Representation of Nature of Science in Science Textbooks

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Abstract: The aim of this study is to examine how the nature of science dimensions are represented in the secondary school 5th, 6th, 7th, and 8th grade science textbooks of the last twenty years. It is also within the scope of the research to investigate how these dimensions in the textbooks changed during the twenty years. The document analysis method was used in order to qualitatively gather data for the research. The data sources in the study consist of a total of 62 textbooks which were allowed to be used in schools by the Ministry of National Education. Among the examined textbooks, only the textbooks published in 2020 were published by private publishing houses, and all other textbooks were published by the Ministry of National Education publishing houses. Textbooks were examined in terms of ten sub-dimensions, such as "empirical", "inferential", "creative", "theory-driven", "tentative", "myth of the scientific method", "scientific theories", "scientific laws", "social dimensions of science", and "social and cultural embeddedness of science", within the scope of the nature of science. The examination of the textbooks in terms of the representation of the specified sub-dimensions was carried out using the detailed rubric developed by Abd-El-Khalick, Waters, and Le (2008). As a result of the examination of science textbooks, "creative", "tentative", and "inferential" sub-dimensions were mostly represented, followed by "empirical", "theory-driven", and "social and cultural embeddedness of science". The sub-dimensions of "scientific theories", "scientific laws", "myth of the scientific method", and "social dimensions of science" are either very limited or not represented. However, in general, it has been concluded that all science books published in the last 20 years in each grade are inadequately represented in terms of the sub-dimensions of the nature of science.

Keywords: Nature of science, Textbook analysis, Science textbooks

Introduction

Currently, the improvement of science and technology in the world has caused our lives to drastically change. And this change has inevitably become a part of our lives. In order to keep pace with these changes, the education programs of science curricula around the world have constantly adapted and evolved. With these

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changes, questions such as what science is, how scientists work, how science should be taught, whether it is more important to gain scientific knowledge or an awareness of the scientific process, have become paramount. For this purpose, the primary intention of science education is determined to develop students as "scientifically literate" individuals both in the world and in our country (American Association for the Advancement of Science [AAAS], 1993; Milli Eğitim Bakanlığı [MEB], 2005, 2013, 2018).

In this study, the changes in the nature of science within the science textbooks from the last 20 years are examined. It is imperative to examine the textbooks in terms of the nature of science, but when the literature is examined, it is perceived that the research on the nature of science are mostly based on teacher and student views (Akçay, 2011; Akerson et al, 2000; Aslan & Taşar, 2013; Bell et al, 2000; Çelikdemir, 2006; Doğan, 2005; İrez, 2004; Khishfe & Abd-El-Khalick, 2002; Köseoğlu et al, 2008; Küçük, 2006; Lederman & Zeidler, 1987; Schwartz et al, 2004). Although there has been an increase in textbook reviews in recent years, it can be said that the number is insufficient both abroad and in Turkey.

The examination of the textbooks in terms of the nature of science has generally been done on chemistry, biology, and physics textbooks (Abd-El-Khalick et al, 2008; Chiappetta & Fillman, 2007; Esmer, 2011; İrez, 2009; Niaz & Maza, 2011; Tortumlu, 2014). This study is significant in terms of examining the representation of the dimensions of the nature of science in the textbooks and reflecting the change in the representation of the dimensions of the nature of science over the course of twenty years.

Method

Design of The Study

In this study, document analysis of science textbooks used in Turkey between the academic years of 2000-2020 was carried out according to the document analysis process of Altheide (1996). Document analysis was used as a stand-alone method.

Data Sources

The sample of the study consists of 5th, 6th, 7th and 8th grade science textbooks prepared by the Ministry of National Education between 2000-2020 academic years and used as a textbook in public schools.

Data Collection Tools and Analysis

The examination of the textbooks was carried out in terms of the 10 sub-dimensions emphasized in international science education documents as stated in the literature and used by researchers who have been working on the nature of science for many years. The nature of science sub-dimensions targeted in the analysis of the selected textbooks are as follows: (1) "empirical", (2) "inferential", (3) "tentative", (4) "creativity", (5) "social

dimensions of science", (6) "theory-driven", (7) "myth of the scientific method", (8) "scientific theory" (9) "scientific law", and (10) "social and cultural embeddedness of science" (Abd-El-Khalick et al., 2008).

In this study, a detailed rubric developed by Abd-El-Khalick et al. (2008) was used. While examining the textbooks, it was not only examined whether the sub dimensions of the nature of science were mentioned or not, but also how and in what way the dimensions of the nature of science were included. According to his rubric, a representation level between -3 and +3 was determined for each sub-dimension related to the nature of science. A score range between -30 and +30 was determined for each book. Textbooks were carefully read and the nature of science sub-dimensions referred to in the books were determined. Later, expressions referring to the same dimensions were grouped together and analyzed homogeneously and their representation status was scored. (Abd-El-Khalick et al, 2008).

Reliability and Validity

The first researcher who carried out the analysis in this study is a biology teacher. The second researcher is an academic expert in the field of science education who teaches the nature of science at the undergraduate and graduate levels. While analyzing the textbooks, the two researchers worked independently and scored the textbooks. Then, apart from these researchers, the results of both researchers were checked by a third researcher who is an academic expert in the nature of science. After all the books were examined and scored, the consistency between the former researchers' scores was calculated. It was determined by the third researcher, the expert in the nature of science, that the agreement between the independent scoring of the two researchers who scored was 85%.

Results

The study has been evaluated in terms of the 10 sub-dimensions of the nature of science in the science textbooks of the last 20 years. A score varying between -3 and +3 was given for the representation of each sub-dimension, and the total scores of the textbooks were determined. The obtained results are presented in the Table 1.

Table 1. Total Scores given to the 5th, 6th, 7th, and 8th Grade Textbooks examined by Years between 2000-2020

Year	5th Grade	6th Grade	7th Grade	8th Grade	Mean
2000	-	1	2	4	2.3
2001	-	1	2	4	2.3
2003	-	11	6	5	7.3
2004	-	10	10	3	7.7
2005	4	10	10	3	6.8
2006	6	11	6	3	6.5

Year	5th Grade	6th Grade	7th Grade	8th Grade	Mean
2007	6	11	11	3	7.8
2008	6	11	11	11	9.8
2009	6	11	11	11	9.8
2010	6	11	11	11	9.8
2011	6	11	12	13	10.5
2012	6	11	10	13	10.0
2013	11	11	10	N/A	10.7
2014	11	N/A	10	N/A	10.5
2015	15	8	N/A	N/A	11.5
2016	15	8	N/A	N/A	11.5
2018	N/A	2	6	N/A	4.0
2019	5	2	3	N/A	3.3
2020	6	6	2	5	4.8
STDEV	3.6	3.9	3.7	4.2	
MEAN	7.8	8.2	7.8	6.8	

When Table 1 is examined, it is seen that the textbooks belonging to the 6th, 7th, and 8th grade, which were published in 2000 and 2001, received between +1 and +4 points. In 2000 and 2001, the 8th grade science textbook had the best representation level with +4 points, and the 6th grade science textbook had the lowest representation level with +1 point.

According to Table 1, it is seen that the textbooks belonging to the 6th, 7th, and 8th grade, which were published in 2003, received between +5 and +11 points. In 2003, the 6th grade science textbook had the best representation level with +11 points, and the 8th grade science textbook had the lowest representation level with +5 points.

According to Table 1, it is seen that the textbooks belonging to the 6th, 7th, and 8th grade, which were published in 2004, received between +3 and +10 points. In 2004, the 6th and 7th grade science textbooks had the best representation level with +10 points, and the 8th grade science textbook had the lowest representation level with +3 points.

According to Table 1, it is seen that the textbooks belonging to the 5th, 6th, 7th, and 8th grade, which were published in 2005, received between +3 and +10 points. In 2005, the 6th and 7th grade science textbooks had the best representation level with +10 points, and the 8th grade science textbook had the lowest representation level with +3 points.

According to Table 1, it is seen that the textbooks belonging to the 5th, 6th, 7th, and 8th grade, which were published in 2006, received between +3 and +11 points. In 2006, the 6th grade science textbook had the best

representation level with +11 points, and the 8th grade science textbook had the lowest representation level with +3 points.

According to Table 1, it is seen that the textbooks belonging to the 5th, 6th, 7th, and 8th grade, which were published in 2007, received between +3 and +11 points. In 2007, the 6th and 7th grade science textbooks had the best representation level with +11 points, and the 8th grade science textbook had the lowest representation level with +3 points.

According to Table 1, it is seen that the textbooks belonging to the 5th, 6th, 7th, and 8th grade, which were published in 2008, 2009, and 2010, received between +6 and +11 points. In 2008, 2009, and 2010, the 6th, 7th and 8th grade science textbooks had the best representation level with +11 points, and the 5th grade science textbook had the lowest representation level with +6 points.

According to Table 1, it is seen that the textbooks belonging to the 5th, 6th, 7th, and 8th grade, which were published in 2011 and 2012, received between +6 and +13 points. In 2011 and 2012, the 8th grade science textbooks had the best representation level with +13 points, and the 5th grade science textbook had the lowest representation level with +6 points.

According to Table 1, it is seen that the textbooks belonging to the 5th, 6th, and 7th grade, which were published in 2013, received between +10 and +11 points. In 2013, the 5th and 6th grade science textbooks had the best representation level with +11 points, and the 7th grade science textbook had the lowest representation level with +10 points.

According to Table 1, it is seen that the textbooks belonging to the 5th and 7th grade, which were published in 2014, received between +10 and +11 points. In 2014, the 5th grade science textbook had the best representation level with +11 points, and the 7th grade science textbook had the lowest representation level with +10 points.

According to Table 1, it is seen that the textbooks belonging to the 5th and 6th grade, which were published in 2015 and 2016, received between +8 and +15 points. In 2015 and 2016, the 5th grade science textbook had the best representation level with +15 points, and the 6th grade science textbook had the lowest representation level with +8 points.

According to Table 1, it is seen that the textbooks belonging to the 6th and 7th grade, which were published in 2018, received between +2 and +6 points. In 2018, the 7th grade science textbook had the best representation level with +6 points, and the 6th grade science textbook had the lowest representation level with +2 points.

According to Table 4.9, it is seen that the textbooks belonging to the 5th, 6th, and 7th grade, which were published in 2019, received between +2 and +5 points. In 2019, the 5th grade science textbook had the best representation level with +5 points, and the 6th grade science textbook had the lowest representation level with

+2 points.

According to Table 1, it is seen that the textbooks belonging to the 5th, 6th, 7th, and 8th grade, which were published in 2020, received between +2 and +6 points. In 2020, the 5th and 6th grade science textbooks had the best representation level with +6 points, and the 7th grade science textbook had the lowest representation level with +2 points.

Consequently, when the average scores of all the examined textbooks were compared, it was seen that the 6th grade had the highest score, the 5th and 7th grades were the same, and the 8th grade books had the lowest score. The total scores of the 5th, 6th, 7th and 8th grade science textbooks from the 10 sub-dimensions of the nature of science between the years 2000-2020 are presented in Figure 1 below.

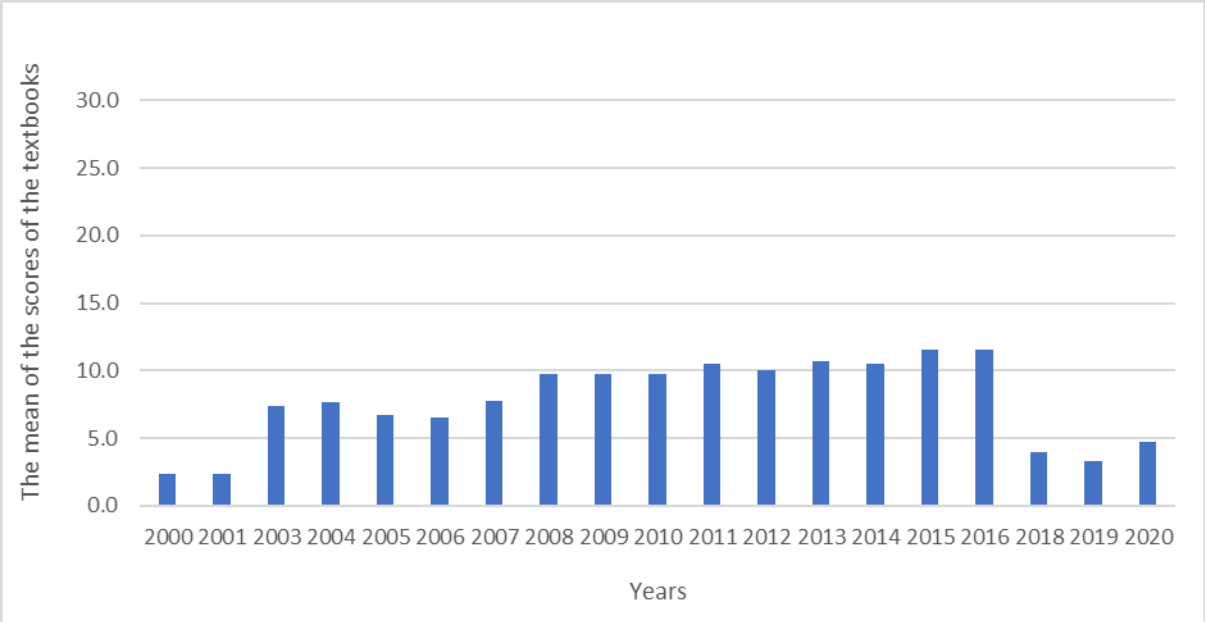

Figure 1. The Mean of the Scores of the Textbooks by Years between 2000-2020

When Figure 1 is examined, when the scores obtained by years are compared, it is seen that the lowest average score belongs to the years 2000 and 2001. The years with the highest average score were found to be 2015 and 2016.

Conclusion

The aim of this study was to perform an examination of science textbooks of the last 20 years carried out in terms of the 10 sub-dimensions used to represent the nature of science, which were determined by Abd-El-Khalick et al. (2008), who has been working on the nature of science for many years. These 10 sub-dimensions are: (1) “empirical”, (2) “inferential”, (3) “tentative”, (4) “creativity”, (5) “social dimensions of science”, (6) “theory-driven”, (7) “myth of the scientific method”, (8) “scientific theory”, (9) “scientific law”, and (10)

"social and cultural embeddedness of science".

As a result of the examination of science textbooks, "creative", "tentative" and "inferential" sub-dimensions were mostly represented, followed by "empirical", "theory-driven", and "social and cultural embeddedness of science". The sub-dimensions of "scientific theories", "scientific laws", "myth of the scientific method", and "social dimensions of science" are either very limited or not represented. However, in general, it has been concluded that all science books published in the last 20 years in each grade are inadequately represented in terms of the sub-dimensions of the nature of science.

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