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GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

REPRESENTATION OF NATURE OF SCIENCE IN SCIENCE TEXTBOOKS OF THE LAST 20 YEARS

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MASTER OF SCIENCE THESIS

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A thesis submitted by Didem Ünlü Sinnett Jr in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE is approved by the committee on 27/12/2021 in Department of Science Education Program.

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Didem ÜNLÜ SINNETT JR

Dedicated to my husband

and my family

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ABSTRACT

Representation of Nature of Science in Science Textbooks of the Last 20 Years

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Department of Science Education

Master of Science Thesis

Supervisor: Prof. Dr. Hakan AKÇAY

The objective of the current research is to examine the way in which the nature of science dimensions are represented in the secondary school science textbooks of grades 5 through 8 in 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 science textbooks which were approved for the school curriculum by the Ministry of National Education. Among the examined textbooks, only the textbooks published in 2020 were created by private publishing houses, and all other textbooks were developed by the Ministry of National Education publishing houses. Textbooks were examined in terms of ten sub-dimensions, such as "tentative", "empirical", "creative", "theory-driven", "inferential", "scientific theories", "myth of the scientific method", "social and cultural embeddedness of science", "scientific laws", and "social dimensions 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 conducted utilizing the detailed rubric established by Abd-El-Khalick, Waters, and Le (2008). In light of the examination of the 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 inadequately represented the nature of science sub-dimensions.

Keywords: Nature of science, science textbooks, textbook analysis

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ÖZET

Son Yirmi Yıla Ait Fen Bilimleri Ders Kitaplarının Bilimin Doğası Açısından İncelenmesi

Didem ÜNLÜ SINNETT JR

Matematik ve Fen Bilimleri Anabilim Dalı

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Bu çalışmanın amacı, son yirmi yıla ait 5., 6., 7., ve 8. sınıf kademelerine ait fen bilimleri ders kitaplarında bilimin doğası alt boyutlarının nasıl temsil edildiğini incelemektir. Ders kitaplarında yer alan bu boyutların yirmi yıl boyunca nasıl değiştiği de araştırma kapsamındadır. Nitel araştırma yöntemlerinden doküman inceleme yöntemi kullanılmıştır. Araştırmadaki veri kaynakları, toplam 62 ders kitabından oluşmaktadır. İncelenen ders kitaplarından sadece 2020 yılında yayınlanan ders kitapları özel yayınevleri tarafından, diğer tüm ders kitapları Milli Eğitim Bakanlığı yayınevleri tarafından basılmıştır. Ders kitapları "çıkarımsal", "değişime açık", "deneysel", "bilimin sosyal ve kültürel gömülülüğü", "bilimin sosyal ve kültürel yapısı", "yaratıcılık", "teori temelli", "bilimsel teori", "bilimsel metot miti", ve "bilimsel kanun" olmak üzere on alt boyut açısından incelenmiştir. Ders kitaplarının belirtilen on alt boyutunu ne kadar temsil ettiğini araştırmak için Abd-El-Khalick, Waters ve Le (2008) tarafından geliştirilen dereceli puanlama anahtarı kullanılmıştır. Fen bilimleri ders kitaplarının incelenmesi sonucunda "yaratıcı", "değişime açık" ve "çıkarımsal" alt boyutların en fazla temsil edildiği, bunu "deneysel", "teori temelli" ve "bilimin sosyal ve kültürel gömülülüğü" izlediği ortaya çıkmıştır. “Bilimsel kuramlar”, “bilimsel yasalar”, “bilimsel yöntem miti” ve “bilimin toplumsal boyutları” alt boyutları ya çok sınırlı düzeyde temsil edilmiş ya da hiç temsil edilmemiştir. Ancak genel olarak son 20 yılda her sınıfta yayınlanan tüm fen bilimleri ders kitaplarının bilimin doğası alt boyutları açısından yetersiz temsil edildiği sonucuna ulaşılmıştır.

Anahtar Kelimeler: Bilimin doğası, fen bilimleri ders kitapları, ders kitabı analizi

1
INTRODUCTION

In this section, the literature review, objective of the thesis, hypothesis, importance of the study, assumptions, limitations and definitions are stated, respectively.

1.1 Literature Review

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 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).

Scientific literacy is a comprehensive phrase includes scientific concepts and ideas across and within various scientific fields, as well as scientific practices (Ayu et al., 2014). Therefore, there is no single definition of scientific literacy. Shiland (1997) defined scientific literacy as an ability to use widely-accepted theories to predict, explain, and understand the natural world. Norris and Philips (2003) tried to bring together all the different explanations of scientific literacy and make a single definition through their research findings. Under this conceptual roof, they added concepts such as "having scientific thinking skills", "understanding the nature of science and its relationship with cultures", and "understanding science and its applications" (Norris & Phillips, 2003, p.22). While there is no agreement about a definition of scientific literacy, most of the educators settled with a general definition that states to the comprehending of scientific principles, concepts, theories, processes, and understanding of the complex relationships between technology, society and science (AAAS, 1990, 1993; Abd-El-Khalick et al, 1998; Millar & Osborne, 1998).

In recent years, in international conferences and scientific documents, it has been emphasized that science education should be strengthened in order to establish a society composed of scientifically literate people. This situation brought about the updating of science education programs in many countries consecutively (Millar, 2006). In our country, the Ministry of National Education carried out a reform movement by putting the concept of scientific literacy into its curriculum in the 2004/2005 academic year. In the science education programs which were developed, it was aimed to raise scientifically literate individuals who can question, observe, collect data, be open to share information, be responsible, knowledgeable, have talent, and can set and solve problems (MEB, 2013).

Nature of science is not only an important factor in teaching science but also the key component of scientific literacy. According to Lederman (1992), nature of science is a wide notion that contains beliefs and values in scientific knowledge and takes into account the lives of people who strive for the development of these beliefs and values. To summarize, nature of science benefits individuals by associating science and the nature of science with daily life, discussing scientific problems, participating in decision-making processes, giving importance to scientific culture, comprehending the criteria of the scientific society, and understanding the content of science in depth. Therefore, nature of science should be included and instructed in science teaching programs (Driver et al, 1996). In consequence, having the characteristics of scientifically literate individuals is only possible by learning the nature of science (Lederman, 2007).

According to Griffith and Barman (1995), the usefulness of science education was insufficient when the nature of science was not comprehended. Science textbooks likewise have an significant part in students' improvement of their perception of the nature of science. İrez (2009) stated that books have two direct and indirect effects on students' learning. While the student's use of the book as a resource and a guide for learning is considered as a direct effect, the indirect effect occurs when teachers use books. Textbooks serve as a guide for both students and teachers. Therefore, textbooks should be carefully prepared in accordance with national standards, curricula and scientific literacy themes, with specific textbook integration of the nature of science.

After a cursory investigation of the literature, the issue of how and to what extent the nature of science is incorporated into textbooks has been identified as a problem that researchers have focused on in recent years. Many research results, especially in the United States, show that teachers' and students' understanding of the nature of science is not at a sufficient level (Abd-El-Khalick et al, 2008; Abd-El-Khalick & Akerson, 2004; Bianchini & Colburn, 2000; Chiappetta & Fillman, 2007; Niaz & Maza, 2011). While one of the most important factors in the emergence of such a result is related to the teacher training process, another is related to the way the subject is integrated into the curriculum and textbooks (Abd-El-Khalick et al, 2008).

The main problem addressed in this study, which has been carried out based on the issues and reasons expressed so far, can be conveyed as follows: How do science textbooks published from 2000-2020 represent the dimensions of the nature of science?

1.2 Objective of the Thesis

The purpose of this research is to examine the manner and depth of integration of the dimensions of the nature of science in the science textbooks, which were authorized by the Turkish Ministry of Education for 5th, 6th, 7th, and 8th grade levels, within the last 20 years.

1.3 Hypothesis

The research questions that were prepared based on the purpose of the study are as follows:

1. How has the nature of science been represented in science textbooks for the last two decades?
2. What are the changes in the representation of the nature of science in science textbooks in the last two decades?

1.4 Importance of the Study

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 with reference to the nature of science, but after a thorough review of relevant literature was examined, it was perceived that the research on the nature of science was 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.

1.5 Assumptions

In this study, it was assumed that all the examined textbooks included the nature of science, that the textbooks were prepared in accordance with the relevant curriculum, that the coders and those who examined the books were impartial, and that the criteria were sufficient for analysis.

1.6 Limitations

Document analysis includes only the published material and excludes all outside material. Some books are absent in the research because they are not stored in the Turkish Ministry of Education National Archive. In this study, the researcher determined the dimensions of the nature of science criteria from the related literature. Lastly, there is no possible means of multiple textbook examiners to analyze the documents identically, regardless of how stringently the process is established.

1.7 Definitions

Scientific literacy: It is knowing the nature of science, understanding how knowledge is obtained, understanding that knowledge in science depends on known facts and may change as new evidence is gathered, knowing basic concepts, theories and hypotheses in science, and perceiving the difference between scientific evidence and personal opinion (Çepni et al, 1997).

The nature of science: It is an intersection formed by issues related to the historical, philosophical, psychological, and sociological aspects of science and that impact science learning and teaching (McComas, Clough, & Almazroa, 1998).

Qualitative research: It is a research in which qualitative data collection techniques such as observation, interview and document analysis are used and a qualitative process is followed to reveal perceptions and events in a natural environment in a realistic and holistic way. (Yıldırım & Şimşek, 2011).

Document analysis method: It can be defined as a review process by collecting existing documents related to the subject to be researched and coding them according to a specific system (Çepni, 2014).

Curriculum: It is a life system that includes all activities related to the teaching of a lesson that is planned to be brought to the individual at school or out of school (Demirel, 2015).

Textbook: It is a resource that regularly conveys the subject information included in the curriculum of a particular course and is prepared in order for students to gain knowledge, skills, and habits (Güneş & Ünsal, 2002).

2

THEORETICAL FRAMEWORK

2.1 Scientific Literacy

The rapid advancement of technology and science in the last century has increased the need for people who can understand science, have access to scientific information, and can use this information. This situation has also been reflected in science education policies and radical changes have been experienced in current years. Scientific literacy was the first step of this change (AAAS, 1990, 1993; Harlen, 2006; MEB, 2005, 2013, 2018).

Scientific literacy has been the most significant purpose of science education in recent years. Although the use of the concept of scientific literacy originated in the start of the 20th century, it has become a commonly used concept after the 1950s. One of the most common definitions was made by AAAS (1990) and it has been briefly defined as the ability to access and use information. According to Hurd (1998), a scientifically literate individual distinguishes between theory and dogma, data and rumors, knows how scientific studies are carried out, understands the nature of science, realizes the risks, limitations and assumptions in decision-making about scientific issues, aware of cultural and moral values while playing a role in solving current problems. Lederman and Niess (1998) emphasized individuals who understand the characteristics of science, who can use scientific knowledge and scientific process skills to solve the problems they face in daily life, understand the nature of science, and know the role of science and technology in the development of societies.

Scientific literacy aims to enable individuals to become accustomed to today's conditions, to understand the facts and events around them, and to bring scientific explanations to them, rather than turning them into experts in their subject areas. A scientifically literate person can understand scientific concepts at the most basic level and can provide scientific explanations to the events that occur around them (Türkmen, 2006).

According to Duschl (1990), in order to draw the full picture of science, the science curriculum must include not only what science knows but also how science acquires knowledge. Therefore, the nature of science ought to be incorporated in the science curriculum and should be taught correctly to students. Starting to instruct students in the nature of science from the initial grades of primary education will contribute positively to achieving science literacy (Taşar, 2003).

2.2 Nature of Science

Science instructors have been working at length to marry the teaching of the nature of science together with the subject content in science lessons. The improvement of the understanding of the nature of science is an important component of scientific literacy (Akerson & Donnelly, 2010). Despite this, science educators could not come to a common agreement on the description of the nature of science. According to Lederman (2007), the reason why the nature of science has not been singularly defined is that individuals comprehend the nature of science differently and the nature of science changes over time.

In the compilation analysis by Abd-El-Khalick and Lederman (2000), the major developments in fields such as sociology, history and philosophy of science were focused on and emphasized. These great changes have also gradually transformed the perspectives of science educators regarding the nature of science (Abd-El-Khalick & Lederman, 2000). In the early 1950s, the concept of the nature of science was used as the equivalent of the scientific method concept. In the 1960s, the situation and academic understanding changed, and the nature of science began to be used as a synonym for the concept of scientific process skills (Abd-El Khalick, 2013).

Since the 1990s, the nature of science has started to be used together with sub-dimensions such as the socio-cultural structure of scientific knowledge, creativity, and imagination, and the personal value judgments of the scientist (AAAS, 1990, 1993; NRC, 1996). Because of these conceptual changes that have been going on for many years, it is emphasized that instead of making a definite definition of the nature of science, it is necessary to reach a common insight on what the nature of science is (Deng et al, 2011).

The nature of science is a wide field that embraces the beliefs and values of scientific knowledge, takes into account human efforts in the development of scientific knowledge, attempts to enlighten how science works, shows what science actually is, displays how scientists work, and enumerates the ways in which society and science relate (McComas & Olson, 1998). Lederman (1992) stated that the nature of science and the epistemology of science mean the beliefs and values in science and scientific knowledge as a way of knowing and understanding. According to Taşar (2003), the nature of science consists of comprehending what science is and what tasks they undertake, who scientists are and their roles, scientific observations, phenomena, scientific theory and laws, scientific method, and how scientific knowledge is produced. The field of nature of science is all about how scientists make use of scientific knowledge, how they develop it, how they decide to investigate a scientific problem, and how they accumulate and utilize scientific data (Ryder et al, 1999).

Despite the many differences of opinion, science educators were able to draw a general framework about what the nature of science is. In addition, the nature of science addresses topics such as scientific epistemology, the values inherent in scientific knowledge, the philosophy of science, the sociology of science, and the history of science (Lederman & Zeidler, 1987; McComas, Clough, & Almazroa, 1998). Based on these interpretations, sub-dimensions of the nature of science that science educators, positive scientists, historians, sociologists, and philosophers can accept as common have been obtained (McComas & Olson, 1998; Osborne et al, 2003).

Abd-El-Khalick, Waters, and Le (2008) determined ten sub-dimensions of the nature of science. Explanations of these sub-dimensions are stated below.

Empirical: Abd-El-Khalick, Waters, and Le (2008) describe the empirical dimension as observed natural phenomena leading to scientific claims. Since scientists are not always able to immediately or directly access the majority of natural occurring phenomena, observations mostly are collected and filtered through a multitude of methods. Scientific propositions express facts that can be observed directly or indirectly. Being factual and based on experiments makes science different from other disciplines such as logic, mathematics, and religion (Yıldırım, 2002). Experiments play a very important role in accessing scientific knowledge, but experiments are not the only way to reach scientific knowledge. Because of the inability to control variables, it is very difficult to perform correct experiments. (McComas, 1998).

Inferential: Abd-El-Khalick, Waters, and Le (2008) describe this inferential dimension as containing a critical distinction between the observational and inferential scientific methods. While observations are "descriptive statements about natural phenomena that are accessible to the senses and about which observers can reach consensus with relative ease", inferences are stated as a type of phenomena only indirectly accessible to the senses. Thus, scientific concepts such as gravity are inferred since they are accessed and/or measured only by the examination of their consequences or manifestations.

Observations are descriptive justifications about natural phenomena or events that can be accessed directly by the sense organs. Inference, conversely, are statements and explanations that cannot be directly reached by the sensory organs. In short, interpretation of the observations can be categorized as inferences. This feature adds an inferential dimension to science, as well as being experimental, because not everything can be observed through the sense organs. For example, scientific information such as the magnetic field and the structure of the atom were created by inferences rather than observations (Abd-El Khalick et al., 2001; Atakan, 2019; Lederman et al., 2002).

Creative: Abd-El-Khalick, Waters, and Le (2008) noted that science does not contain strictly rational or systematic activity. Human creativity often drives the production of scientific knowledge in the form of explanations and theoretical entities invented by scientists. These scientific explanations and entities become "functional theoretical models rather than faithful copies of reality" with assistance from the creative and inferential nature of science.

Scientists employ their creative and imaginative capacity to put together hypotheses and theories. Contrary to popular belief, science cannot be just a rational endeavor independent of human elements. For example, scientific explanations about atoms, DNA and black holes are not exactly the same, but theoretical inferences obtained with imagination and creativity (Abd-El Khalick et al, 2001; Lederman, 2007; Lederman et al., 2002). According to İrez (2006), the creativity and imagination of scientists are necessary at every stage, from determining and shaping a scientific problem, to conducting the research, to interpreting the results. Scientists use their imagination and creativity to make scientific data more understandable or to create a picture of the whole event from limited data.

Theory-driven: Abd-El-Khalick, Waters, and Le (2008) explained that the nature of science is theory-driven, as the background factors of "theoretical and disciplinary commitments, beliefs, prior knowledge, training, and expectations" play an influential part in scientists' work. Scientists' decisions regarding which "problems to investigate and method of investigations, observations, and interpretations of these observations" are all affected by these background factors. The character of theory in the building of scientific knowledge is anchored in individuality, where neutral observation is not the facilitator of progress.

The events, in which scientists are affected during the production of scientific knowledge, play an essential role in putting forward theories. Therefore, in opposition to popular belief, science never begins with impartial observation (Abd-El-Khalick et al., 2001; Akerson & Donnelly, 2010). Scientific knowledge is in a systematic and consistent structure based on inferences and logical arguments. In this respect, scientific knowledge is based on a theoretical origin. Observations and experiments are done for a purpose, and before the observation is made, there must be a theory that orients the observer to this goal. This situation brings with it problems related to the reliability of the observations made based on theory, and also provides an advantage in the emergence of original comments (Çelik & Bayrakçeken, 2006).

Tentative: Abd-El-Khalick, Waters, and Le (2008) point to the durability and reliability of scientific knowledge but concede that there still remains a degree of flexibility or uncertainty. Science is not stationary, so knowledge evolves as new evidence is revealed. Scientific claims are updated with the aid of conceptual and technological advances. A necessity for preceding evidence to be reinterpreted due to new or revised theoretical ideas is an imperative of scientific knowledge advancement. This provisional aspect of the nature of science is lastly attributable to changes seen in cultural and social spheres, as well as established research programs making a change in tack.

Scientific knowledge welcomes adjustment and is subject to reiteration because of new perspectives and technological developments. The fact that scientific knowledge is open to advancement is due to its inferential, imaginative, subjective, and cultural characteristics, as well as its inability to be proven completely. An infinite number of observations are required to prove a law or a theory absolutely (Lederman et al., 2002). Scientific information is not static and absolutely correct information. Scientific information may change with new evidence or interpretation of the identical data in different ways. All information that we now regard as correct may not be accepted in the future (Abd-El-Khalick et al, 1998).

Myth of the scientific method: Abd-El-Khalick, Waters, and Le (2008) compared this dimension to a myth of "a recipe-like stepwise procedure that typifies all scientific practice". Here, the scientific method is questioned since infallibility of knowledge is an erroneous belief. Scientists are tasked to "observe, compare, measure, test, speculate, hypothesize, debate, create ideas and conceptual tools, and construct theories and explanations", but the existence of one sequence of activities, whether conceptual, logical, or practical, that will definitely bring about valid claims or definitive knowledge, is absent.

The idea that there is only one scientific method applied step by step by all scientists is one of the most common misconceptions among individuals about the nature of science. Science has many activities such as observing, measuring, testing, making predictions, and establishing hypotheses, but these activities do not have a specific order or necessity (Abd-El-Khalick et al., 2001). Keesler prepared a list of the principles of scientific research in 1945 and organized this list into a questionnaire and distributed it to a certain number of scientists. He asked scientists to rank these principles according to their importance and published the results. However, the publication of this list in some textbooks in the form of scientific method formed the basis of today's false belief (McComas, 1998). Chalmers (2007) stated that there are many different methods in different branches of science and that these methods are constantly in flux. In addition, scientists can use different methods in their research, and they can change their methods at any time in their studies (Palmquist & Finley, 1997).

Scientific theories: Abd-El-Khalick, Waters, and Le (2008) posit that theories are centered on notions or truisms and speculate that non-observable entities exist, so direct testing of these theories is futile. Indirect evidence becomes the source of support and validation for theories, where “scientists derive specific testable predictions from theories and check them against observations. An agreement between predictions and observations increases confidence in the tested theory”. Theories play an important part in formulating research problems and guiding future research. Scientists use theories to make testable predictions and try to control them experimentally. Experimental verification of predictions increases the validity of the theories. (Abd-El Khalick et al, 2001; Lederman et al, 2002).

Scientific laws: Abd-El-Khalick, Waters, and Le (2008) emphasize the differences between laws and theories while elucidating this dimension. While “laws are descriptive statements of relationships among observable phenomena”, theories are “inferred explanations for observable phenomena or regularities in those phenomena.” A hierarchical relationship does not exist between laws and theories.

Laws are statements that define the relationships between directly observable phenomena. For example, Boyle's Law, which explains the relationship between volume and pressure of gases at constant temperature. As a matter of fact, Kinetic Theory can be used to explain Boyle's Law (Abd-El Khalick et al., 2001; Atakan, 2019; Lederman et al., 2002). There is a mistaken belief in individuals that theories will turn into laws if they are supported by solid evidence. This belief brings with it the misconception that there is a simple hierarchy between laws and theory and that laws are more reliable sources of information than theories. However, many laws trying to explain similar concepts in science were put forward long before the theory on the same subject. For example, Mendel's Laws of Inheritance were put forward in 1866, the Chromosome Theory emerged in 1915. In addition, this false belief also contradicts the changing nature of scientific knowledge. Because individuals with this belief think that they will not change because they see the laws as proven information. Laws and theories are different types of knowledge, and one cannot be transformed into another. Theories are just as logical a kind of scientific knowledge as laws. Scientists are not producing theories on the grounds that one day they will turn into laws. In addition to explaining observations that seem unrelated to each other, theories also play an important role in the emergence of new scientific problems (Abd-El-Khalick et al, 1998; Atakan, 2019; Lederman et al, 2002; McComas, 1998).

Social dimensions of science: Abd-El-Khalick, Waters, and Le (2008) asserted that scientific knowledge contains a dimension of social negotiation, which must not be confused or categorized with "relativistic notions of science." Science is a human endeavor and is influenced and embedded in a social environment, cultural and economic factors, religious and philosophical views, politics, and power structures. However, all these elements are not hurdles to the further advancement of science. Although scientists are affected by these factors, they can decide under what conditions science should be performed. However, it cannot be ignored that these elements affect scientists in the process of forming scientific knowledge (Abd-El-Khalick et al, 1998; Lederman et al, 2002). Science is a product of social and cultural traditions and is made by scientists who are raised in this culture. If a theory is supported by evidence but does not coincide with social and cultural beliefs, it may be rejected by the scientific community. For example, for a period in the history of science, the opinion that the circle was the most perfect geometric shape and therefore the Earth's orbit should be a circle, or that the Earth is at the center of the universe, was dominant, and even there was a lot of reaction against scientists who put forward different views on this issue. As a matter of fact, since the examination of corpses was considered a sin in the Middle Ages, the development of anatomy science was prevented (Abd-El-Khalick et al, 1998; Chalmers, 2007; Lederman et al, 2002; McComas, 1998).

Social and cultural embeddedness of science: Abd-El-Khalick, Waters, and Le (2008) maintained that since science remains "a human enterprise embedded and practiced in the context of a larger cultural milieu", it is both a cause and effect of a multitude of cultural components and realms, comprising "social fabric, worldview, power structures, philosophy, religion, and political and economic factors". Publicly funded scientific research is one place where such effects are demonstrated. The social and cultural impact on science can been observed in the precise nature of "acceptable" explanations of natural phenomena. The social and cultural embeddedness of science exemplifies how science is embedded and affected by the wider social and cultural context in which it is applied. Recently, academicians have called for more attention to these issues (Summers et al, 2020).

2.3 Approaches in Teaching the Nature of Science

Three approaches to teaching the nature of science are defined and applied (Abd-El-Khalick & Lederman, 2000). The approaches used to develop students', teachers' and pre-service teachers' understanding of the nature of science can be examined under the three sections of explicit-reflective, implicit-reflective, and historical.

In the explicit-reflective approach, the nature of science is directly subjected to teaching. Students use scientific process skills by participating in scientific activities and discuss and infer the nature of science during or as a result of the activity (Akerson, Abd-El-Khalick, & Lederman, 2000; Lederman, 2007; Schwartz et al, 2004). According to this approach, the nature of science should be considered as a cognitive goal, not an affective goal. So instead of waiting for the concepts of the nature of science to develop spontaneously, these concepts should be taught to students directly. For this, separate activities should be included in the nature of science teaching and these activities should be done by distributing them among the subjects of science lessons in the classroom (Abd-El-Khalick & Lederman, 2000; Khishfe & Lederman, 2006). Teaching the nature of science with a direct-reflective approach does not mean giving the nature of science components directly to individuals, but instead it means structuring the teaching environment where individuals can reflect on these elements by participating in related activities (Schwartz et al., 2004).

In the implicit-reflective approach, it is not necessary to express the nature of science clearly. It is thought that students who participate in scientific activities like scientists will have reached the acquisitions about science and the nature of science at the end of the activity (Schwartz et al., 2004). This approach assumes that, through research-based teaching, students who participate in scientific activities or 'do science' gain insight into the components of the nature of science (Lederman & Lederman, 2004). This approach suggests that individuals will spontaneously grasp the nature of science, without any extra work, by participating in science-related projects and research. Therefore, activities for scientific process skills, such as experimental environments prepared for a specific purpose and laboratory studies, are designed for students (Abd-El Khalick & Lederman, 2000). In this approach, the concepts of the nature of science are not directly explained to students, and students are expected to reach these concepts indirectly through research-based activities (Khisfe & Abd-El-Khalick, 2002). However, studies have shown that the indirect approach is not sufficient to improve individuals' understanding of the nature of science (Khishfe & Abd-El-Khalick, 2002; Meichtry, 1992; Sandoval & Morrison, 2003). The reason for the failure of the indirect approach is that the nature of science is considered as an affective learning goal and the nature of science is thought to be realized by itself as a by-product (Abd-El-Khalick & Lederman, 2000).

In the historical approach, the history of science is used as an educational tool in teaching the nature of science. The historical approach aims to understand the nature of science by explaining how scientific knowledge developed in the historical process and how the ideas rejected in ancient times were effective in the emergence of new scientific ideas (McComas & Olson, 1998). Teaching with a historical approach is particularly effective in understanding how scientific knowledge is by nature both malleable and changeable (Solomon et al, 1992). This approach advocates that the concepts of the nature of science can be taught to students by combining science teaching with science history activities. For this, it envisages that science teaching should be carried out by including stories from the history of science, the lives and inventions of scientists (Abd-El-Khalick & Lederman, 2000; Khisfe & Abd-El-Khalick). Placing the history of science in science curricula is also based on this principle. Two methods are generally used in the placement of the examples from the history of science into the science curriculum. The first of these is the story method, and in this method, it is considered as a whole by establishing a consistent relationship between the nature of science and the history of science, and the concepts of the nature of science are placed in a historical story. The other method is known as the addition method and examples from the history of science are presented to the science curriculum as a footnote or an information text. It is stated that it is more appropriate to use the story method for student-centered teaching (Howe, 2004). However, some studies have shown that the historical approach is insufficient in developing individuals' comprehending of the nature of science. In a study by Abd-El Khalick and Lederman (2000), an interpretation of the nature of science was tried to be given to university students by using a historical approach. However, at the end of the study, it was seen that the historical approach was not very successful in changing students' views. The reason for this has been shown that students' perceptions depend on their prior knowledge and experiences they gained during education. When the historical approach is applied as a reading piece, it is necessary for students to think in accordance with the world view of the scientist and to establish a relationship with the environment in which the scientist lives. This situation cannot always be realized by the students. In addition, it is one of the obstacles of the historical approach that the information in the historical text has lost its validity today or that the contributions of studies conducted a long time ago have been ignored (Abd-El-Khalick & Lederman, 2000).

2.4 Curriculum

With the 2000 curriculum, it is seen that the foundations of the constructivist approach, which is the basic approach of contemporary education programs, were laid. It is recommended that the teacher should ensure the student's own learning as a guide. The program aims to raise individuals who are actively interested in the world, who share the data obtained through observations and experiments with others, who can communicate effectively, are responsible and literate in the field of science. The concept of science literacy was also included in the curriculum for the first time in the 2000 curriculum (Aykaç et al, 2011; MEB, 2000).

As a result of the improvements in the structure of society, in the fields of education, and the bad results of international exams such as TIMMS and PISA, it was brought to the agenda that a new program should be developed in 2004 (Ersoy, 2013). The positive and negative aspects of the 2000 science curriculum were discussed and taken into account in the development of the new program. In addition, science teaching programs in developed countries were examined and the Science and Technology Lesson Curriculum was prepared in 2004 (MEB, 2005).

The constructivist approach, the foundations of which were laid with the 2000 curriculum, has been made more concrete with this program, and the teaching strategy of the program has been created on the basis of the constructivist approach. The vision of the program is to train all students, regardless of their individual differences, as science and technology literate. The "Science-Technology-Society-Environment" dimension was added to the 2004 curriculum and the name of the course was changed to "Science and Technology". Lesson hours were increased from three lessons per week to four per week. The program was implemented gradually in primary education 1-5 grades during the 2005-2006 academic year and in 6-8 grades during the 2006-2007 academic year (MEB, 2005). In the 2004 curriculum, the principle of spiraling was taken as a basis and the subjects were given with a content that gradually deepens as the grade level progressed. In addition, the concepts are given in steps considering the age and level of the students. The aim of meaningful learning, the development of problem-solving skills, the adoption of the understanding that information is usually not self-sufficient, and the content being in a spiral structure are seen as important innovations of the program (Ersoy, 2013; MEB, 2005).

With the law enacted in 2012, the compulsory education period was increased to 12 years (four years primary school, four years secondary school and four years high school). The reasons for this regulation were cited as the problems caused by uninterrupted education and the problems experienced as a result of students of different age having education in the same schools (Doğan et al, 2014). After these developments, the Science Course Curriculum was published and gradually implemented starting from 5th grade in the 2013-2014 academic year and from 3rd grade starting from the 2014-2015 academic year. It was decided to gradually abolish the Science and Technology Lesson Curriculum, which was developed in 2004. In addition, the name of the course was changed to "Science" (MEB, 2013). The vision of the 2013 Science Curriculum was defined as “To train all students as science literate individuals” and the science literate individual was identified as an individual who researches, questions, can solve problems, is open to cooperation, confident and can communicate effectively. (MEB, 2005, 2013).

When the 2018 curriculum is examined, it is seen that there is no significant change from the 2013 curriculum as a vision. In the 2018 program, different from the 2013 program, it is seen that the objectives that ensure the adoption of the principles of acquiring knowledge about science and engineering practices, developing entrepreneurial skills, national values, universal morality, and scientific ethical principles are included. While scientific process skills and life skills were similarly emphasized among the skills aimed to be acquired by students in both programs, the theme of "engineering and design skills" was added as a separate skill area in 2018. Under this theme, students are expected to define a problem for the concepts in the units, develop a product, and present this product in the atmosphere of a science fair (Deveci, 2018; MEB, 2018).

2.5 The Nature of Science in Textbooks

Textbooks are the primary sources used by teachers, students and parents for information sources throughout history (Chiappetta & Fillman, 2007). Textbooks are quite functional compared to other tools due to reasons such as ease of use, easy accessibility, availability at any time, and in any environment (Seven, 2001). Changes made in the curriculum should not be considered merely as adding or removing new subjects to the curriculum. Along with the innovations in the curriculum, textbooks, educational tools, and school equipment should be constantly renewed (Çepni & Çil, 2009). In this respect, a qualified textbook should coincide with the curriculum, provide a regular teaching opportunity in accordance with the objectives of the course, and contain the methods and techniques required for the acquisitions (Kılıç & Seven, 2007).

Textbooks should be up-to-date and scientifically correct, not showing science as a body of knowledge, but containing other aspects of science, reflecting the science-technology-society relationship, and representing the nature of science (Köseoğlu et al, 2008). Textbook review studies are of great importance in revealing the shortcomings of textbooks. Thanks to these studies, textbooks are rearranged and updated in accordance with scientific developments (Yıldız, 2013). Today, all textbooks, including science textbooks, are prepared by the government, and distributed to students free of charge. While this reduces the financial burden on students and parents, it increases the financial burden of the state. With the government trying to reduce the costs, quality had to be compromised. Accordingly, criticisms are made that the quality of the textbooks has decreased. Considering the important role of textbooks in the education system, it is inevitable to increase the quality of textbooks for the success of science education programs (Abd-El-Khalick et al., 2008).

Researchers who examined the nature of science in textbooks mentioned some deficiencies regarding the nature of science in their textbooks. Researchers have reported some misconceptions about law-theory and scientific method components in their scientific studies. It was stated that some components such as the socio-cultural context were ignored (Abd-El-Khalick et al, 2008; İrez, 2009; Vesterinen et al, 2013).

Research results within Turkey also show how textbooks conflict with the vision of scientific education in terms of the nature of science (Çakıcı, 2012; İrez, 2009) Generally, it has been reported that the authors either remain silent or put insufficient emphasis on the components of the nature of science (Çakıcı, 2012; Esmer, 2011; Yamak, 2009). Given the vision of science education, textbooks should become a catalyst that accelerates students' scientific literacy. Therefore, in the process of raising students as scientifically literate individuals, textbooks have an important role and cannot neglect teaching nature of science ideals (Çakıcı, 2012).

2.6 Related Research

Abd-El-Khalick, Waters, and Le (2008) investigated the level of representation of the nature of science in 14 high school chemistry textbooks that have been widely used in the United States for the last 40 years, as of 2008. Kinetic molecular theory, atomic structure, and gas laws sections of the chemistry textbooks were examined in the study. A rubric adapted from Abd-El-Khalick (1998) has been developed to evaluate textbooks. With this rubric, the 10 sub-dimensions of the nature of science, including “empirical”, “inferential”, “creative”, “theory-driven”, “tentative”, “scientific theories”, “scientific laws”, “social dimensions of science”, “the myth of the scientific method”, and “social and cultural embeddedness of science”, were tested. The degree of representation level of each sub-dimension of the nature of science in textbooks was defined and marked between -3 and +3 points. Through the use of this document analysis method, beside the 10 sub-dimensions, direct versus indirect approach were also examined in the textbooks. The (+3) score was used for cases where there was a satisfactory explanation of what a particular dimension of the nature of science is, and there was a consistent presentation of the target dimension in other parts of the textbook. For this score, the target dimension was clearly (directly) expressed in the book, and examples were supported by historical stories. The (+2) score was used in cases where the explanation was partially complete and there was no integrity with the other parts of the textbook, but the dimension was explained clearly (directly). The (+1) score was used in cases where the target dimension was presented with an indirect approach, but accurately and consistently with examples, historical chapters, and instructions. The (0) score was used for situations where the nature of science dimensions are not mentioned directly or indirectly. The (-1) score was used in cases where the nature of science was indirectly misrepresented. The (-2) score is used when it indirectly or explicitly conveys false messages about the nature of science. The (-3) score was used when the target dimension was undoubtedly explained incorrectly, and this was supported by examples and reading passages. The present research employed an adapted version of this rubric (Abd-El-Khalick et al, 2008).

In the analysis, three researchers coded and the agreement value between raters for reliability and validity was found to be at a high level with 86%. Other differences of opinion were resolved by negotiation. Ultimately, the researchers expected a score between -30 and +30 for each book after analyzing the 10 sub-dimensions. At the end of the evaluation, four (29%) of the textbooks received negative values, while 10 (71%) of them received positive values. However, positive values remained between 3 and 12 points. According to this, it has been reported that the textbooks were insufficient to represent the nature of science.

Chiappetta and Fillman (2007) examined a selection of five high school biology textbooks which were taught in the United States based on four themes of the nature of science. These themes were: (a) “science as a body of knowledge”, (b) “science as a way of investigating”, (c) “science as a way of thinking”, and (d) “science and its interactions with technology and society”. The researchers aimed to determine whether those four themes of the nature of science in existing high school biology textbooks of 2007 had a different balance from the years of the science education reform about 15 years ago. The conceptual framework (rubric) developed by Garcia (1985) was used for textbook evaluation in this study. The theme of “science as a body of knowledge” refers to presenting concepts, hypotheses, principles, laws, theories, and models, and asking questions for remember of information. The theme of “science as a way of investigating” refers to learning by using materials, understanding through the use of tables and charts, making calculations, reasoning out an answer, participating in a thought experiment, and getting information from the internet. The theme of “science as a way of thinking” refers to how a scientist discovers or experiments, shows historical development of ideas, illustrates an empirical basis of science, models the use of assumptions, employs inductive or deductive reasoning, shows cause and effect relationships, gives evidence and proof, presents methods of science, and solves problems. The theme of “science and its interactions with technology and society” refers to the usefulness of science or technology, presents negative effects of science or technology, addresses societal issues related to science or technology, and discusses careers in science or technology. As a data collection source, five high school biology textbooks were assessed. A total of six units of these textbooks, including scientific methods, cells, inheritance, DNA, evolution, and ecology, were examined. For reliability between coders, percent agreement and accompanying Cohen's Kappa values were calculated separately for each chapter in each textbook. It was observed that Cohen's Kappa values varied between 0.36 and 1.00 and the values calculated accordingly were observed to be sound in terms of reliability. In terms of the aforementioned four themes of scientific literacy, existing biology textbooks were compared with textbooks analyzed 15 years ago in this study. In this way, it has been tested whether the textbooks can adapt to educational reforms. As a result, it has been revealed that most of the biology textbooks examined place more emphasis on the dimensions of "science as technology and society interaction" and "science as a way of thinking" compared to 15 years ago.

In the study carried out by Niaz and Maza (2011), 75 general chemistry textbooks used in the USA were examined in terms of their representation of the nature of science based on nine criteria. Depending on the evaluation of the criteria, the dimension of the nature of the relevant science is classified to be "No mention", "Mention" and "Satisfactory" in the books. All textbooks were assessed on a scale of 0-18 points out of 9 criteria. For each criterion, textbooks were awarded 2 points if "Satisfactory", 1 point if "Mention" and 0 points if "No mention". The percentage of textbooks classified as “No mention” (N) ranged from 44% to 94.7%, as “Mention” (M) ranged from 1.3% to 38.7%, and as “Satisfactory” (S) ranged from 1.3% to 17.3%. Most of the textbooks reviewed were found to be quite insufficient to represent the nature of science according to the nine criteria.

McComas (2003) analyzed concepts of "law" and "theory" while investigating U.S. middle school biology textbooks. These two concepts were chosen as they were viewed as being paramount elements of the nature of science and exemplify both the tools and products of science. It has been noted that the varying meanings and uses of these terms in both general discourse and in a variety of other school disciplines have led to much confusion as to their proper application in a science context.

This study was designed with a six-part model definition for "law" and "theory" based on a review of the philosophy of science literature with specific reference to biology. These model descriptions were compared to presented in several U.S. middle school biology books. Most of the available U.S. middle school biology texts have been studied and examined in terms of the manner in which the concepts of “law” and “theory” are described and subsequently applied. It was tried to clarify whether students and teachers who use such texts will achieve a precise result. This study focused on teaching biology as it is a graduation requirement for almost all U.S. high school students. The term "law" is rarely defined in textbooks. Most biology textbooks included a wide of examples of laws (usually from genetics). Of the textbooks reviewed, just 33% show how theories are broad unifying statements, and 26% show how theories can predict future observations. Not one of the textbooks discussed the invention or creation aspect of "theory" building.

Esmer (2011) analyzed two 9th grade chemistry textbooks, one from Turkey and the other from England, in terms of the dimensions of the nature of science. The Turkish book was implemented throughout the country and the English book was taught in private high schools. The qualitative research and ethnographic content analysis method used by İrez (2008) informed the methodological scope of this study (Esmer, 2011). The nature of science dimensions presented by Lederman (2006) were used in the evaluation.

For reliability, Cohen's Kappa value was calculated to be 0.504. This value was evaluated according to the statements of Landis and Koch (1977) and was found acceptable for this study. In the analysis, the nature of science dimensions were emphasized in only 16 sentences in the Turkish textbook and in only 15 sentences in the English textbook. In the Turkish textbook, regarding the dimensions of the nature of science, the most emphasized dimension was “observation and inference are distinct entities of science” (6 times), while the least emphasis was on “science is partially the product of human creativity and imagination" (1 time). In the English textbook taught in England, "science is partly the product of human creativity and imagination" and "scientific knowledge is tentative, empirical and theory laden" dimensions were emphasized 4 times for each, "observation and inference are distinct entities of science" and "science is influenced by the social and cultural environment of the scientist" dimensions were emphasized once for each. As a result, the researcher stated that both chemistry textbooks were quite insufficient in relation to the inclusion of the nature and dimensions of science.

Tortumlu (2014) examined 9th, 10th, 11th, and 12th grade high school chemistry textbooks, which were authorized by the Ministry of National Education to be used throughout the country, in terms of the dimensions of the nature of science. The dimensions of the nature of science proposed in the NSTA (2000) (variability of scientific knowledge, experimentation, inferential-theoretical, subjectivity in science, creativity/imagination, theories/laws, socio-cultural ties, theory-law), and additional dimensions (observation-inference, science-technology relationship, the use of models in science, scientific methodology is not a stand-alone effort, the moral dimension of science, interdisciplinary relations) were used for coding. The study of Aydın, Demirdöğen and Hanuscin (2013) was used to determine the additional dimensions. Besides the dimensions of the nature of science, which approach (explicit-reflective, implicit, and historical) and their association with the content (embedded in the content and independent of the content) were also examined in this study. Variability of scientific knowledge, experimentation, observation-inference dimensions were emphasized in general terms. However, the use of models in science, moral dimension of science, creativity/imagination dimensions were not emphasized sufficiently in chemistry textbooks. Considering all of the books, the most preferred approach is the implicit approach. In terms of associating with the content, while it was presented as embedded in the content in the 9th grade textbooks, it was mostly presented as independently of the content in the 12th grade textbooks.

Atakan (2019) examined how the nature of science dimensions were included in a selection of science textbooks taught in the 6th, 7th and 8th grades of elementary schools since the foundation of the Republic of Turkey in order to determine how changes occurred in the process of representing these dimensions in the textbooks. Document analysis method, one of the qualitative research methods, was used in this study. Data sources consisted of a total of 24 textbooks prepared according to the 1926, 1948, 1968, 1992, 2000, 2004, 2013, 2018 curriculum that were permitted to be taught in schools by the Ministry of National Education. Textbooks were examined in terms of eight sub-dimensions, which are "empirical”, “inferential”, “tentative”, “creative”, “social and cultural structure of science”, “theory-driven”, “myth of the scientific method” and “the nature of theories and laws". A detailed rubric established by Abd-El-Khalick, Waters, and Le (2008) was employed. With that rubric, the textbooks were examined for accuracy, integrity and approach. While examining the textbooks, it was not only investigated whether the dimensions of the nature of science were mentioned, but also how and in what way the dimensions of the nature of science were included. According to the rubric, a representation level between -3 and +3 was determined for each dimension related to the nature of science. A score range between -24 and +24 was determined for each textbook. It was determined through the analysis that the representation of the sub-dimensions of the nature of science was insufficient across all textbooks examined. Although the dimensions of “empirical”, “inferential” and “tentative” were included in the majority of the textbooks, the dimensions of “creative”, “theory-driven” and “social and cultural structure of science” were only found in a few textbooks, and the dimensions of “myth of the scientific method” and “nature of theories and laws” were almost entirely absent in the textbooks. Even though it was determined that the representation of the sub-dimensions of the nature of science was at an improved level in textbooks since 2000, it was observed that the textbooks of all education programs were not at a sufficient level.

3

METHODOLOGY

3.1 Design of The Study

This study was performed with document analysis, which is one of the widely approved qualitative research methods. Qualitative research is a method that adopts an interpretative approach to the research question based on an interdisciplinary holistic perspective. The facts and events that have been established and observed are handled in their own context and then interpreted with relation to the meanings people attribute to them (Altunışık et al., 2010).

Document analysis is a qualitative research method used to examine the content of written documents rigorously and systematically (Wach, 2013). Document analysis is a systematic method used to evaluate and examine any documents, both published and electronic. Like other methods used in qualitative research, document analysis necessitates the analysis, reflection, and interpretation of data to gain an understanding of the underlying meaning, thus creating insight to the relevant subject and developing empirical knowledge (Corbin & Strauss, 2008). Researchers usually examine previous research, review literature, and incorporate this information in their research. It includes finding, selecting, interpreting, evaluating, and synthesizing the data contained in the documents. Document analysis helps to classify data by organizing them into main themes, categories, and case examples, especially through content analysis (Labuschagne, 2003).

According to various researchers, document analysis is advantageous in terms of being an efficient method in terms of time usage, sample size, usability, low cost, reuse, individuality and originality, precision, wide scope and time, lack of reactivity, and reaching data that are not easily accessible. The limitations and difficulties of document analysis have been expressed by various researchers as insufficient detail, incompleteness, low recoverability, bias, limitation, selection, accessibility, lack of a standard format, and coding difficulty (Bailey, 1982; Bowen, 2009; Corbetta, 2003; Merriam, 1988; Yıldırım & Şimşek, 2008; Yin, 1994).

Altheide (1996) classifies the document analysis process as determining the criteria to be included in the documents, collecting documents and data, determining the basic analysis areas, coding, verifying and analyzing the document. Two interrelated principles that drive the analysis process are impartiality and reliability. An analysis is considered reliable when given the opportunity to analyze the same set of documents under similar conditions and another reader reaches the same general conclusion (Altheide, 1996). A different analysis was made by Forster (1995). According to this researcher, the document analysis process incorporates accessing the documents, checking the originality, understanding the documents, analyzing the data, and using the data.

Table 3.1 Document analysis process according to various researchers

Altheide (1996)	**Forster (1995)**
✓ Determining the criteria to be included in the documents ✓ Document and data collection ✓ Determining the basic analysis areas ✓ Coding the document ✓ Verification ✓ Analyzing	✓ Accessing the documents ✓ Checking the originality ✓ Understanding the documents ✓ Analyzing the data ✓ Using the data

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.

3.2 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. A total of 62 science textbooks, including 14 textbooks belonging to 5th grades, 18 textbooks belonging to 6th grades, 17 textbooks belonging to 7th grades and 13 textbooks belonging to 8th grades, were examined. Details about the textbooks are presented in Table 3.2.

Table 3.2 Textbooks examined within the scope of the research

Publication Year	**Grade Level**	**Book Titles**	**Publisher**
2000	6	Fen Bilgisi	MEB (Çığırgan et al., 2000a)
	7	Fen Bilgisi	MEB (Çığırgan et al., 2000b)
	8	Fen Bilgisi	MEB (Çığırgan et al., 2000c)
2001	6	Fen Bilgisi	MEB (Çığırgan et al., 2001a)
	7	Fen Bilgisi	MEB (Çığırgan et al., 2001b)
	8	Fen Bilgisi	MEB (Çığırgan et al., 2001c)
2003	6	Fen Bilgisi	MEB (Güngör et al., 2003)
	7	Fen Bilgisi	MEB (Büyük et al., 2003)
	8	Fen Bilgisi	MEB (Koyuncu et al., 2003)
2004	6	Fen Bilgisi	MEB (Güngör et al., 2004)
	7	Fen Bilgisi	MEB (Büyük et al., 2004)
	8	Fen Bilgisi	MEB (Koyuncu et al., 2004)
2005	5	Fen ve Teknoloji	MEB (Yılmaz et al., 2005)
	6	Fen Bilgisi	MEB (Güngör et al., 2005)
	7	Fen Bilgisi	MEB (Büyük et al., 2005)
	8	Fen Bilgisi	MEB (Koyuncu et al., 2005)
2006	5	Fen ve Teknoloji	MEB (Yılmaz et al., 2006)
	6	Fen ve Teknoloji	MEB (Tunç et al., 2006a)
	7	Fen ve Teknoloji	MEB (Tunç et al., 2006b)
	8	Fen Bilgisi	MEB (Koyuncu et al., 2006)
2007	5	Fen ve Teknoloji	MEB (Yılmaz et al., 2007)
	6	Fen ve Teknoloji	MEB (Tunç et al., 2007a)
	7	Fen ve Teknoloji	MEB (Tunç et al., 2007b)
	8	Fen Bilgisi	MEB (Koyuncu et al., 2007)
2008	5	Fen ve Teknoloji	MEB (Yılmaz et al., 2008)
	6	Fen ve Teknoloji	MEB (Tunç et al., 2008a)
	7	Fen ve Teknoloji	MEB (Tunç et al., 2008b)
	8	Fen ve Teknoloji	MEB (Tunç et al., 2008c)
2009	5	Fen ve Teknoloji	MEB (Yılmaz et al., 2009)
	6	Fen ve Teknoloji	MEB (Tunç et al., 2009a)
	7	Fen ve Teknoloji	MEB (Tunç et al., 2009b)
	8	Fen ve Teknoloji	MEB (Tunç et al., 2009c)
2010	5	Fen ve Teknoloji	MEB (Bağcı et al., 2010)
	6	Fen ve Teknoloji	MEB (Tunç et al., 2010a)
	7	Fen ve Teknoloji	MEB (Tunç et al., 2010b)
	8	Fen ve Teknoloji	MEB (Tunç et al., 2010c)

Table 3.3 Textbooks examined within the scope of the research (continued)

Publication Year	Grade Level	Book Titles	Publisher
2011	5	Fen ve Teknoloji	MEB (Bağcı et al., 2011)
	6	Fen ve Teknoloji	MEB (Taşar, (Ed.), 2011)
	7	Fen ve Teknoloji	MEB (Tunç et al., 2011a)
	8	Fen ve Teknoloji	MEB (Tunç et al., 2011b)
2012	5	Fen ve Teknoloji	MEB (Bağcı et al., 2012)
	6	Fen ve Teknoloji	MEB (Taşar, (Ed.), 2012)
	7	Fen ve Teknoloji	MEB (Leblebicioğlu, (Ed.), 2012)
	8	Fen ve Teknoloji	MEB (Tunç et al., 2012)
2013	5	Fen Bilimleri	MEB (Kaya et al., 2013)
	6	Fen ve Teknoloji	MEB (Taşar, (Ed.), 2013)
	7	Fen ve Teknoloji	MEB (Leblebicioğlu, (Ed.), 2013)
2014	5	Fen Bilimleri	MEB (Kaya et al., 2014)
	7	Fen ve Teknoloji	MEB (Leblebicioğlu, (Ed.), 2014)
2015	5	Fen Bilimleri	MEB (Kaya et al., 2015)
	6	Fen Bilimleri	MEB (Ünsal (Ed.), 2015)
2016	5	Fen Bilimleri	MEB (Kaya et al., 2016)
	6	Fen Bilimleri	MEB (Ünsal (Ed.), 2016)
2018	6	Fen Bilimleri	MEB (Demirçalı &Alkan, 2018)
	7	Fen Bilimleri	MEB (Demirkazan et al., 2018)
2019	5	Fen Bilimleri	MEB (Akter et al., 2019)
	6	Fen Bilimleri	MEB (Yıldırım et al., 2019)
	7	Fen Bilimleri	MEB (Akdemir & Atasoy, 2019)
2020	5	Fen Bilimleri	SDR Dikey (Ünver et al., 2020)
	6	Fen Bilimleri	Sevgi (Çiğdem et al., 2020)
	7	Fen Bilimleri	Tutku (Seyrek et al., 2020)
	8	Fen Bilimleri	SDR Dikey (Yancı, 2020)

3.3. 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. The rubric that targeted the 10 sub-dimensions of the nature of science is stated at Table 3.3. 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).

Table 3.4 The rubric used in the analysis of textbooks

Score	Explanation	Example
Three points	The relevant nature of science dimension is scored for cases where the dimension is clearly expressed in the book, consistent with other parts of the book, and supported by historical stories.	Empirical (5th Grade) - “More than one way and method can be used in obtaining scientific knowledge. For example, we can reach a similar result by observing the movement of the pencil box dropped from the same point on an inclined plane consisting of three different floors with the same tools and equipment.” (Kaya et al., 2015, p. 89).
Two points	The relevant nature of science dimension is scored for cases where the dimension is clearly expressed in the book but not adequately explained, and when one dimension is mentioned while the other related dimension is neglected.	Tentative (6th Grade) - “Theodore Schwann and Matthias Schleiden in 1838-1839 revealed the cell theory ‘All living things, from single-celled organisms to oak trees and humans, are made up of cells.’ In the following years, scientific knowledge about the cell has increased with the developing technology. In 1858, Rudolph Virchow introduced the modern cell theory by adding new information to the cell theory” (Ünsal, (Ed.), 2015, p.10).

Table 3.5 The rubric used in the analysis of textbooks (continued)

Score	Explanation	Example
One point	The relevant nature of science dimension is scored for cases where it is presented indirectly (e.g., examples, activities or historical chapters) and is consistent with other parts of the book.	Tentative (5th Grade) - "Thousands of years ago, people believed that the Earth was flat. These people thought that the sky was also a cover that covered the Earth. According to them, the stars, the sun, and the moon were also suspended within this cover" (Yılmaz et al., 2005, p.131).
Zero points	The relevant nature of science dimension is scored for cases where the related nature of science dimension is not directly or indirectly addressed.	N/A
Negative one point	The relevant nature of science dimension is scored for cases where it is implicitly misrepresented.	Empirical (7th Grade) - "Science begins with observation. Every scientist first observes the events, living things, sun, stars, and plants around him. An effective observation is not just looking, but looking carefully and systematically for a specific purpose, using all the senses. Because just looking is not enough to understand and see nature" (Tunç et al., 2006b, p.7).
Negative two points	The relevant nature of science dimension is scored for cases where explicit or implicit contradictory statements in textbooks exist.	Myth of scientific method (7th Grade) - "What do scientists do to understand nature? What path does it follow? Step 1: Observe. Step 2: Determine the research question. Step 3: Determine the variables. Step 4: Build a hypothesis. Step 5: Design experiments. Step 6: Save data. Step 7: Draw Conclusions" (Tunç et al., 2006b, p.7).
Negative three points	The relevant nature of science dimension is scored for cases where the relevant nature of science dimension is misunderstood and supported by examples and reading passages.	N/A

3.4. 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%.

4

RESULTS AND DISCUSSION

In this section, the research findings obtained as a result of the document analysis with specific reference to the sub-dimensions are given. Findings were visualized with tables and graphs, making them easier to interpret.

The study has been evaluated in terms of the 10 sub-dimensions of the nature of science in 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 tables. A total of 62 science textbooks, including 14 textbooks belonging to 5th grades, 8 textbooks belonging to 6th grades, 17 textbooks belonging to 7th grades and 13 textbooks belonging to 8th grades, were examined. It has been observed that the content of the books is almost the same in consecutive years when the curriculum does not change while reviewing a book at a grade level.

Each grade level was examined separately. The data obtained from the books examined for each grade level were first shown with a table and interpreted. In addition, separate graphs were prepared according to the years for each grade to investigate change according to the years for 20 years. It was stated in which years the highest scores were obtained and in which years the lowest scores were obtained. A second graph has also been prepared for each level. A sub-dimension graph was also prepared for each level. In the prepared graphs, it is shown which sub-dimension gets the most points in total and which sub-dimension gets the least points.

4.1 Analysis of Fifth Grade Science Textbooks

5th grade science textbooks were examined in terms of the nature of science and tabulated by giving scores between -3 and +3 for the 10 sub-dimensions. According to the rubric used in the study, the total score that a textbook can obtain varies between -30 and +30. These results are given in Table 4.1 below.

Table 4.1 The representation of the sub-dimensions of the nature of science examined in the 5th grade science textbooks

Grade	Year	"Empirical"	"Inferential"	"Creative"	"Theory-driven"	"Tentative"	"Myth of the scientific method"	"Scientific theories"	"Scientific laws"	"Social dimensions of science"	"Social and cultural embeddedness of science"	Total
5th Grade	2005	-2	+1	+1	0	+1	0	0	0	+1	+2	+4
	2006	-1	+1	+1	0	+1	+1	0	0	+1	+2	+6
	2007	-1	+1	+1	0	+1	+1	0	0	+1	+2	+6
	2008	-1	+1	+1	0	+1	+1	0	0	+1	+2	+6
	2009	-1	+1	+1	0	+1	+1	0	0	+1	+2	+6
	2010	+2	+1	+1	0	+2	-2	0	0	0	+2	+6
	2011	+2	+1	+1	0	+2	-2	0	0	0	+2	+6
	2012	+2	+1	+1	0	+2	-2	0	0	0	+2	+6
	2013	+3	+1	+2	+1	+2	+1	0	0	0	+1	+11
	2014	+3	+1	+2	+1	+2	+1	0	0	0	+1	+11
	2015	+3	+2	+2	+1	+2	+2	0	+1	+1	+1	+15
	2016	+3	+2	+2	+1	+2	+2	0	+1	+1	+1	+15
	2019	+2	+1	+1	0	+1	-2	0	+1	+1	0	+5
	2020	+1	+2	+2	+1	+1	-2	0	0	0	+1	+6
	Total	+15	+17	+19	+5	+21	0	0	+3	+8	+21	+109

When Table 4.1 is examined, it is seen that the 5th grade textbook of 2005 received +4 points total. Within the scope of the nature of science, the "social and cultural embeddedness of science" sub-dimension got the highest score by getting +2 points, while the "empirical" sub-dimension got the lowest score with -2 points. “Social dimensions of science”, “inferential”, “creative” and “tentative” got +1 point. “Theory-driven”, “myth of the scientific method”, “scientific theories”, and “scientific laws” could not get any points.

According to Table 4.1, it is seen that the 5th grade textbooks of 2006, 2007, 2008 and 2009 received +6 points total. Within the scope of the nature of science, the "social and cultural embeddedness of science" sub-dimension got the highest score by getting +2 points, while the "empirical" sub-dimension got the lowest score with -1. “Social dimensions of science”, “inferential”, “creative”, “myth of the scientific method”, and “tentative” got +1 point. “Theory-driven”, “scientific theories”, and “scientific laws” could not get any points.

According to Table 4.1, it is seen that the 5th grade textbooks of 2010, 2011 and 2012 received +6 points total. Within the scope of the nature of science, the "social and cultural embeddedness of science", “empirical”, and “tentative” sub-dimensions got the highest score by getting +2 points, while the “myth of the scientific method” sub-dimension got the lowest score with -2 points. “Inferential” and “creative” sub-dimensions got +1 point. “Social dimensions of science”, “theory-driven”, “scientific theories”, and “scientific laws” sub-dimensions could not get any points.

According to Table 4.1, it is seen that the 5th grade textbooks of 2013 and 2014 received +11 points total. Within the scope of the nature of science, the “empirical” sub-dimension got the highest score by getting +3 points. “Tentative” and “creative” sub-dimensions got +2 points. “Myth of the scientific method”, “inferential”, “theory-driven”, and “social and cultural embeddedness of science” sub-dimensions got +1 point. “Scientific theories”, “scientific laws”, and the “social dimensions of science” sub-dimension could not get any points.

According to Table 4.1, it is seen that the 5th grade textbooks of 2015 and 2016 received +15 points total. Within the scope of the nature of science, the “empirical” sub-dimension got the highest score by getting +3 points. “Myth of the scientific method”, “inferential”, “creative”, and “tentative” sub-dimensions got +2 points. “Theory-driven”, “scientific laws”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions got +1 point. “Scientific theories” sub-dimension could not get any points.

According to Table 4.1, it is seen that the 5th grade textbook of 2019 received +5 points total. Within the scope of the nature of science, the “empirical” sub-dimension got the highest score by getting +2 points, while the “myth of the scientific method” sub-dimension got the lowest score with -2 points. “Tentative”, “scientific laws”, and “social dimensions of science” sub-dimensions got +1 point. “Theory-driven”, “scientific theories”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

According to Table 4.1, it is seen that the 5th grade textbook of 2020 received +6 points total. Within the scope of the nature of science, the “inferential” and “creative” sub-dimensions got the highest score by getting +2 points, while the “myth of the scientific method” sub-dimension got the lowest score with -2 points. “Theory-driven”, “social and cultural embeddedness of science”, “empirical”, and “tentative” sub-dimensions got +1 point. “Scientific theories”, “scientific laws”, and “social dimensions of science” sub-dimensions could not get any points.

The total scores of the 5th grade science textbooks from the 10 sub-dimensions of the nature of science between the years 2005-2020 are presented in Figure 4.1 below.

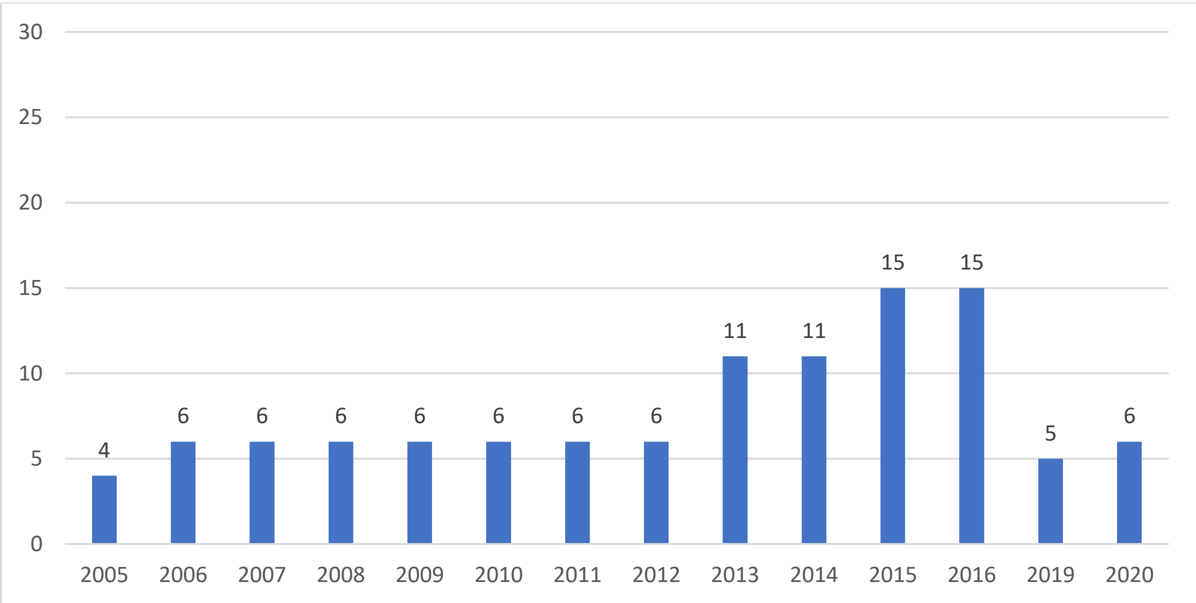

Figure 4.1 Total points given to the 5th grade textbooks examined by year between 2005-2020

The maximum score for each sub-dimension of the nature of science is +3, and the minimum score is -3. In this case, since there are 10 sub-dimensions, the highest score for each year is +30 and the lowest score is -30. When Figure 4.1 is examined, it is seen that the years with the highest scores were 2015 and 2016 with +15 points, and the year with the lowest score was 2005 with +4 points.

The total scores of the 10 sub-dimensions of the nature of science of the 5th grade science textbooks between 2005-2020 are presented in Figure 4.2 below.

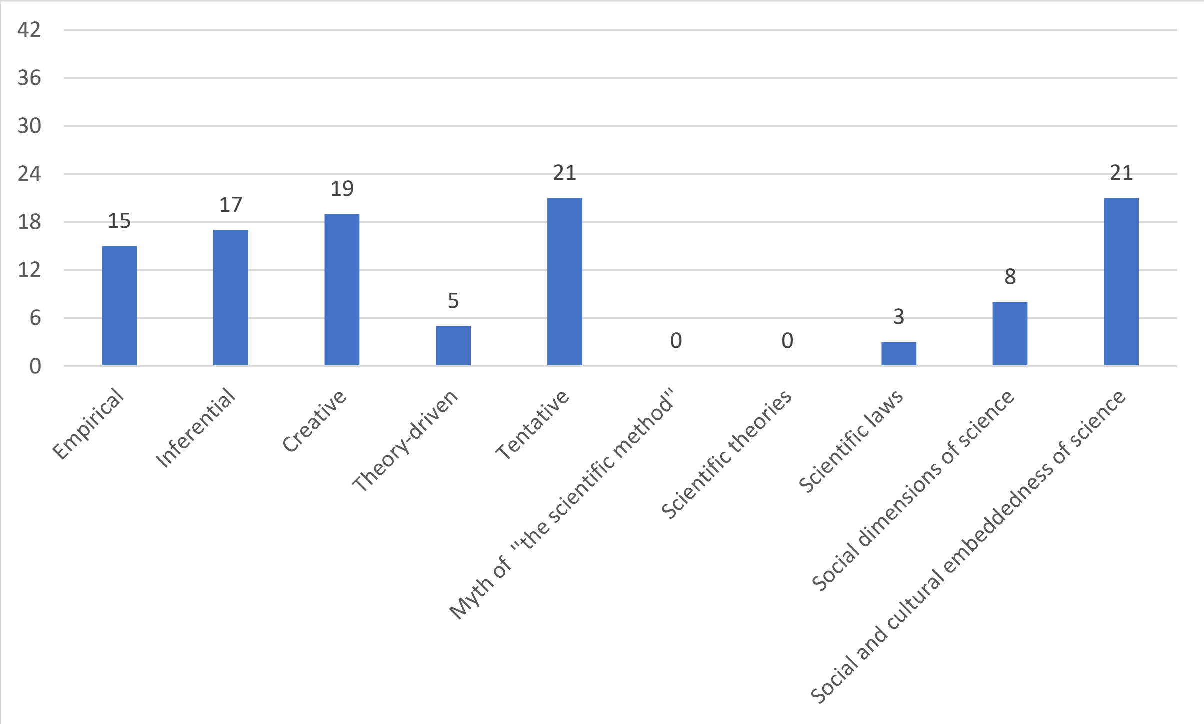

Figure 4.2 The total scores of the 10 sub-dimensions of the nature of science of the 5th grade textbooks between the year 2005-2020

A total of 14 science textbooks written in 14 different years belonging to the 5th grade level were examined. Since the maximum score for each sub-dimension of the nature of science is +3 and the minimum score is -3, the total maximum score that 5th graders can get from each sub-dimension is +42, and the total minimum score is -42.

When Figure 4.2 is examined, it is seen that the sub-dimensions with the highest score was “tentative” and “social and cultural embeddedness of science” with +21 points, and sub-dimensions with the lowest score was “myth of the scientific method” and “scientific theories” without any points.

4.2 Analysis of Sixth Grade Science Textbooks

6th grade science textbooks were examined in terms of the nature of science and tabulated by giving scores between -3 and +3 for the 10 sub-dimensions. According to the rubric used in the study, the total score that a textbook can get varies between -30 and +30. These results are given in Table 4.2 below.

Table 4.2 The representation of the sub-dimensions of the nature of science examined in the 6th grade science textbooks

Grade	Year	" Empirical"	" Inferential"	" Creative"	" Theory-driven"	" Tentative"	" Myth of the scientific method"	" Scientific theories"	" Scientific laws"	" Social dimensions of science"	" Social and cultural embeddedness of science"	Total
6th Grade	2000	0	+1	0	0	0	0	0	0	0	0	+1
	2001	0	+1	0	0	0	0	0	0	0	0	+1
	2003	+2	+2	+3	+1	+1	0	0	0	+1	+1	+11
	2004	+1	+2	+2	+1	+3	0	0	0	0	+1	+10
	2005	+1	+2	+2	+1	+3	0	0	0	0	+1	+10
	2006	+2	+2	+3	+1	+2	0	0	0	0	+1	+11
	2007	+2	+2	+3	+1	+2	0	0	0	0	+1	+11
	2008	+2	+2	+3	+1	+2	0	0	0	0	+1	+11
	2009	+2	+2	+3	+1	+2	0	0	0	0	+1	+11
	2010	+2	+2	+3	+1	+2	0	0	0	0	+1	+11
	2011	+1	+1	+1	+3	+2	+1	0	0	+2	0	+11
	2012	+1	+1	+1	+3	+2	+1	0	0	+2	0	+11
	2013	+1	+1	+1	+3	+2	+1	0	0	+2	0	+11
	2015	+1	+1	+2	+1	+3	0	0	0	0	0	+8
	2016	+1	+1	+2	+1	+3	0	0	0	0	0	+8
	2018	-1	+1	+1	0	+1	-1	0	0	0	+1	+2
	2019	-1	+1	+1	0	+1	-1	0	0	0	+1	+2
	2020	+2	+1	+1	+1	0	+1	0	0	0	0	+6
	Total	+17	+25	+31	+19	+31	+1	0	0	+7	+10	+141

When Table 4.2 is examined, it is seen that the 6th grade textbooks of 2000 and 2001 received only +1 point total. Within the scope of the nature of science, while only “inferential” sub-dimension got +1 point, the rest of the sub-dimensions could not get any points.

According to Table 4.2, it is seen that the 6th grade textbook of 2003 received +11 points total. Within the scope of the nature of science, the "creative” sub-dimension got the highest score by getting +3 points. “Empirical” and “inferential” sub-dimensions got +2 points. “Theory-driven”, “tentative”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions got +1 point. “Myth of the scientific method”, “scientific theories”, and “scientific laws” sub-dimensions could not get any points.

According to Table 4.2, it is seen that the 6th grade textbooks of 2004 and 2005 received +10 points total. Within the scope of the nature of science, the "tentative” sub-dimension got the highest score by getting +3 points. “Creative” and “inferential” sub-dimensions got +2 points. “Empirical”, “theory-driven”, and “social and cultural embeddedness of science” sub-dimensions got +1 point. “Myth of the scientific method”, “scientific theories”, “scientific laws”, and “social dimensions of science” sub-dimensions could not get any points.

According to Table 4.2, it is seen that the 6th grade textbooks of 2006, 2007, 2008, 2009 and 2010 received +11 points total. Within the scope of the nature of science, the "creative” sub-dimension got the highest score by getting +3 points. “Empirical”, “inferential”, and “tentative” sub-dimensions got +2 points. “Theory-driven” and “social and cultural embeddedness of science” sub-dimensions got +1 point. “Myth of the scientific method”, “scientific theories”, “scientific laws”, and “social dimensions of science” sub-dimensions could not get any points.

According to Table 4.2, it is seen that the 6th grade textbooks of 2011, 2012 and 2013 received +11 points total. Within the scope of the nature of science, the " theory-driven” sub-dimension got the highest score by getting +3 points. “Social dimensions of science” and “tentative” sub-dimensions got +2 points. “Myth of the scientific method”, “empirical”, “inferential”, and “creative” sub-dimensions got +1 point. “Scientific theories”, “scientific laws”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

According to Table 4.2, it is seen that the 6th grade textbooks of 2015 and 2016 received +8 points total. Within the scope of the nature of science, the " tentative” sub-dimension got the highest score by getting +3 points. “Creative” sub-dimension got +2 points. “Theory-driven”, “empirical”, and “inferential” sub-dimensions got +1 point. “Myth of the scientific method”, “scientific theories”, “scientific laws”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

According to Table 4.2, it is seen that the 6th grade textbooks of 2018 and 2019 received +2 points total. Within the scope of the nature of science, “social and cultural embeddedness of science”, “inferential”, “creative”, and “tentative” sub-dimensions got +1 point, while the “myth of the scientific method” and “empirical” sub-dimensions got -1 point. The rest of the sub-dimensions could not get any points.

According to Table 4.2, it is seen that the 6th grade textbook of 2020 received +6 points total. Within the scope of the nature of science, the "empirical” sub-dimension got the highest score by getting +2 points. “Theory-driven”, “myth of the scientific method”, “inferential”, and “creative” sub-dimensions got +1 point. “Scientific theories”, “tentative”, “scientific law”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

The total scores of the 6th grade science textbooks from the 10 sub-dimensions of the nature of science between the years 2000-2020 are presented in Figure 4.3 below.

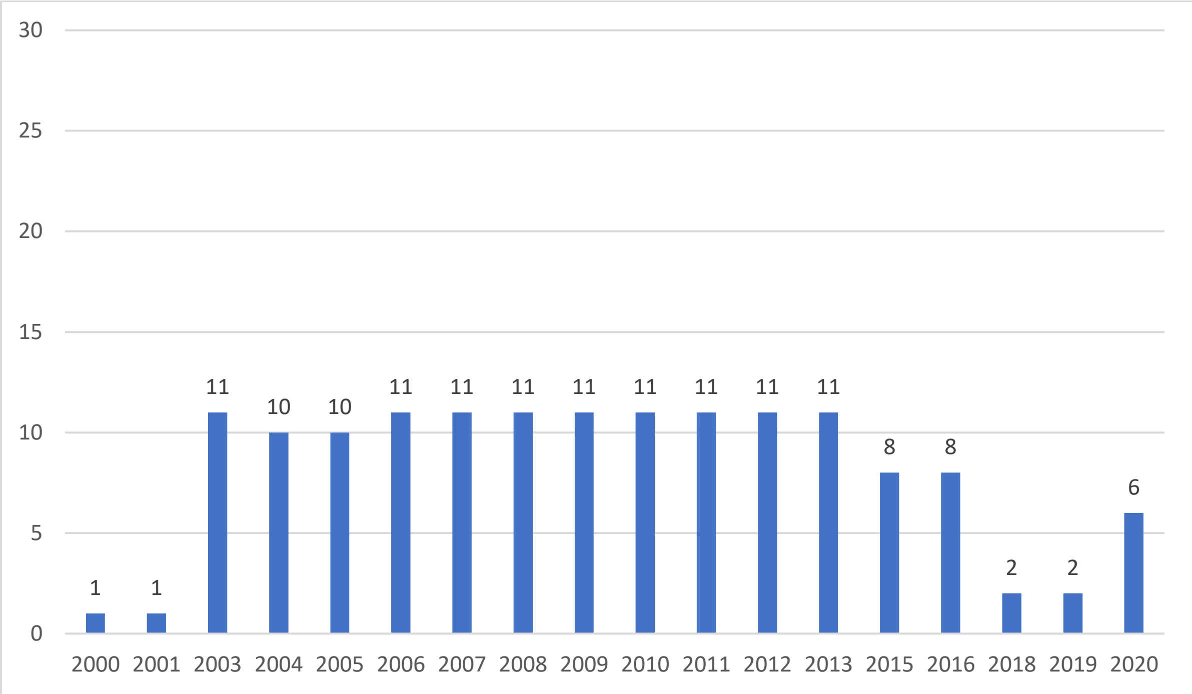

Figure 4.3 Total points given to the 6th grade textbooks examined by year between 2000-2020

The maximum score for each sub-dimension of the nature of science is +3, and the minimum score is -3. In this case, since there are 10 sub-dimensions, the highest score for each year is +30 and the lowest score is -30. When Figure 4.3 is examined, it is seen that the years with the highest score were 2003, 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013 with +11 points, and the years with the lowest score were 2000 and 2001 with +1 point.

The total scores of the 10 sub-dimensions of the nature of science of the 6th grade science textbooks between 2000-2020 are presented in Figure 4.4 below.

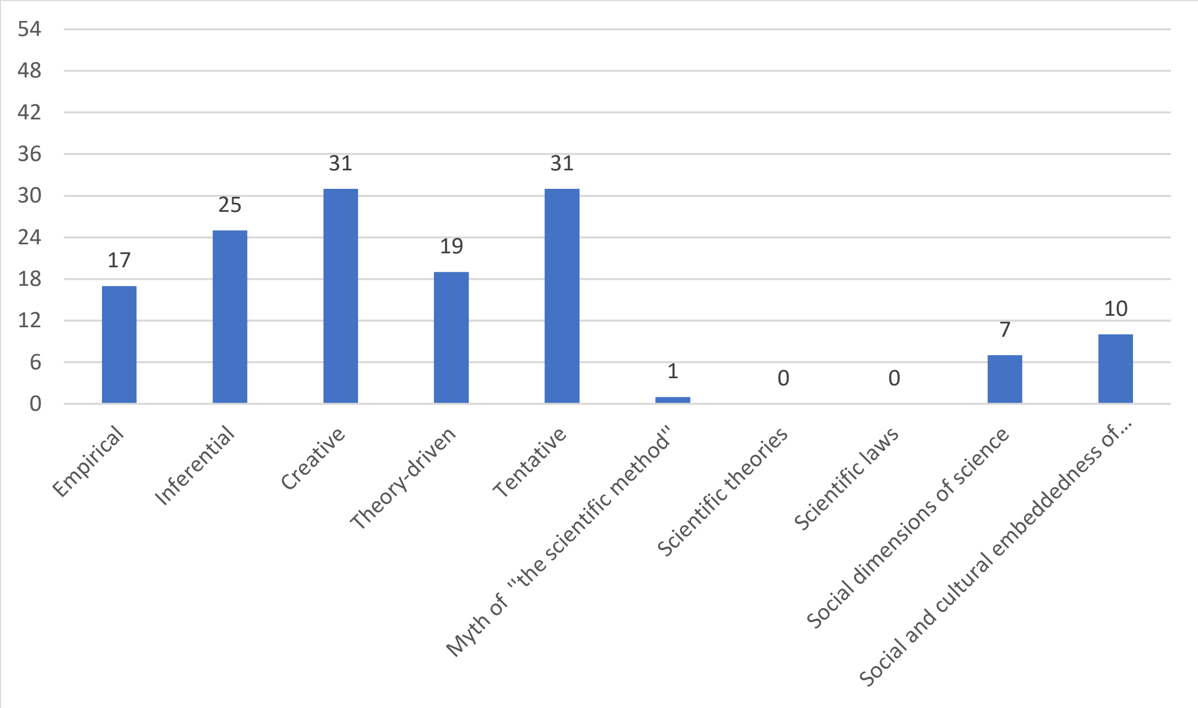

Figure 4.4 The total scores of the 10 sub-dimensions of the nature of science of the 6th grade textbooks between the years 2000-2020

A total of 18 science textbooks written in 18 different years belonging to the 6th grade level were examined. Since the maximum score for each sub-dimension of the nature of science is +3 and the minimum score is -3, the total maximum score that 6th graders can get from each sub-dimension is +54 and the total minimum score is -54.

When Figure 4.4 is examined, it is noted that the sub-dimensions with the highest score were "tentative" and "creative" with +31 points, and the sub-dimensions with the lowest score were "scientific theories" and "scientific laws" without any points.

4.3 Analysis of Seventh Grade Science Textbooks

7th grade science textbooks were examined in terms of the nature of science and tabulated by giving scores between -3 and +3 for the 10 sub-dimensions. According to the rubric used in the study, the total score that a textbook can get varies between -30 and +30. These results are given in Table 4.3 below.

Table 4.3 The representation of the sub-dimensions of the nature of science examined in the 7th grade science textbooks

Grade	Year	"Empirical"	"Inferential"	"Creative"	"Theory-driven"	"Tentative"	"Myth of the scientific method"	"Scientific theories"	"Scientific laws"	"Social dimensions of science"	"Social and cultural embeddedness of science"	Total
7th Grade	2000	0	+1	+1	0	0	0	0	0	0	0	+2
	2001	0	+1	+1	0	0	0	0	0	0	0	+2
	2003	-1	+1	+1	+2	+2	+1	0	0	0	0	+6
	2004	+1	+1	+1	+2	+2	+1	0	+2	0	0	+10
	2005	+1	+1	+1	+2	+2	+1	0	+2	0	0	+10
	2006	-1	+1	+3	+1	+2	-2	+1	0	0	+1	+6
	2007	+1	+1	+2	+1	+2	+2	+1	0	0	+1	+11
	2008	+1	+1	+2	+1	+2	+2	+1	0	0	+1	+11
	2009	+1	+1	+2	+1	+2	+2	+1	0	0	+1	+11
	2010	+1	+1	+2	+1	+2	+2	+1	0	0	+1	+11
	2011	+1	+1	+3	+2	+3	+2	0	0	0	0	+12
	2012	+1	+3	+1	+1	+2	+1	+1	0	0	0	+10
	2013	+1	+3	+1	+1	+2	+1	+1	0	0	0	+10
	2014	+1	+3	+1	+1	+2	+1	+1	0	0	0	+10
	2018	+1	+1	+1	+1	+3	-2	+1	0	0	0	+6
	2019	+1	+1	+1	+1	+1	-2	0	0	0	0	+3
	2020	+1	+1	+1	0	+1	-2	0	0	0	0	+2
	Total	+11	+23	+25	+18	+30	+8	+9	+4	0	+5	+133

When Table 4.3 is examined, it is seen that the 7th grade textbooks of 2000 and 2001 received +2 points total. Within the scope of the nature of science, while "inferential" and "creative" sub-dimensions got +1 point, the rest of the sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbook of 2003 received +6 points total. Within the scope of the nature of science, the "theory-driven" and "tentative" sub-dimensions got the highest score by getting +2 points, while the "empirical" sub-dimension got the lowest score with -1 point. “Myth of the scientific method”, “inferential”, and “creative” sub-dimensions got +1 point. “Scientific theories”, “scientific laws”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbooks of 2004 and 2005 received +10 points total. Within the scope of the nature of science, the "tentative”, “theory-driven”, and “scientific laws” sub-dimensions got +2 points. “Creative”, “inferential”, “empirical”, and “myth of the scientific method” sub-dimensions got +1 point. “Social and cultural embeddedness of science”, “scientific theories”, and “social dimensions of science” sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbook of 2006 received +6 points total. Within the scope of the nature of science, the “creative” sub-dimension got the highest score by getting +3 points, while the “myth of the scientific method” sub-dimension got the lowest score with -2 points. “Tentative” sub-dimension got +2 points. “Theory-driven”, “inferential”, “scientific theories”, and “social and cultural embeddedness of science” sub-dimensions got +1 point. “Scientific laws” and “social dimensions of science” sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbooks of 2007, 2008, 2009 and 2010 received +11 points total. Within the scope of the nature of science, “creative”, “tentative”, and “myth of the scientific method” sub-dimensions got the highest score by getting +2 points. “Empirical”, “inferential” "theory-driven”, “scientific theories”, and “social and cultural embeddedness of science” sub-dimensions got +1 point. “Scientific laws” and “social dimensions of science” sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbook of 2011 received +12 points total. Within the scope of the nature of science, the "creative” and “tentative” sub-dimension got the highest score by getting +3 points. “Theory-driven” and “myth of the scientific method” sub-dimensions got +2 points. “Empirical” and “inferential” sub-dimensions got +1 point. “Scientific theories”, “scientific laws”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbooks of 2012, 2013 and 2014 received +10 points total. Within the scope of the nature of science, the "inferential” sub-dimension got the highest score by getting +3 points. “Tentative” sub-dimension got +2 points. “Empirical”, “creative”, “theory-driven”, “myth of the scientific method”, and “scientific theories” sub-dimensions got +1 point. “Scientific laws”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbook of 2018 received +6 points total. Within the scope of the nature of science, “tentative” sub-dimension got the highest score by getting +3 points, while the “myth of the scientific method” sub-dimension got the lowest score with -2 points. "Empirical”, “inferential”, “creative”, “theory-driven”, and “scientific theories” sub-dimensions got +1 point. “Scientific law”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points.

According to Table 4.3, it is seen that the 7th grade textbook of 2019 received +3 points total. Within the scope of the nature of science, "empirical”, “inferential”, “creative”, “theory-driven”, and “tentative” sub-dimensions got +1 point. “Scientific theories”, “scientific law”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points. “Myth of the scientific method” sub-dimension got the lowest score with -2 points.

According to Table 4.3, it is seen that the 7th grade textbook of 2020 received +2 points total. Within the scope of the nature of science, "empirical”, “inferential”, “creative” and “tentative” sub-dimensions got +1 point. “Theory-driven”, “scientific theories”, “scientific law”, “social dimensions of science”, and “social and cultural embeddedness of science” sub-dimensions could not get any points. “Myth of the scientific method” sub-dimension got the lowest score with -2 points.

The total scores of the 7th grade science textbooks from the 10 sub-dimensions of the nature of science between the years 2000-2020 are presented in Figure 4.5 below.

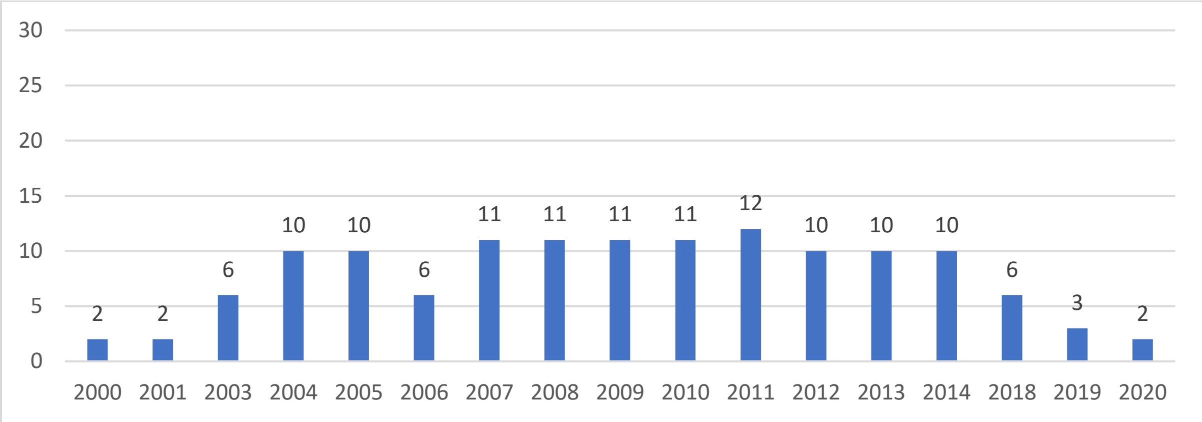

Figure 4.5 Total points given to the 7th grade textbooks examined by year between 2000-2020

The maximum score for each sub-dimension of the nature of science is +3, and the minimum score is -3. In this case, since there are 10 sub-dimensions, the highest score for each year is +30 and the lowest score is -30. When Figure 4.5 is examined, it is seen that the year with the highest score was 2011 with +12 points, and the years with the lowest score were 2000, 2001, and 2020 with +2 points.

The total scores of the 10 sub-dimensions of the nature of science of the 7th grade science textbooks between 2000-2020 are presented in a Figure 4.6 below.

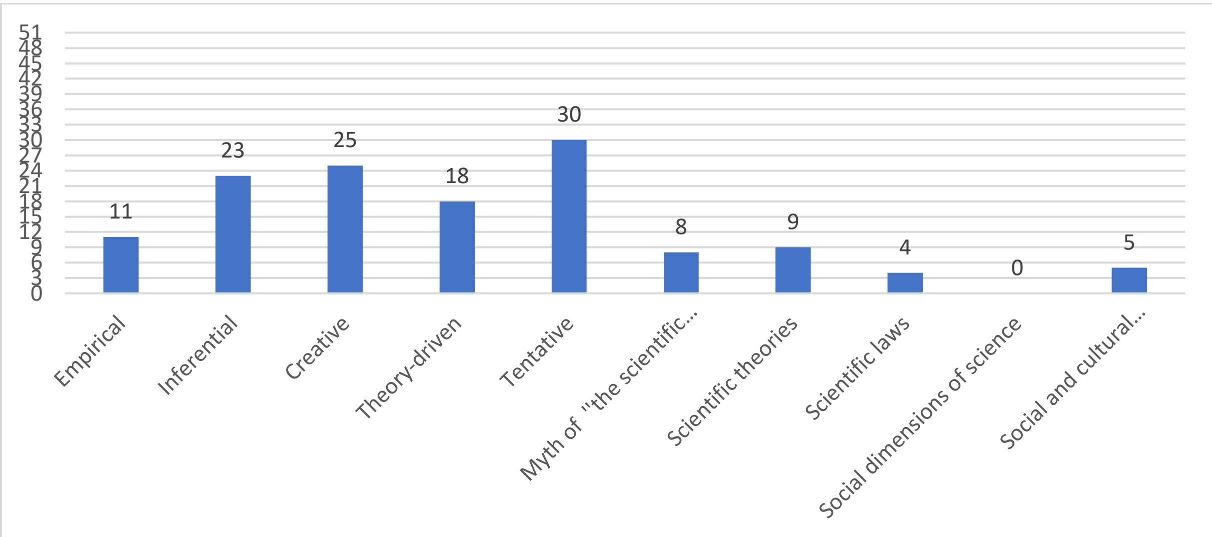

Figure 4.6 The total scores of the 10 sub-dimensions of the nature of science of the 7th grade textbooks between the years 2000-2020

A total of 17 science textbooks written in 17 different years belonging to the 7th grade level were examined. Since the maximum score for each sub-dimension of the nature of science is +3 and the minimum score is -3, the total maximum score that 7th graders can get from each sub-dimension is +51, and the total minimum score is -51. When Figure 4.6 is examined, it is seen that the sub-dimension with the highest score was “tentative” with +30 points, and sub-dimension with the lowest score was “social dimensions of science” without any points.

4.4 Analysis of Eighth Grade Science Textbooks

8th grade science textbooks were examined in terms of the nature of science and tabulated by giving scores between -3 and +3 for the 10 sub-dimensions. According to the rubric used in the study, the total score that a textbook can get varies between -30 and +30. These results are given in Table 4.4 below.

Table 4.4 The representation of the sub-dimensions of the nature of science examined in the 8th grade science textbooks

Grade	Year	“ Empirical”	“ Inferential”	“ Creative”	“ Theory-driven”	“ Tentative”	“ Myth of the scientific method”	“ Scientific theories”	“ Scientific laws”	“ Social dimensions of science”	“ Social and cultural embeddedness of science”	Total
8th Grade	2000	+1	+1	+1	0	+1	0	0	0	0	0	+4
	2001	+1	+1	+1	0	+1	0	0	0	0	0	+4
	2003	+1	+1	+1	+1	+1	0	0	0	0	0	+5
	2004	-2	+1	+1	+1	+1	+1	0	0	0	0	+3
	2005	-2	+1	+1	+1	+1	+1	0	0	0	0	+3
	2006	-2	+1	+1	+1	+1	+1	0	0	0	0	+3
	2007	-2	+1	+1	+1	+1	+1	0	0	0	0	+3
	2008	+2	+1	+3	+2	+1	+1	0	0	0	+1	+11
	2009	+2	+1	+3	+2	+1	+1	0	0	0	+1	+11
	2010	+2	+1	+3	+2	+1	+1	0	0	0	+1	+11
	2011	+3	+2	+3	+2	+2	0	0	0	0	+1	+13
	2012	+3	+2	+3	+2	+2	0	0	0	0	+1	+13
	2020	+1	0	+1	0	+2	+1	0	0	0	0	+5
	Total	+8	+14	+23	+15	+16	+8	0	0	0	+5	+89

When Table 4.4 is examined, it is seen that the 8th grade textbooks of 2000 and 2001 received +4 points total. Within the scope of the nature of science, while "empirical", "inferential", "creative", and "tentative" sub-dimensions got +1 point, the rest of the sub-dimensions could not get any points.

According to Table 4.4, it is seen that the 8th grade textbook of 2003 received +5 points total. Within the scope of the nature of science, while "empirical", "inferential", "creative", "theory-driven", and "tentative" sub-dimensions got +1 point, the rest of the sub-dimensions could not get any points.

According to Table 4.4, it is seen that the 8th grade textbooks of 2004, 2005, 2006, and 2007 received +3 points total. Within the scope of the nature of science, "inferential", "creative", "theory-driven", "tentative", and "myth of the scientific method" sub-dimensions got +1 point. "Scientific theories", "scientific laws", "social dimensions of science", and "social and cultural embeddedness of science" sub-dimensions could not get any points. "empirical" sub-dimension got the lowest score with -2 points.

According to Table 4.4, it is seen that the 8th grade textbooks of 2008, 2009, and 2010 received +11 points total. Within the scope of the nature of science, the "creative" sub-dimension got the highest score by getting +3 points. "Empirical" and "theory-driven" sub-dimensions got +2 points. "Inferential", "tentative", "myth of the scientific method", and "social and cultural embeddedness of science" sub-dimensions got +1 point. "Scientific theories", "scientific laws", and "social dimensions of science" sub-dimensions could not get any points.

According to Table 4.4, it is seen that the 8th grade textbooks of 2011 and 2012 received +13 points total. Within the scope of the nature of science, the "empirical" and "creative" sub-dimensions got the highest score by getting +3 points. "Tentative", "theory-driven", and "inferential" sub-dimensions got +2 points. "Social and cultural embeddedness of science" sub-dimension got +1 point. "Scientific theories", "scientific laws", and "social dimensions of science" sub-dimensions could not get any points.

According to Table 4.4, it is seen that the 8th grade textbook of 2020 received +5 points total. Within the scope of the nature of science, "tentative" sub-dimension got the highest score by getting +2 points. "Empirical", "creative", and "myth of the scientific method” sub-dimensions got +1 point. The rest of the sub-dimensions could not get any points.

The total scores of the 8th grade science textbooks from the 10 sub-dimensions of the nature of science between the years 2000-2020 are presented in Figure 4.7 below.

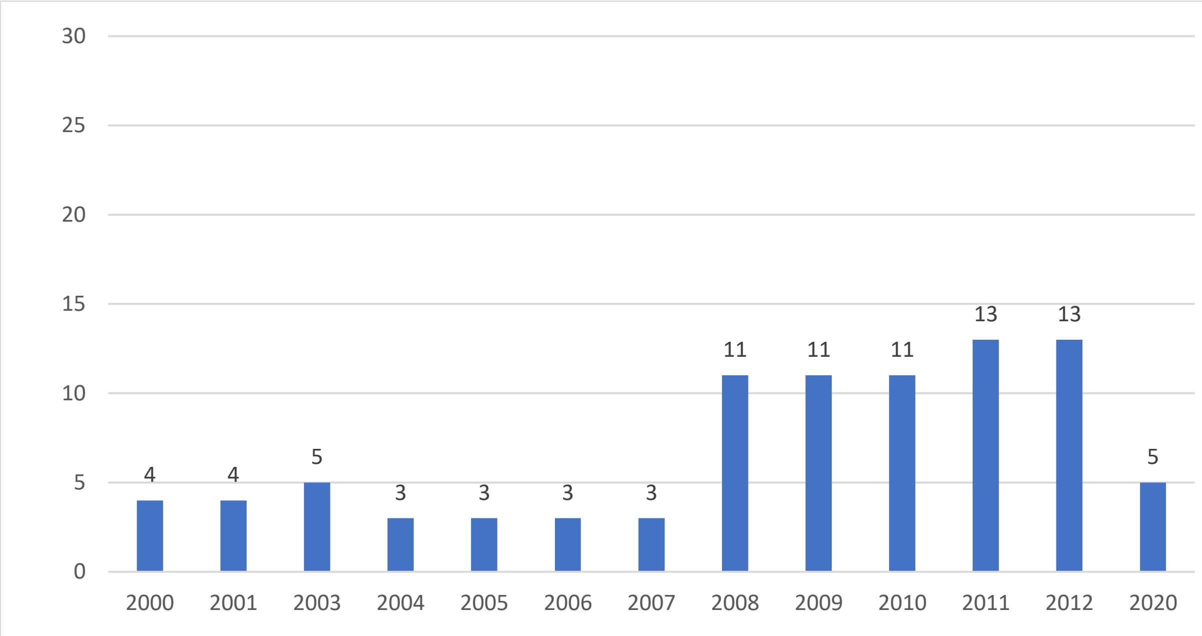

Figure 4.7 Total points given to the 8th grade textbooks examined by year between 2000-2020

The maximum score for each sub-dimension of the nature of science is +3, and the minimum score is -3. In this case, since there are 10 sub-dimensions, the highest score for each year is +30 and the lowest score is -30. When Figure 4.7 is examined, it is seen that the years with the highest score were 2011 and 2012 with +15 points, and the years with the lowest score were 2004, 2005, 2006, and 2007 with +3 points.

The total scores of the 10 sub-dimensions of the nature of science of the 8th grade science textbooks between 2000-2020 are presented in Figure 4.8 below.

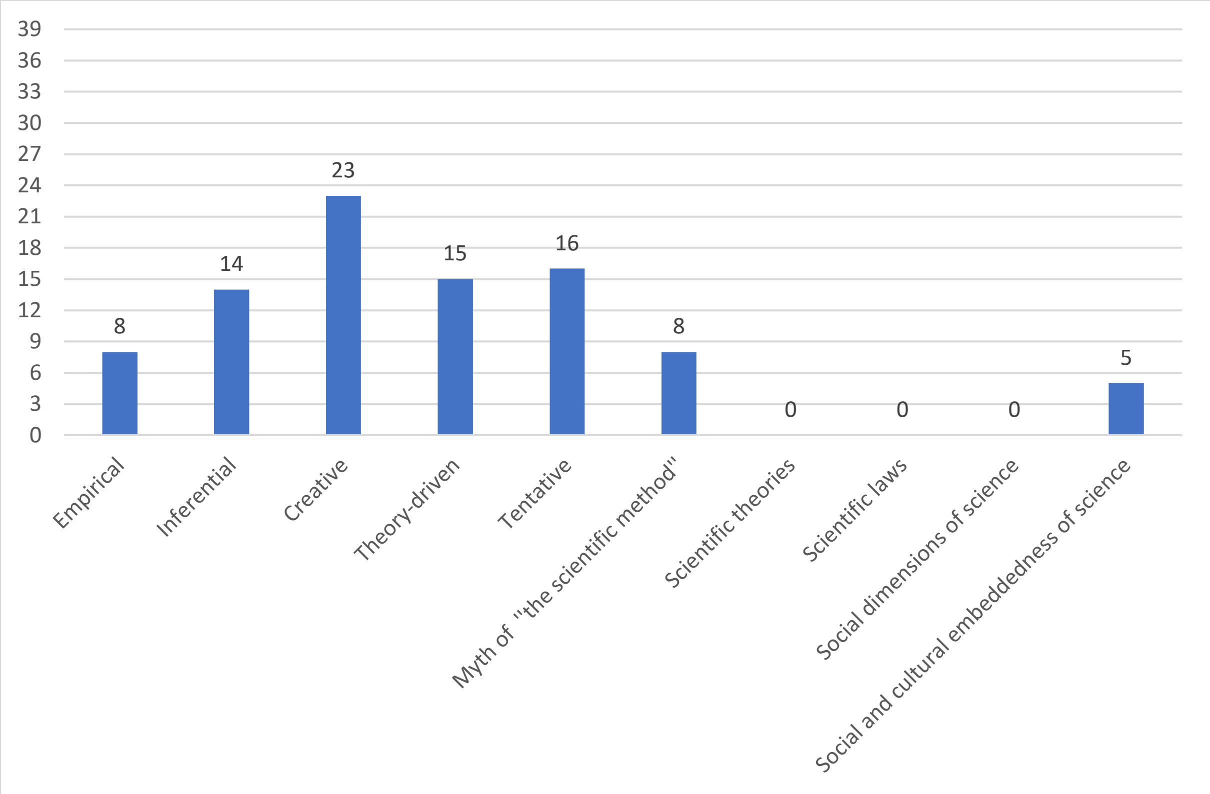

Figure 4.8 The total scores of the 10 sub-dimensions of the nature of science of the 8th grade textbooks between the years 2000-2020

A total of 13 science textbooks written in 13 different years belonging to the 8th grade level were examined. Since the maximum score for each sub-dimension of the nature of science is +3 and the minimum score is -3, the total maximum score that 8th graders can get from each sub-dimension is +39, and the total minimum score is -39.

When Figure 4.8 is examined, it is seen that the sub-dimension with the highest score was "creative" with +23 points, and sub-dimensions with the lowest score were "scientific theories", "scientific laws", and "social dimensions of science" without any points.

4.5 Summary of the Results

Sample expressions corresponding to the scores given to the representation of the nature of science sub-dimensions in the textbooks are presented Table 4.5 below.

Table 4.5 Citations corresponding to the scores given for the sub-dimensions of the nature of science in the science textbooks

Sub-dimensions	**Grade**	**Scores**	**Example Expressions from Science Textbooks**
Scientific theory	7th Grade	+3	The theory is the explanations made in the question of evaluating many observations together. For example, as a result of observations based on the divergence of objects in space, the theory that the universe is expanding was put forward. Theories may change over time with new observations. (Akdemir & Atasoy, 2019, p. 111)
Theory-Driven	7th Grade	+1	Astronomer Edwin Hubble discovered in 1929 that galaxies are moving away from each other and from Earth. In this way, he proved that the universe has not remained constant since its formation but is constantly expanding. Although it is not known exactly how the universe was formed, some theories are tried to be explained. One of these theories is the Big Bang Theory. (Demirkazan et al., 2018, p. 41)
"Inferential"	5th Grade	+1	In the 1400s, sailors who sailed the seas and stayed on the seas for a long time were fed with dry foods (such as rice, chickpeas, and dried beans). After a while, the sailors began to catch a disease of unknown cause. The sick sailors' gums swelled and began to bleed, their teeth fell out, and their wounds healed too slowly. Sick sailors were weakening and dying. A captain who faced a similar situation on his ship, thinking that this disease could be contagious, left the patients to die on a deserted island. The sailors who were left on the island recovered when they ate the greens and fruits they found on the island in order not to starve. Thinking that the cause of this disease may be due to the diet, scientists observed that those fed with citrus fruits (such as lemons, oranges, and tangerines) recovered more quickly in their study with a group of sailors. (Kaya et al., 2014, p. 15)

Table 4.5 Citations corresponding to the scores given for the sub-dimensions of the nature of science in the science textbooks (continued)

Sub-dimensions	**Grade**	**Scores**	**Example Expressions from Science Textbooks**
"Tentative"	6th Grade	+1	Due to the nature of science, it leads other developments after a scientific development. In this way, science and technology are advancing rapidly. It is likely that other scientists will develop newer technologies using sound propagation and reflection in the future. (Ünsal, Y. (Ed.), 2015, p. 228)
"Myth of scientific method"	7th Grade	-1	We need to design an experiment, make observations, and analyze to test our hypothesis and see if our predictions are correct. The experiment we designed should be done as a controlled experiment. (Demirkazan et al., 2018, p. 14)
"Scientific law"	5th Grade	+2	Newton made important contributions to science in the field of physics by combining his superior learning ability with the education he received. Newton's Laws dominated the scientific world for nearly 300 years. Many events can still be explained by Newton's Laws. (Kaya et al., 2014, p. 81)
"Social and cultural embeddedness of science"	5th Grade	+1	Ancient Turks had different beliefs about the moon and the sun. One of these beliefs talks about the resentment of the sun and the moon. As a result of this resentment, one comes and the other leaves. Throughout history, people have wondered about the sky. (Yılmaz et al., 2009, p. 147)
"Creativity"	7th Grade	+1	Becquerel and Curie laid the foundation of the science of radiology as a result of their work. Becquerel discovered radioactivity, and Curie discovered the elements Radium and Polonium, which have radioactivity. Radioactivity is used in fields such as medicine, industry, agriculture, and electronics. (Demirkazan et al., 2018, p. 120)

Table 4.5 Citations corresponding to the scores given for the sub-dimensions of the nature of science in the science textbooks (continued)

Sub-dimensions	**Grade**	**Scores**	**Example Expressions from Science Textbooks**
"Social dimensions of science"	5th Grade	+1	Before Newton, Ibn-i Sina also worked on issues related to force and made many contributions to the sciences. As it can be understood from here, scientific knowledge is not only created by certain cultures. Scientists from different nations contributed to scientific knowledge over time. (Kaya et al., 2013, p. 81)
"Empirical"	6th Grade	-1	Precise information should be collected during the experiment. This information is called "data". In many experiments, the data consists of numbers and reflects the change of the dependent variable. For example, in an experiment, reading the temperature of the water every ten minutes and recording the values is data collection. The more data you have, the better you will be able to work towards supporting or disproving your hypothesis. (Yıldırım et al., 2019, p. 11)

The total scores of all the examined textbooks related to the nature of science are given in Table 4.6 below.

Table 4.6 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
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 4.6 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.6, 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 4.9 below.

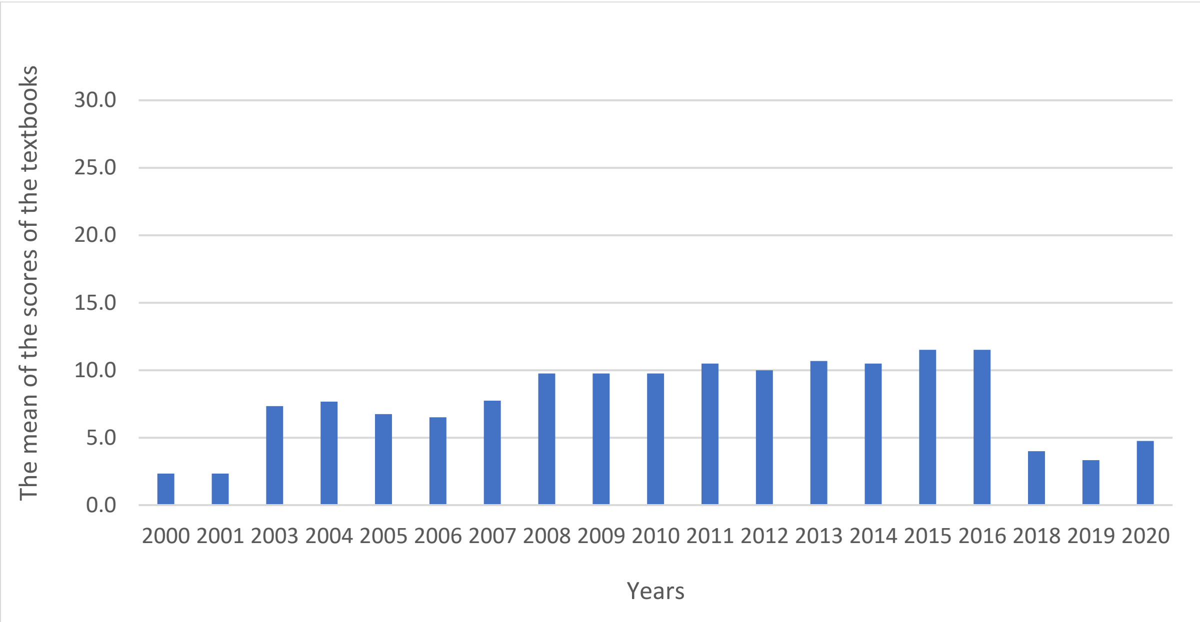

Figure 4.9 The mean of the scores of the textbooks by years between 2000-2020

When Figure 4.9 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.

4.6 Discussion and Recommendations

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.

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.

The main reason why textbooks had low scores in the results of this research is that the nature of science dimensions are under-represented or represented incorrectly in the majority of the science textbooks. In fact, although the "empirical" sub-dimension is mentioned with a relatively high frequency, it has a low score due to the use of incorrect or incomplete expressions in many science textbooks. Another reason why textbooks get low scores in this research is that they represent the nature of science dimensions more indirectly. As a matter of fact, although some textbooks contain expressions for most of the sub-dimensions of the nature of science, the level of representation of the textbook was found to be insufficient because the dimensions were indirectly represented. It has been determined that there is mostly indirect expression in almost all sub-dimensions, especially in the “creative” and “tentative” sub-dimensions. In addition, the sub-dimensions of “scientific theories” and “scientific laws” are less represented in middle school science textbooks because they can be more easily emphasized in high school curriculum subjects rather than secondary school level subjects. Additionally, it was noticed that there was no separate section or activity found that starts with the title of “the nature of science” in any of the textbooks. Most of the expressions about the nature of science in the books were found in the introduction part of the book, in the subject content, in the texts describing the lives of scientists, or in the reading texts.

Among the science textbooks used in the document analysis, the science books published for all grade levels in 2020 were published by a private company, and the rest of the science textbooks were published by the Ministry of National Education. A total of 62 books (14 for the 5th grade, 18 for the 6th grade, 17 for the 7th grade, and 13 for the 8th grade) were examined. Only one science textbook was investigated for each year. The total scores of the 10 nature of science sub-dimensions of science textbooks were calculated for each grade. In order to make a more accurate comparison, the mean was taken for each grade. The averages showed that the grade with the highest score was 6th, and the grade with the lowest score was the 8th.

5th grade textbooks have been included in the middle school curriculum since 2012 by the Ministry of National Education. But, in this study, 5th grade textbooks were included in the study before this date, as of 2004. Some science textbooks could not be examined because they could not be found in the archive library of the Ministry of National Education. These missing textbooks led to difficulty in making an accurate comparison for each grade by year. However, it is clearly seen that the total score of all grades in 2000 and 2001 is the lowest. It has been also determined that the level of representation of the nature of science dimensions in textbooks does not show a regular increase when the 20-year change of nature of science sub-dimensions in the historical process is examined. If it were otherwise, it would be seen that the score, which was very low in 2000, tended to increase continuously, but it was determined that the score first increased and then decreased again within the 20-year period.

Overall, it was determined that in this study, which examines the nature of science in middle school science textbooks of the last twenty years, all textbooks examined were insufficient in terms of representing the sub-dimensions of the nature of science. The results of this research overlap with similar studies in the previous literature (Abd-El-Khalick et al, 2008; Atakan, 2019; Çakıcı, 2012; Esmer, 2011; İrez, 2009; Niaz & Masa, 2011; Özden & Cavlazoğlu, 2015; Topak, 2017; Tortumlu, 2014; Vesterinen et al., 2013; Yamak, 2009). These results show that the content of textbooks and curricula should be updated. If scientific literacy is to be achieved, radical changes must be made in curricula and textbooks. For this purpose, the concept of scientific literacy and nature of science should be clearly stated in the curricula, the dimensions that make up the nature of science should be clearly explained and even turned into an acquisition for students (Atakan, 2019; Köseoğlu et al, 2008; Küçük, 2006). Furthermore, the concepts of the nature of science should be included with a direct-reflective approach, not with an indirect approach, and all sub-dimensions that make up the nature of science should be represented in the textbooks. In fact, a separate unit on the nature of science should be included in the textbooks (Atakan, 2019; Lederman & Lederman, 2004).

The results obtained in this research are limited to the 10 sub-dimensions included in the nature of science. Considering these limitations, some suggestions can be made for similar studies to be conducted in the future. For example, a similar study can be done with textbooks belonging to different disciplines, or textbooks can be examined by adding new sub-dimensions representing the nature of science. In addition, the representation of the dimensions of the nature of science can be determined by examining the textbooks with a different rubric. Almost all of this study was done with the textbooks published by the Ministry of National Education. In future research, textbooks belonging to private publishing houses can also be examined. In fact, textbooks published by private publishing houses and the Ministry of National Education can be compared in terms of the nature of science.

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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

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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 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 1.1.

Table 1.1 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
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

Year	5th Grade	6th Grade	7th Grade	8th Grade	Mean
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 1.1 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1, 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.

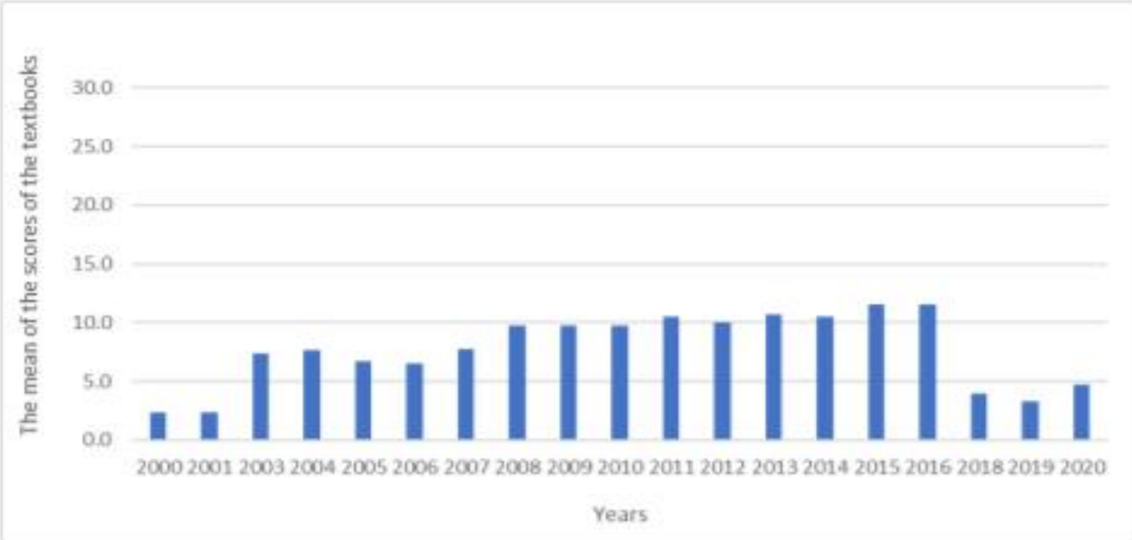
According to Table 4.9, it is seen that the textbooks belonging to the 5th, 6th, and 7th grade, which were published in 2019, received between +2 and +5 points. In 2019, the 5th grade science textbook had the best representation level with +5 points, and the 6th grade science textbook had the lowest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

According to Table 1.1, 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 1.1 below.

Figure 1.1 The mean of the scores of the textbooks by years between 2000-2020



When Figure 1.1 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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