IJSTS
International Journal of Sport Technology and Science

International Journal of Sports Technology and Science
https://www.globsportsjournal.com/
ISSN: 3023-6266

A REFLECTIVE EVALUATION ON THE NATURE OF SCIENCE IN EDUCATION

(Review study)

Gamze Serin [a]

[a] Ministry of National Education, Mersin University, Institute of Educational Sciences, PhD Student, *Mersin, Turkey*

Received: 01.11.2024 Revised version received: 17.11.2024 Accepted: 10.12.2024

Abstract

In today's world, where science becomes more important day by day and plays an active role in the development of everything related to life, the content and effectiveness of educational activities carried out within the scope of science have become very important. While it is aimed to develop scientifically literate individuals through education, being able to create minds that understand the foundations of science and look to the future by understanding its nature is one of the most effective acquisitions that can be gained in science education. This research aims to draw attention to the place and importance of nature of science in education. Within the scope of the research, ideas and changing understandings about the nature of science will be touched upon, and the importance of the nature of science in terms of education and its teaching to students will be emphasized.

Keywords: Nature of science, positive science, education

© 2024 IJSTS & the Authors. Published by *International Journal of Sports, Technology and Science (IJSTS)*. This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (CC BY-NC-ND) (**http://creativecommons.org/licenses/by-nc-nd/4.0/**).

[1]Corresponding author (Gamze Serin). ORCID ID.: 0000-0002-1208-5553 E-mail: gamzeserinn1@gmail.com

1. Introduction

The nature of science is a concept that explains the changes in the development process of scientific knowledge and the epistemological and social structures influencing these changes (Lederman, 1992). In another definition, it refers to an interdisciplinary approach that attempts to understand science by bringing together its different social aspects such as history, philosophy, sociology, and psychology (McComas et al., 2000). In the 1950s, the term "nature of science" was used to express the scientific method, whereas in the 1960s, there were shifts in its meaning, evolving into a concept that refers to scientific process skills (Abd-El Khalick, 2013). According to Khishfe and Lederman (2007), the inability to define the nature of science with a single definition is due to its ongoing changes and the different meanings that have been attached to it over time.

When reviewing the literature on the nature of science and science education, it is observed that there are different perspectives regarding what scientific knowledge is, how it is explained, and how these aspects are taught to students. Considering that science is multifaceted, composed of various fields, and open to change, it is understandable that a clear definition of the nature of science cannot be reached (Köseoğlu, Tümay, & Budak, 2008). For the past 70 years, the way scientists explain science has been under discussion. Experimental processes based on observation have started to be criticized. It is not possible to base science solely on observation and experimentation (T. Kuhn, 1962). With new beliefs, scientific knowledge is a process that includes not only observation and experimentation, but also explanation, theory formation, and model building, where the acquired knowledge is developed and structured. This view holds that the process of observation and experimentation is just the beginning. The continuation of the process involves high-level thinking skills, including scientific reasoning, which is based on finding rational solutions (Siegel, 1989).

In Turkey, understanding the nature of science and science education begins in elementary school, with science lessons. In the Science and Technology curriculum (Grades 3-8), the concept of the nature of science is defined as understanding what science is, how and for what purpose scientific knowledge is created, the processes through which knowledge passes, how knowledge can change over time, and how it is used in new research (MEB, 2013). MEB also emphasizes that, not only students but also teachers who will provide science education must have the ability to recognize the nature of science and scientific knowledge and provide students with an understanding of their historical development. Therefore, it is crucial to equip teachers and pre-service teachers with the understanding of the nature of science, a key component of scientific literacy (Önen, 2011).

Today, researchers agree on the importance of understanding science and the nature of science in learning and teaching science skills. This is because it is believed that students' understanding of science will help them make informed decisions in scientific matters and learn the knowledge provided by science effectively and correctly in their future lives. Therefore, helping students develop an understanding of the nature of science, raising awareness of the purpose, characteristics, and limitations of science, and ensuring that they learn how science works and how knowledge is produced are critical goals for science educators. Ultimately, this aims to spread scientific literacy throughout society (Abd-El-Khalick et al., 2001; Yüce & Önel, 2015). Teaching the nature of science effectively will also help students realize the vital importance of knowledge that drives societal change (Wong, 2002).

Students must be able to use knowledge accurately, structure it correctly in making social decisions, and deeply understand the source and limitations of that knowledge. Therefore, at the core of scientific literacy is the ability to deeply internalize the nature of science (Lederman, 2004). Despite its significance, studies on the nature of science show that both in our country and around the world, students and teachers generally do not possess sufficient knowledge of the nature of science (King, 1991; Lederman, 1992; Pomeroy, 1993). The conceptual explanation of the nature of science and its reflection in educational curricula is an important issue addressed globally and within our country. In recent years, research on this topic has been increasing. This study aims to approach the nature of science from a descriptive perspective within the framework of education. Additionally, it seeks to contribute to the literature by gathering relevant sources on the subject.

2. Method

2.1. Data Collection

The research was conducted using the document analysis technique. Document analysis, which is one of the qualitative research methods, is an analysis technique that reveals the historical development of a subject by examining relevant sources and taking notes, which are then evaluated (Baş & Akturan, 2008). In addition, the descriptive survey model was used to depict the situation as it currently exists. In the descriptive survey model, the subject is researched in detail, and these investigations are combined to present the data (Erkuş, 2005).

2.2. Data Collection Tool

The research data were obtained through a literature review. Literature review is a process consisting of the stages of collecting data, discussing the significance of the collected data, establishing its relationship with the problem, and classifying the knowledge. In this technique, the aim is to collect data by examining existing sources, documents, and other materials (Balcı, 2016; Karasar, 2009). In this study, which was created using the compilation method, printed scientific sources such as theses, books, journals, and articles were utilized.

2.3. Analysis of Data

Balcı (2016) stated that one of the most preferred techniques in qualitative research data analysis is descriptive analysis. In this study, descriptive content analysis was adopted. Descriptive content analysis is a systematic study aimed at defining the general trends and research results in a specific research area (Çalık & Sözbilir, 2014). A researcher conducting descriptive analysis aims to discover and uncover the information hidden within the data they have collected from the field (Serin & Zambak, 2020). For this purpose, works, articles, and research related to the nature of science and education were scanned, examined, and interpreted.

3. Findings

The nature of science is a fundamental framework that brings together many areas of study in the social sciences. The nature of science, which serves as a foundation in fields such as history, sociology, psychology, and philosophy, also seeks answers to many questions. The questions that are sought to be answered can be listed as follows:

- What is science?
- How is science shaped and developed?
- How do scientists carry out their work?
- What is the impact of social norms and sociological structures on science?
- To what extent and in what ways is science influenced by psychology, sociology, and philosophy? (McComas & Olson, 2000).

Although the answers to these questions may vary across societies, researchers working on science have been able to explain the nature of science and all these questions within a general framework based on universal values (McComas, Clough, & Almazroa, 1998).

Since the 1960s, philosophers of science have begun to question the claims made about science. In particular, the fundamental assumption that science is an approach focused on experiments and observations began to change significantly. It has started to be emphasized that science has a broad nature that cannot be limited to experiments and observations, encompassing paradigms, observations, and theories (T. Kuhn, 1962). Based on this perspective, scientists have approached the nature of science by considering it through several sub-dimensions (Osborne, Collins, Ratcliffe, Millar, & Duschl, 2003). These seven sub-dimensions, which are also adopted by today's science educators, are shown in Figure 1.

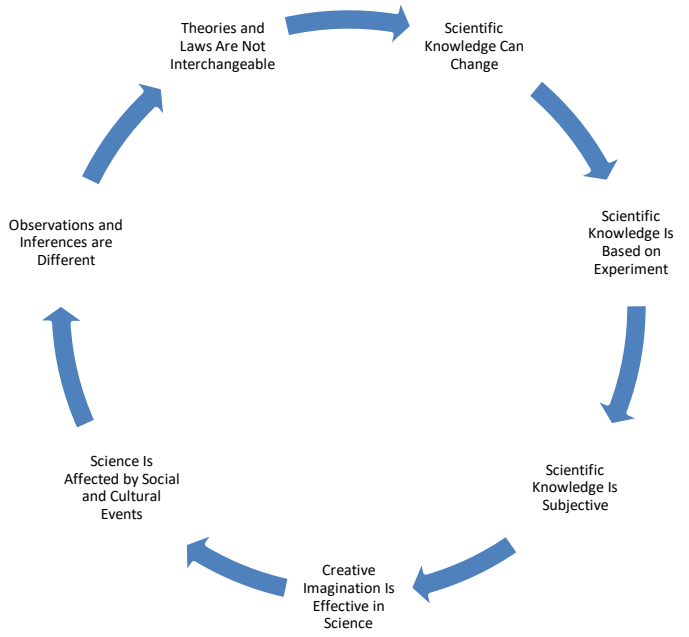

Figure 1: Subdimensions of the Nature of Science (Lederman, 2007).

Like science itself, concepts, subdimensions, and beliefs about the nature of science form a dynamic structure, continuously evolving. As our perception and understanding of science, and consequently the universe, develops, our perceptions of the nature of science may also change (Suchting, 1995). The disagreement about the nature of science and its subdimensions can be attributed to the complex and multifaceted nature of science. This complexity leads to philosophers, historians, and sociologists of science easily falling into disagreements (Abd-El-Khalick, Bell, & Lederman, 1998). However, when gathered under a general framework, it can be expressed as shown in Figure 1.

Studies on the importance of understanding the nature of science agree on the significance of understanding and internalizing the subject, explaining it through five concepts (Thomas & Durant, 1987).

These arguments are shown in Figure 2.

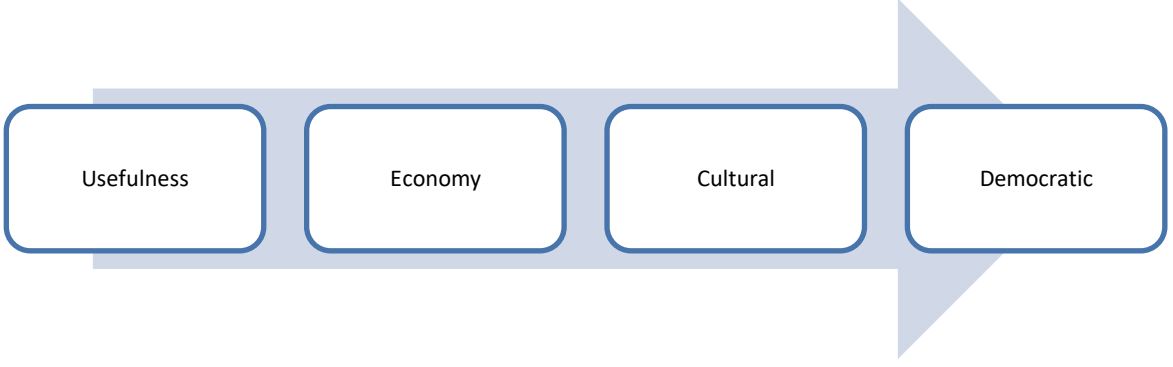

Figure 2: Concepts Explaining the Benefits of the Nature of Science (Thomas ve Durant, 1987).

The Argument of Usefulness:

Science and technology are fundamental topics present in every area of human life. People may encounter various problems related to these topics even in their daily lives. Understanding the nature of science can be beneficial in solving any type of problem encountered. Grasping scientific concepts, whether in professional life or daily routines, can bring ease to human life (Driver et al., 1996).

The Argument of Economy:

Societies that understand the nature of science and live their lives with this mindset are expected to be beneficial both individually and socially. The emergence of generations who understand the nature of science in societies can make those societies scientifically literate. As a result, societies can become productive, innovative, and economically advanced (Driver et al., 1996).

The Democratic Argument:

Individuals who understand the nature of science are more likely to express their views on science and technology-related issues that concern society. To be able to speak for one's community and engage in discussions when necessary, one must understand the nature of science. For example, societies capable of evaluating controversial socio-scientific issues like nuclear power plants in a democratic framework and making decisions will likely experience progress (Driver et al., 1996).

The Cultural Argument:

Science is a concept that greatly influences the cultures of contemporary societies. The assimilation of science into society, without conflicting with cultural values, will have a positive impact on the community. Thus, societies that understand the nature of science will develop both scientifically and culturally, while also encouraging young scientists (Shen, 1975).

The Moral Argument:

Understanding the nature of science plays an important role in grasping and internalizing the moral dimensions embedded in societal foundations. Societies that understand the nature of science can also consider universal ethical principles in the scientific process (Driver et al., 1996).

Considering the arguments expressed above, the nature of science plays a crucial role in the development of countries and societies. Therefore, many countries have been making efforts for years to develop students' views on the nature of science, and according to documents such as NGSS (2013) and MEB (2013), these efforts will continue in the future.

The Nature of Science and Education

The importance of understanding science and the nature of science in learning and teaching science has been recognized by educators since the early 20th century. The first step in this regard was taken during the 1907 meeting of the Central Association of Science and Mathematics Teachers in the United States, where a focus was decided on scientific processes and methods (Lederman, 1992). Since then, improving students' views on science and thus promoting scientific literacy in society has become an important goal for science educators (İrez, Çakır, & Doğan, 2007).

The most important goal of science education in the context of science education has been to teach the nature of science to students. Understanding the nature of science is of great importance for students to become scientifically literate. For this reason, the nature of science is considered the foundation of scientific literacy. Many educators advocate for including and teaching the nature of science in science curricula (Hogan, 2000; Solomon, 1991).

"Knowing the nature of science" is an acquisition that should be provided to students from the elementary school level (Muşlu, 2008). The prerequisite for students to acquire this characteristic is for teachers to have a sufficient back ground in the nature of science and to be able to convey it to students in effective ways (İnce & Özgelen, 2015). In a study, Lederman (1992) found that teachers were not sufficiently familiar with the concepts of the nature of science and, as a result, were unable to convey them accurately and effectively to students. Therefore, in order for teachers to help develop their students' views on the nature of science, teachers themselves must first develop their own views on the nature of science and adapt to activities focused on the nature of science (Özgelen, 2010).

When examining the literature, it is seen that science education programs implemented from the past to the present have not been very effective in developing students' views on the nature of science. To overcome this issue, science curricula need to include specific approaches designed for teaching the nature of science, in addition to the general teaching approaches used. While the current curriculum includes the development of students' views on the nature of science as one of its goals, it is evident that the existing approaches have not sufficiently achieved this objective (Köksal & Ertekin, 2015).

Approaches Effective in Teaching the Nature of Science

Approaches effective in teaching the nature of science can be grouped under three categories: historical, indirect, and open-reflective approaches (Abd-El-Khalick & Lederman, 2000; Khishfe & Abd-ElKhalick, 2002).

Historical Approach:

In this approach, students trace the changes in science from the past to the present, influenced by historical developments. It is expected that students will form the idea that science, by nature, renews, evolves, and expands. Solomon et al. (1992) clearly demonstrated the historical approach within the context of the nature of science. This approach leads students to develop a mental framework in which scientific ideas are seen as temporary and changeable. It was also revealed that students could not evaluate past theories in the context of the present. With the teaching of the nature of science, students are expected to approach the nature of science from a historical perspective.

Indirect Approach:

Proponents of this approach argue that students' understanding of the nature of science will naturally progress when they engage in scientific activities through inquiry-based and student-centered practices (Lawson, 1982). This approach, which believes that students will master the nature of science through implicit learning when actively participating in the process, was widely adopted in the 1960s and 1970s. However, some studies have criticized this approach for not addressing the detailed aspects of the nature of science, and for being superficial (Moss et al., 1998; Tamir, 1972).

Open-Reflective Approach:

This approach argues that the nature of science is too abstract and complex to be learned implicitly or indirectly, and therefore must be taught through deep, reflective thinking (Lederman, 2004; Akindehin, 1988). In this approach, the nature of science is considered an important concept in its own right and is deeply analyzed in the educational setting. The goal is to provide students with opportunities to question, reach conclusions through experience, establish scientific connections, and make generalizations about science (Köseoğlu, Tümay, & Budak, 2008). Studies have found that this approach significantly improves students' understanding of the nature of science. Therefore, the open-reflective approach has been emphasized by many science educators in recent years (Akerson et al.,

2000; Carey et al., 1989). It is believed that all three of these approaches could be useful in developing students' understanding of the nature of science. However, in recent years, science education has increasingly focused on scientific argumentation and inquiry-based research using the open-reflective approach (Köseoğlu, Tümay, & Budak, 2008).

4. Discussion, Conclusion and Recommendations

Since this study is a review, its findings may serve as a reference for future research on the nature of science. The content analysis conducted during the study revealed that the field of the nature of science has become quite popular in recent years. However, the studies conducted so far largely overlap in terms of scope and content, which could hinder the expansion of the field. Therefore, researchers should use different methods and approaches to explore the topic further, which may lead to new research questions (İnce & Sözgelen, 2015).

There has been a considerable amount of research on education and the nature of science. Most of these studies have reached similar conclusions. One such study, Özcan (2013), suggests that in order to improve teachers' proficiency in the nature of science, emphasis should be placed on graduate education. Teacher candidates should be educated in this area during their training so that they can become well-prepared teachers for future generations. Additionally, teachers' deficiencies in the subject should be identified, and in-service training can address these gaps. Studies focusing on misconceptions about the nature of science among teacher candidates and teachers can also lead to educational programs targeting teachers (Polat, 2000). Furthermore, researchers can expand the literature by selecting underexplored or untouched groups for their sample, such as primary school teachers, preschool teachers, and their respective candidates, along with academics. Research involving elementary and preschool students can also be included, as the results could help support the development of new curricula (İnce & Özgelen, 2015).

A close examination of the literature on the nature of science and education reveals that the nature of science should be emphasized across all subjects, particularly science education, and that students should be provided with opportunities for deep reflective thinking. The open-reflective approach, which is closest to this understanding, can contribute significantly to the success of educational practices aimed at improving scientific literacy. While using the open-reflective approach, students should be provided with opportunities to actively engage in scientific activities similar to those of scientists, thus allowing them to experience the process of structuring scientific knowledge in their minds (Köseoğlu, Tümay, & Budak, 2008). Some studies have revealed that textbooks lack sufficient content on the nature of science or provide very little on the topic (Özden & Cavazoğlu, 2015; Özer et al., 2017). The lack of understanding of the nature of science among students, teachers, and perhaps society at large could be due to the shortcomings in the curriculum. Since the 2005 revision, the science curriculum has somewhat expanded in terms of science history and the nature of science, but this revision has been insufficient. Integrating the importance of the nature of science more fully into the curriculum could be beneficial.

Acknowledgements

We would like to thank the study participants, our colleagues and all the scientists whose scientific resources we benefited from.

Declaration of Conflicting Interests and Ethics

"In this article, journal writing rules, publishing principles, research and publication ethics rules and journal ethics rules were followed. Liability for any violations that may arise regarding the article belongs to the authors. "The authors declare no conflict of interest.

References

Abd-El-Khalıck, F., Lederman, N.G., Bell, R. L. ve Schwartz, R.S. (2001). Views of nature of science questionnaire (VNOS): Toward validand meaningful assessment of learners' conceptions of nature of science. *Annual International Conference of the Association for the Education of teachers in Science (AETS)'da sunulmus bildiri, Costa Mesa, CA.*

Abd-El-Khalick, F. (2013). Teaching with and about nature of science, and science teacher knowledge domains. *Science ve Education,* 22(9), 2087-2107.

Abd-El Khalick, F., ve Lederman, N. G. (2000). The influence of History of science courses on students' views of nature of science. *Journal of Research in Science Teaching*, 37, 295-317.

Akerson, V., Abd-El Khalick, F., ve Lederman, N. G. (2000). Influence of a reflective explicit activity- based approach on elementary teachers' conceptions of nature of science. *Journal of Research in Science Teaching,* 37, 295-317.

Akindehin, F. (1988). Effect of an instructional package on preservice science teachers' understanding of the nature of science and acquisition of science-related attitudes. *Science Education, 72, 73–82.*

Balcı, A. (2016). Sosyal bilimlerde araştırma yöntem teknik ve ilkeleri. Ankara: *Pegem Akademi.*

Baldi, S., Jin, Y., Skemer, M., Green, P.J., ve Herget, D. (2007). Highlights From PISA 2006: Performance of U.S. *15-Year-Old Students in Science and Mathematics Literacy in an International Context* (NCES 2008–016). NCES. Washington, DC.

Baş, T., ve Akturan, U. (2008). Nitel araştırma yöntemleri NVivo 7.0 ile nitel veri analizi.(1. baskı). *Ankara: Seçkin Yayıncılık*.

Carey, S., Evans, R., Honda, M., Jay, E., ve Unger, C. (1989). An experiment is when you try it and see if it works: A study of grade 7 students' understanding of the construction of scientific knowledge. *International Journal of Science Education*, 11, 514–529.

Çalık, M. ve Sözbilir, M. (2014). İçerik analizinin parametreleri. *Eğitim ve Bilim*, 39(174), 33-38.

Driver, R., Asoko, H., Leach, J., Scott, P., ve Mortimer, E. (1994). Constructing scientific knowledge in the classroom. *Educational researcher,* 23(7), 5-12.

Erkuş, A. (2005). Bilimsel araştırma sarmalı. Ankara: *Seçkin Yayıncılık.*

Gürses, A., Doğar, Ç. ve Yalçın, M. (2005) "Bilimin doğası ve yüksek öğrenim öğrencilerinin bilimin doğasına dair düşünceleri" *Milli Eğitim Dergisi*, 166, http://yayim.meb.gov.tr/dergiler/166/index3-icindekiler.htm

Hogan, K. (2000). Exploring a process view of students' knowledge about the nature of science. *Science Education*, 84(1), 51-70.

İnce, K., ve Özgelen, S. (2015). Bilimin Doğası Alanında Son 10 Yılda Yapılan Çalışmaların Farklı Değişkenler Açısından İncelenmesi. *Mersin University Journal of the Faculty of*

Education/Mersin Üniversitesi Eğitim Fakültesi Dergisi, *11*(2).

Karasar, N. (2009). Bilimsel araştırma yöntemi. Ankara: *Nobel Yayın Dağıtım.*

Khishfe, R., ve Abd-El-Khalick, F. (2002). Influence of explicit and reflective versus implicit inquiry-oriented instruction on sixth graders' views of nature of science. J*ournal of Research in Science Teaching*, 39(7), 551-578.

Khishfe, R. ve Lederman, N. (2007). Öğretim bağlamı ile bilimin doğasına ilişkin görüşler arasındaki ilişki. *Uluslararası Fen Eğitimi Dergisi* , *29* (8), 939-961.

King, B. (1991). Begining teachers' knowledge of and attitude toward history and philosophy of science. *Science Education*, 75, 135-141.

Köksal, S. ve Ertekin, P. (2015). Bilimin doğası öğretiminde kuramdan uygulamaya yönelik yaklaşımlar. N., Yenice (Ed.) içinde, Bilimin Doğası Gelişimi ve Öğretimi (ss. 189- 215). Ankara: *Anı Yayıncılık.*

Köseoğlu, F. (2007). Yeni Bir Paradigma: Yapılandırıcı Öğrenme ve Öğretme Modeli. *Basımda.*

Köseoğlu, F., Tümay, H., ve Budak, E. (2008). Bilimin doğası hakkında paradigma değişimleri ve öğretimi ile ilgili yeni anlayışlar. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, *28*(2), 221-235.

Kuhn, T. (1962). The structure of scientific revolutions. Chicago: *University of Chicago Press*.

Lawson, A.E. (1982). The nature of advanced reasoning and science instruction. *Journal of Research in Science Teaching*, 19, 743–760.

Lederman N. G. (1992). Students''and teachers' conceptions of the nature of science: A review of the research. *Journal of Research in Science Teaching*, 29, 331-359. https://doi.org/10.1002/tea.3660290404

Lederman, N.G. (2004). Syntax of nature of science within inquiry and science instruction. In L.B. Flick ve N.G. Lederman (Eds.), Scientific Inquiry and Nature of Science. Netherlands: *Kluwer Academic Publishers.*

Mccomas, W. F., ve Olson, J., K. (2000). Internatıonal Science Education Standards documments (41-52) In W.F.Mccomas (Ed.) The nature of science in science education rationales and strategies. *Kluwer Academic Publishers*

McComas, W. F., Clough, M. P., ve Almazroa, H. (2000). The role and character of the nature of science in science education. In W. F. McComas (Ed.), The nature of science in science education. *Science ve Technology Education Library.* https://doi.org/10.1007/0-306-47215-5_1

MEB. (2013). İlköğretim kurumları (ilkokullar ve ortaokullar) fen bilimleri dersi (3, 4, 5, 6, 7 ve 8. sınıflar) öğretim programı. Ankara.

Moss, D.M., Abrams, E.D., ve Kull, J.R. (1998). Describing students' conceptions of the nature of science over an entire school years.

Muşlu, G. (2008). *Ilköğretim 6. sınıf öğrencilerinin bilimin doğasını sorgulama düzeylerinin tespiti ve çeşitli etkinliklerle geliştirilmesi*. yayınlanmış doktora tezi, Marmara Üniversitesi.

NGSS Lead States. (2013). Next generation science standards: For states, by states. Washington, DC: The National Academy Press.

Ocak, İ., ve Yeter, F. (2018). 2006 – 2016 yılları arasında çalışılmış "bilimin doğası" konulu ulusal tez ve makalelerin incelenmesi. *Kuramsal Eğitimbilim Dergisi*. 11(3), 522-543.

Osborne, J., Collins, S., Ratcliffe, M., Millar, R., ve Duschl, R. (2003). What "ideas about science" should be taught in school science? A Delphi study of the expert community. *Journal Of Research In Science Teaching*, 40(7), 692-720.

Önen, F. (2011). *Bilimin doğası konusunda derse entegre edilmiş ve edilmemiş doğrudan yansıtıcı yaklaşım etkinliklerinin fen bilgisi öğretmen adaylarının bilimsel bilginin doğası anlayışına etkisi:* Atom ve kimyasal bağlar (Yayımlanmamış doktora tezi). Marmara Üniversitesi, İstanbul.

Özden, M. ve Cavlazoğlu, B. (2015). İlköğretim fen dersi öğretim programlarında bilimin doğası: 2005 ve 2013 programlarının incelenmesi. *Eğitimde Nitel Araştırmalar Dergisi*, 3(2), 40-65. https://doi.org/10.14689/issn.2148-2624.1.3c2s3m.

Özer, F., Doğan, N., Çakmakçı, G., İrez, S. ve Yalaki, Y. (2017). Bilimin doğası içerik temelli etkinlik örneği: Abur cubur. *Araştırma Temelli Etkinlik Dergisi*, 7(2), 93-107.

Özgelen, S. (2010). *Exploring the development of pre-service science teachers' views on nature of science in inquiry-based laboratory instruction.* Yayınlanmış doktora tezi. Middle East Technical University.

Pomeroy, D. (1993). Implications of teachers' beliefs about the nature of science: Comparison of the beliefs of scientists, secondary science teachers, and elementary teachers. *Science education*, *77*(3), 261-78.

Serin, E. ve Zambak, Ö. (2020). Futbolda Strateji Gerekliliği Üzerine Düşünsel Bir Yaklaşım [An Intellectual Approach to the Necessity of Strategy in Footbal], *Spor Eğitim Dergisi,* 4 (3), 72-79.

Shen, B.S. P. (1975). Scientific literacy and the public understanding of science. In S. B. Day (Ed.) *Communication of scientific information* (44-52). Basel: Karger

Siegel, C. L. (1989). *Topics in Complex Function Theory, Volume 3: Abelian Functions and Modular Functions of Several Variables* (Vol. 16). John Wiley ve Sons.

Solomon, J., (1991).Exploring The Nature Of Science. *Glasgoew*, England: Blackie.

Suchting, W. A. (1995). The nature of scientific thought. *Science & Education*, 4 (1), 1-22.

Taşar, M. F. (2003). Teaching history and the nature of science in science teacher education programs. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *1*(13), 30-42.

Taşkın, T. (2021). Bilimin doğası konulu makalelerin çeşitli değişkenler açısından incelenmesi. *Bolu Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, 21(1), 1-20. https://dx.doi.org/10.17240/aibuefd.2021.21.60703-794024

Thomas, G. and Durant, J. (1987) Why should we promote the public understanding of science? In M. Shortland (Ed.) Scientific Literacy Papers. (pp. 1-14). *Oxford: Oxford University Department for External Studies.*

Yüce, Z. ve Önel, A. (2015). Fen öğretmen adaylarının bilimin doğasını anlamaları ve evrim teorisini kabul düzeylerinin belirlenmesi. *Turkish Studies -International Periodical for the Languages, Literature and History of Turkish.* DOI Number: http://dx.doi.org/10.7827/TurkishStudies.8476, p. 857-872.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the Journal.
This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (**CC BY-NC-ND) (http://creativecommons.org/licenses/by-nc-nd/4.0/**).