECD, 2018). During the two periods of the PISA test, the average score achieved by Indonesia has decreased. That is, the state of learners in terms of literacy is still low, especially science (Sukowati et al., 2017). In addition, the understanding of teaching scientific literacy is not optimal (Noor, 2020).

Indonesia is not the only country in Southeast Asia participating in PISA. Countries in Southeast Asia that participate in PISA include Thailand, Malaysia, Brunei Darussalam, and Singapore (OECD, 2018). In the 2018 PISA test, Singapore ranked 2nd and obtained 551 in the science category. Singapore's high ranking is inversely proportional to Indonesia's. It shows that students' scientific literacy in Singapore is higher than students in Indonesia.

Scientific literacy components can be integrated into science subjects and included in science learning tools as learning scenarios that can be used in the classroom (Situmorang, 2016). A textbook is one of the essential components in learning that can practice the NOS aspect. Textbooks in learning have an essential role as a source of learning because they can foster motivation and stimulate student activity so that students can be more active and improve their quality based on students understanding of the materials in the lesson (Rahmawati, 2015). So far, there has been no research study to analyze how the NoS context exists in science textbooks in Indonesia. Analyzing the NoS context in science textbooks is essential to evaluate teaching materials following educational goals and the applicable curriculum (Jannah et al., 2019). Singapore's high PISA score can be an appropriate comparison of how the NoS representation should be.

Based on a preliminary study conducted by Sumarni et al. (2020) from 17 to 30 September 2020 resulted that 25% of teachers had trained NoS to students, 31% had never trained NoS to students, and 44% of teachers did not know NoS at all. Then, the preliminary study results also revealed that topics that are still relatively difficult to practice both in learning and the application of NoS aspects are the topics of Electricity and Magnetism.

The topic taken in this research is Electricity because it adapts to this topic's existence in several existing textbooks. This topic is in the SMP/MTs science textbooks for class IX Semester 1 Curriculum 2013 Revised Edition 2018, the Integrated Science textbooks for SMP/MTs Class IX Curriculum 2013 Revised Edition 2018, and Lower Secondary Science Matters Textbook Volume B 2nd Edition 2013. In textbooks, IPA SMP/MTs Class IX Semester 1 Curriculum 2013 Revised 2018 Edition and Integrated Science Books for SMP/MTs Class IX Curriculum 2013 Revised Edition 2018, the topic of electricity is in chapters four and chapter 5. While in Lower Secondary Science Matters Textbook Volume B 2nd Edition 2013, Electrical Systems can be found in chapter 13.

Based on the description above, it is necessary to analyze science textbooks in Indonesia and Singapore. The analysis was conducted to compare the content of science textbooks in Indonesia and science textbooks in Singapore in terms of the NOS aspect. In addition, it also explains the NOS aspects of science textbooks in Indonesia and science textbooks in Singapore.

Method

The approach used in this research is descriptive qualitative. The research design used in this research is comparative content analysis: three science textbooks, namely Electrical for Indonesian books and Electrical Systems for Singapore books. The focus of this research is on science textbooks for SMP/MTs Class IX Semester 1 Curriculum 2013 Revised 2018 Edition by Siti Zubaidah, et al. Publisher of the Ministry of Education and Culture, Integrated Science Textbooks for SMP/MTs Class IX Curriculum 2013 Revised 2018 Edition by Erlangga Publishing Servant Team, and Lower Secondary Science Matters Textbook Volume B 2nd Edition 2013 by Joan Fong, et al.

Table 1. Identity of the analyzed books

Book Code	Writer	Publisher	Publication Year
A	Zubaidah, et al.	Ministry of Education and Culture	2018
B	Tim Abdi Guru	Erlangga	2013
C	Joan Fong, et al.	Marshall Cavendish Education	2013

The data collection technique in this research is to examine the documents in each textbook using a non-test instrument. The instrument is an observation guide to assess textbooks based on the NOS aspect. The NOS analytical observation guidelines were adapted from

Abd-El-Khalick, (2008). The overall score for each book is a minimum of -30 and a maximum of 30. Scoring criteria are used to make it easier to determine the score. Therefore, there are several terms used, namely explicit and the information conveyed in whole or in part is called explicitly true (EB); explicit and the information conveyed deviates from science or is incorrectly called explicitly false (EK); implicit and the information submitted in whole or in part is called faithful implicit (IB); implicit and the information conveyed deviates with science or is wrong is called implicitly mistaken (IK). The scoring criteria used are shown in Table 2.

Table 2. Scoring Criteria

Score	Criteria
3	(i) All citations are represented EB. Without any IB, IK, and EK citations, even though it is only one quote.
2	(i) Quotations represent EB and IB. (ii) Most citations represent IB; at least one citation is represented by EB.
1	(i) All quotes are represented IB. (ii) Quotes are represented as IK, but most quotes are defined as IB. (iii) All quotes are represented by IB, there must be at least one IB and one EK.
0	(i) No NoS aspect found or no NoS aspect
-1	(i) Most of the citations are represented on an IK basis.
-2	(i) Quotations are IB, IK, with at least one citation representing EK.
-3	(i) All citations are represented EK.

The data analysis in this study used the fixed comparison method by Moleong (2014), which is as follows:

a. Data reduction, namely identifying the presence of NoS in each book that has been obtained and coding it with the dimensions of 10 aspects of NoS.
b. Data categorization is carried out by categorizing according to the similarity of the NoS aspects.
c. Synthesis, carried out by linking one category to another in the dimensions of the NoS aspect that has been obtained.
d. Develop working hypotheses related to the data obtained to answer research questions.

Result and Discussion

Comparison of Science Textbook Content in Indonesia and Science Textbooks in Singapore Viewed from the NoS Aspect

The analysis results are presented in Table 3 in the form of scores for book A, book B, and book C, which are analyzed based on ten aspects of NoS. As many as ten aspects of NoS were targeted in the analysis, and the possible cumulative score for a textbook ranged from – 30 to 30 (Abd-El-Khalick, 2008). The range of scores given is -3 to 3 based on specific criteria for each score. The comparison scores of books A, B, and C are shown in Tabel 3.

Table 3. Science Textbook Scores Based on NOS Aspects

NOS Aspect Score	Books		
	A	B	C
Empirical	2	2	3
Inferential	3	3	3
Creative	2	3	2
Theory Driven	0	0	0
Tentative	2	2	2
Scientific Method	1	0	2
Scientific Theories	1	2	0
Scientific Law	3	2	0
Social Dimension of Science	1	1	3
Proximity of Social and Cultural Sciences	1	1	3
Amount	16	16	17

Based on these results, Indonesian science textbooks A have more NoS aspects than Singapore science textbooks. The number of NoS aspects contained in the Indonesian Natural Sciences Textbook A is 9 out of 10 NoS aspects. Meanwhile, there are only 7 out of 10 total NoS aspects in Singapore science textbooks. This superior number of NoS aspects makes it a good opportunity for Indonesian science textbooks to become good science textbooks in training students for NoS and scientific literacy, especially on electricity. It is in line with the findings by Andriani and Ismet (2017), namely that the existence of textbooks that emphasize the nature of science or NoS should help students change their perspective, which tends to use rote learning to master science. Based on this, the textbooks under study contain more than seven aspects of NoS, so it is hoped that the books analyzed are by students' cognitive development.

The NoS aspect that is explicit has complete information and is consistent (explicitly correct) with a score of 3 is represented in Indonesian and Singapore science textbooks, namely the inferential aspect. Then the theory-driven aspects are not described in Indonesian or Singaporean books. Some aspects of NoS which are represented explicitly in books are still superior to Singapore science textbooks. However, the availability of NoS aspects in Singapore's science textbooks is less than in Indonesian science textbooks.

When viewed from the number, the total aspects of NoS found in the Singapore science textbooks are seven aspects, of which three aspects have been explicitly represented correctly. While the two Indonesian science textbooks only have two aspects that are expressly described accurately. It shows that the Singapore science textbooks represent some aspects of NoS explicitly and can play a role in increasing students' understanding of several aspects of NoS and scientific literacy. Research by Amilia et al. (2017) states that junior high school students need science teaching materials that make science's nature explicit. It is expected to develop

students' scientific literacy skills. Aspects of NoS that are taught explicitly to students can improve learning outcomes about science material, interest in science, and decision-making on science-related issues.

Science textbooks in Indonesia and Singapore have generally represented the NoS aspect. The total scores for the textbooks analyzed ranged from 16 to 17 points, with Indonesian science textbooks Zubaidah et al. (2018) scored 16 points, Tim Abdi Guru (2018) scored 16 points, and the Singapore Science textbook (Marshall Cavendish, 2013) scored a total score of 17 points. The study results are not much different from the research by Jannah et al. (2019), which resulted that class X high school physics textbooks showed scores ranging from 8 to 18 points, which means that they are still far from the maximum score.

The scores obtained from the three books analyzed are still far from the maximum score, but they can be good. The range of the lowest to the highest scores is not too far apart. This score shows that both Indonesian and Singaporean textbooks have not presented all aspects, namely ten aspects of NoS maximally with categories represented explicitly, consistently, and completely. According to Maturradiyah and Rusilawati (2015), textbooks play an essential role in learning, namely as a medium for delivering information.

NoS Aspects on Science Textbooks in Indonesia and Science Textbooks in Singapore

Comparative analysis research on science textbooks for junior high schools in Indonesia and Singapore viewed from the Nature of Science (NoS) aspect resulted that overall Indonesian and Singapore science textbooks already represented several relevant aspects of NoS. However, the theory-driven aspects were still not found in the three books. These and the existing aspects have not been well represented. It is following research conducted by Wei et al, (2013). They stated that NOS was not treated well and scored low because most aspects of the nature of science are only presented through biographical narratives and discovery notes, which have little relevance to NoS.

Zubaidah et al, (2018) book contain almost all of the NoS aspects of the three existing books. The complete NoS aspects emerged from the books in Indonesia and Singapore, namely the empirical, inferential, creative, tentative aspects, the social dimensions of science, and the closeness of social and cultural sciences. Apart from these, other aspects are only owned by the analyzed books. There are aspects of NoS represented in the book that is conveyed explicitly or implicitly. Aspects conveyed explicitly are written, firm, and easy-to-understand material.

In contrast, aspects conveyed implicitly are marked by writing indirect material, requiring reader interpretation, and only conveying examples without explicitly relating the NoS aspect (Jannah et al., 2019). Analyzing three textbooks from the two countries better represents the empirical, inferential, creative, and tentative aspects. These aspects are represented explicitly, although there are not fully represented aspects. The only aspect that is represented explicitly, entirely, and consistently by the books of each country is the inferential aspect.

The empirical aspects found in the textbooks analyzed are represented explicitly but not entirely in the books of Indonesia and Singapore (score 2). In the book Indonesia (Zubaidah et al., 2018), the empirical aspect is represented in proof from theory. However, on another page, the book represents the empirical aspect by showing the findings by scientific researchers, for example, in quotations such as quotations. The practical aspect of Zubaidah et al. (2018) is a theory-driven aspect or interpretation in generating scientific claims. In Indonesia's book (Tim Abdi Guru, 2018), the empirical aspect is represented through scientific evidence. Although the practical aspects are shown with historical sketch evidence in the form of findings by scientists on other pages, the empirical aspects must be derived from observations of natural phenomena, not experimental evidence by scientists. In the book Singapore (Joan Fong et al., 2013), the empirical aspect is represented by inviting students to conduct experiments or observations, as in the quote. So that the practical aspects are presented in the form of observations through human perception tools. The statement of the empirical aspects of the Singapore book can lead someone to prove scientific claims through repeated testing. The practical aspects in the three books have been conveyed explicitly because observations or experiments accompany them. It is in line with the statement of Rahmayani et al. (2019) in their research, which states that to understand that science is empirical, students must be able to distinguish between observation and inference.

The Indonesian and Singapore books' inferential aspects are represented explicitly, entirely, and consistently (score 3). According to Abd-El-Khalick, (2008), statements of inferential aspects are statements about phenomena that are not directly accessible to the senses and can only be accessed through their manifestations or effects. In Indonesia's book (Zubaidah et al., 2018), the inferential aspect is represented by statements that are not accessible to the senses. In the book Indonesia (Tim Abdi Guru, 2018), inferential aspects are also represented by phenomena that are not accessible to the senses. In the book Singapore (Joan Fong et al., 2013), the inferential aspect is represented by describing a phenomenon that is not accessible to the senses with phenomena that students can observe and reason.

The creative aspects of the three books are represented explicitly (scores 2 and 3). According to

Abd-El-Khalick et al., (2008), the creative aspect is scientific knowledge that involves human creativity or scientists who find explanations and theoretical entities. In the book Indonesia (Zubaidah et al., 2018), the creative aspect is represented by explaining scientists' findings. However, the quote is incomplete because the findings are not a sketch dissertation or valid historical evidence. In the book Indonesia (Tim Abdi Guru, 2018), creative aspects are represented based on scientists' findings. The creative aspects are represented and complete because they are accompanied by historical sketches of the year the findings were found. The book Singapore (Joan Fong et al., 2013) represents creative aspects with creative inventions currently used in life. So that students get creative information from not only scientists but also students are required to be creative. It is in line with Rahayu & Widodo's (2019) research, which states that the more available information and technology are, the more one's views are required to be more creative, including scientific discoveries.

The tentative aspects in Indonesian and Singapore science textbooks are represented explicitly, but the information is incomplete (score 2) for the three analyzed books. The two Indonesian books, Zubaidah et al, (2018) and the Abdi Guru Team (2018) represent the tentative aspect by explaining only theoretical things without new findings or evidence. Then in the Singapore Science textbook (Joan Fong et al., 2013), the empirical aspect is presented by explaining the facts in the form of conditions that are currently happening. However, the representation statement is not supported by new theoretical ideas, so it is still incomplete. It is in line with Jannah et al. (2019) that it is necessary to explicitly convey the tentative aspect because it can open students' understanding of the openness of a theory to be developed and retested with newer facts.

This aspect of the scientific method is only found in Indonesian books (Zubaidah et al., 2018) and Singapore books (Joan Fong et al., 2013). In the book Indonesia (Zubaidah et al., 2018), this aspect of the scientific method is represented in a researcher's steps when testing his research. However, the representation is still incomplete in explaining the stages. Then, in the book Singapore (Joan Fong et al., 2013), this aspect of the scientific method is represented in the form of questions or questions. However, this aspect of the scientific method is not a single sequence of certain activities that lead to valid claims. The scientific method aspect in the Singapore book is also not accompanied by supporting evidence or historical sketches of scientists or researchers, only to test students' knowledge of a scientific method. It follows the statement of Abd-El-Khalick et al., (2008), namely that there is no scientific method that guarantees the development of perfect knowledge.

Aspects of scientific theories are only represented in the two Indonesian books. In the book Indonesia (Zubaidah et al., 2018), aspects of the scientific theories described have been accompanied by evidence or historical sketches. However, the information is incomplete because it does not explain the existence of testing or inspection through observation. Meanwhile, in the book Tim Abdi Guru (2018), aspects of scientific theories are evidenced by historical sketches and scientists' specific predictions. Because the representation is not proven by observation, the information submitted is considered incomplete.

Aspects of scientific law are also represented by the two Indonesian books only. In Zubaidah et al. (2018), aspects of scientific law are represented by presenting phenomena stated in scientific law. In the book, there are statements of scientific laws stated from the results of scientific experiments. However, most of them are stated by presenting phenomena related to existing scientific laws. In the book Tim Abdi Guru (2018), aspects of scientific law are stated explicitly by directly mentioning the sound of law without presenting phenomena related to the law.

Aspects of the social dimensions of science in the two Indonesian books are implicitly represented, without any evidence of activity or complete historical sketches. It can be seen in the results of the quotations obtained. Zubaidah's book et al. (2018) only represent scientists' findings that are useful in life but do not explain how the origins of these findings emerged. The book Tim Abdi Guru (2018) represents useful findings but is not explained in more detail. While in the book Singapore (Joan Fong et al., 2013), this aspect is represented by presenting a more detailed and complete historical sketch of a scientist. The delivery of the social dimensions of science must indeed be clarified, especially the sketch of the history of scientists, both their findings and achievements, so that they can be helpful as social sciences.

According to Abd-El-Khalick et al., (2008), the closeness aspect of social and cultural sciences refers to the use of physics in the creation of technology that supports human life. Aspects of the closeness of social and cultural sciences in the books analyzed are only Singapore books which represent these aspects explicitly, with complete information, and consistently (score 3). Meanwhile, both books from Indonesia only provide implied information (point 1). Indonesian books (Zubaidah et al., 2018) and (Tim Abdi Guru, 2018) represent this aspect only with single evidence, incomplete explanations, and no consistency with other pages. In Singapore, books (Joan Fong et al., 2013) represent this aspect with factual evidence.

Conclusion

In comparing the NoS aspects of science textbooks in Indonesia and science textbooks in Singapore when viewed from the number of NoS aspects found, science textbooks in Indonesia have more NoS aspects than science textbooks in Singapore. However, when viewed from the total score, science textbooks in Singapore are superior to science textbooks in Indonesia. The NoS aspects represented in science textbooks in Indonesia and science textbooks in Singapore are empirical, inferential, creative aspects, social dimensions of science, and proximity to social and cultural sciences. The aspect that is represented explicitly, with complete information, and consistent in science textbooks in Indonesia and science textbooks in Singapore is the inferential aspect. The aspect that is not raised by science textbooks in Indonesia and science textbooks in Singapore is the theory-driven aspect.

Based on the research done, the researcher provides several suggestions: (a) The government should provide standards for writers or compilers of science textbooks for junior high schools in Indonesia to represent aspects of NoS. One of them is making science textbooks in Singapore a guideline for a good representation of NoS aspects. It can make the textbooks that are used as considerations for educators and students for learning activities to improve NoS abilities and scientific literacy. (b) Education providers should choose junior high school science textbooks that contain NoS aspects that are explicit, consistent and have complete information. Education providers can also use Singapore science textbooks as a secondary learning resource and Indonesian science textbooks used in general. (c) For further research, namely, develop teaching materials by integrating NoS aspects which refer to the results of the NoS analysis of science textbooks in Singapore as consideration for presenting quotations and/or representations of NoS aspects in the developed teaching materials.

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