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Exploring pre-service pre-school teachers' perceptions of the nature of science: A qualitative study

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ABSTRACT

The purpose of this study is to examine pre-service pre-school teachers' understanding of the nature of science. In this study, phenomenology design, one of the qualitative research methods, was used. A total of 36 pre-service pre-school teachers who were studying in the fourth grade of a university in Turkey in the Preschool Teaching Department of the Faculty of Education in the 2020-2021 spring semester participated in the research. A questionnaire consisting of ten open-ended questions was used in the study. The data were analyzed by content analysis. As a result of this research, it was observed that pre-service pre-school teachers mostly did not have sufficient views on the examined dimensions of the nature of science and they had misconceptions. Based on the results of the research, it can be suggested that postgraduate education, in-service training and workshops focused on the nature of science will be beneficial for teachers and pre-service teachers. In addition, it may be suggested to improve the courses on the nature of science and scientific inquiry and/or add such courses to the undergraduate program. It can be suggested that the courses on the nature of science should be given not only at the undergraduate level, but also in other teaching levels in accordance with the grade level.

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INTRODUCTION

Training individuals with the mastery of 21st century skills who do not accept information as it is, rather evaluate it critically, question, research, solve problems and make evidence-based decisions has become a necessity of our age. In support of this, the 10 important skills in the World Economic Forum's "The Future of Jobs" report are listed as follows: 1-Analytical thinking and innovation, 2-Active learning and learning strategies, 3-Problem solving, 4-Critical thinking and analysis, 5-Creativity, originality, pioneering, 6-Leadership, 7-Technology use and control, 8-Programming, 9-Flexibility, stress tolerance, 10-Reasoning, problem solving (WEF, 2020). Science education plays an important role in education in order to train qualified individuals having these skills. Individuals having these skills are also science literate individuals. An individual who is trained to be science literate is sensitive to social problems, engages in reasoning to solve these problems and has creativity and analytical thinking skills. These people are individuals who can understand science and its nature, and besides all these, who can use science and the nature of science in their lives at the appropriate time (Milli Eğitim Bakanlığı [MEB], 2013). The two fundamental components of science literacy are the nature of science and the nature of scientific inquiry (Schwartz, Lederman and Crawford, 2004; Lederman, 2009; Lederman and Lederman, 2012; Lederman, Lederman and Antink, 2013). As can be understood from here, the nature of science is an important part of science literacy (Akerson, Avsar Erumit & Kaynak, 2019; Lederman, 2007). When the relevant literature is reviewed, it is seen that the necessity of students to have sufficient understanding about the nature of science is mentioned with a similar perspective (AAAS, 1990; NRC, 1996; Akerson, Abd-El-Khalick and Lederman, 2000; Lederman and Lederman, 2012). On the other hand, in many studies, it is stated that students mostly have insufficient beliefs about the nature of science (Schwartz et al., 2004; Lederman, 2007; Lederman and Lederman., 2014; Leblebicioğlu et al., 2017). In this context, training science literate (understanding the nature of science) individuals is among the main objectives of all education programs, starting from pre-school education to higher education (NRC, 1996).

In particular, education in the pre-school period, where development and learning are very rapid and the brain architecture of individuals develops, can have significant effects on the future lives of individuals. The education given in this process is important in the cognitive, emotional and social development of individuals and the knowledge and skills gained in this period form the basis of individuals' lives (Altay, 2011; MEB, 2006; Sezer, 2019). For this reason, a qualified science education that includes science and the nature of science should be offered starting from the pre-school period because such a science education given to preschool children improves their scientific thinking skills and enables them to learn science concepts (Akerson et al., 2011; Eshach and Fried, 2005; Olgan, Alpaslan and Öztekin, 2014). In the preschool period, children feel the need to satisfy their curiosity about the events happening around them. For this reason, it is seen as one of the objectives of science education that children become aware of their environment and understand their environment (French, 2004). Thus, it is seen that the basic concepts of science are acquired in the pre-school period and forming the basis of science literacy is also included among the objectives of pre-school education (Lind, 2005). For the accomplishment of this objective, pre-school teachers and pre-service teachers need to have knowledge about science and the nature of science. When they have knowledge on this subject, they can accurately reflect science and the nature of science to children. Indeed, research shows that in order for students to learn about the nature of science, teachers must understand it and how to teach it (Akerson, Cullen and Hanson, 2009; Sorensen, Newton and Mccarthy, 2012). Touching upon this point, Toyoma (2016) emphasizes that teachers have tasks such as motivating students to learn science, arousing students' curiosity about science and encouraging students to research and discover. Facilitated by educators, students' natural curiosity drives learning processes and comprehensive subjects are integrated into various subject areas (NAAEE, 2019). For such reasons, it is expected that teachers should have sufficient knowledge and experience about the nature of science and have a

positive (advanced) perspective on the nature of science (Akerson, Cullen and Hanson, 2009; Baykara and Yakar, 2020; Lederman, Bartos and Lederman, 2014; Mesci, Çavuş Güngören and Yeşildağ Hasançelebi, 2020; NRC, 1996). When the literature is examined, it is seen that both pre-service teachers (Abd-El Khalick and Boujaude, 1997; Doğan Bora, 2005) and teachers' thoughts on the nature of science are insufficient (Dorji, Jatsho, Choden and Tshering, 2022; Lederman, 1992; Schwartz et al., 2004; Lederman and Lederman, 2004; Lederman, 2007; Lederman et al., 2014).

Moreover, although much emphasis has been placed on the importance of giving education on the nature of science starting from the pre-school period in the literature (AAAS, 1990; Abd-El-Khalick, Bell and Lederman, 1998; Akerson et al., 2011; NRC, 1996), there is not enough research in this area. In other words, in the literature, there are many studies on the nature of science conducted at elementary, secondary and tertiary levels of education (Çakıcı and Bayır, 2012; Doğan and Abd-El-Khalick, 2008; Doğan and Özcan, 2010; Erdoğan, Çakıroglu and Tekkaya, 2006; Kaya, 2012; Korkmaz, Altun, Üstkaya and Usta, 2014; Küçük, 2006). In addition, it is seen that studies on the nature of science have generally been carried out on science, physics, chemistry, biology, mathematics teachers and pre-service teachers (Abd-El-Khalick and Akerson, 2004; Doğan-Bora and Abd-El-Khalick, 2008; Gürses, Doğar and Yalçın, 2005). On the other hand, it is seen that there are few studies that examine the perceptions of pre-service pre-school teachers about the nature of science in detail (Cumhur, Yıldırım, Bolat and İskeleli, 2018; Erdaş-Kartal and Ada, 2018; Mıcık, 2021). Thus, conducting further studies with the participation of pre-service pre-school teachers seems to be of great importance because they will be the teachers of future who will introduce children to the nature of science and help them understand it. For this reason, it is thought that the current study will help fill the gap in the literature and provide guidance to similar studies. In addition, the current study employed the phenomenological design in order to make detailed analyses, unlike the quantitative studies in the literature. In the current study, which was carried out considering all these issues, it was aimed to examine the views of pre-service pre-school teachers on the nature of science. In this connection, the questions that guide the study are as follows

• What are the opinions of pre-service pre-school teachers about what science is?

• What are the opinions of pre-service pre-school teachers about scientific knowledge being open to change?

• What are the opinions of pre-service pre-school teachers about the subjectivity of scientific knowledge?

• What are the opinions of pre-service pre-school teachers about the effect of imagination and creativity on scientific knowledge?

• What are the opinions of pre-service pre-school teachers about the effect of social and cultural life on science?

• What are the opinions of pre-service pre-school teachers about the existence of a universal scientific method used in scientific studies?

• What are the opinions of pre-service pre-school teachers about the concepts of theory and law?

METHOD

Research Design

The current study employed the phenomenological design, one of the qualitative research methods. The main goal in the phenomenological design is to reveal how the participants make sense of a situation (Johnson and Christensen, 2014). As it was aimed to examine pre-service pre-school teachers' perceptions of the nature of science in depth in the current study, the phenomenological design was preferred.

Research Study Group

The study group of the current research is comprised of fourth-year students attending the Department of Preschool Teaching in the Education Faculty of a university in Turkey in the spring term of the 2020-2021 academic year. The participants of the study were determined by using the criterion sampling method, one of the purposive sampling methods. The criteria used in the selection of the participants are their having already taken the course of Science Education, having the experience of teaching practice at least for one term and being volunteer to participate in the study. As a result, a total of 36 pre-service pre-school teachers, 31 females and 5 males, participated in the study.

Research Instruments and Processes

A questionnaire consisting of 10 open-ended questions developed and prepared by the researchers was used as a data collection tool in the study. The reason for choosing this data collection tool is to understand more deeply the reasons underlying the answers compared to the scale consisting of closed-ended questions and to reach relatively more generalizable results compared to semi-structured interviews (Creswell, 2008). In order to establish the content validity of the questions in the questionnaire, the opinions of two field experts, one with a doctorate in science education and one with a doctorate in pre-school education, were sought. The online version of the questionnaire was prepared and sent to the participants to be completed. Before the application, the teachers were informed that their personal information would be kept confidential and that the data would only be used for scientific purposes. In addition, collecting data online brought advantages such as participating in the process at any place and time, and feeling comfortable. Some sample items in the questionnaire are as follows:

1. What do you think is science?

2. What comes to your mind when you think of the nature of science?

3. Do you think that the thoughts of the person revealing the information and the way of his/her interpreting the information affect scientific knowledge? Why?

4. Do you think imagination and creativity have an effect on the production of scientific knowledge?

5. Can theories turn into laws over time? Why?

Data Analysis

After the data collection stage was completed, all the data were transferred to MS Excel and printed out. Then, starting from PT1, each document belonging to the controlled data was given a code as PT1, PT2, ….PT36. The data were analyzed by using content analysis. Two field experts, one working in the field of science education and the other in the field of preschool education independently analyzed the data. Data analysis was carried out on the basis of the content analysis approach proposed by Creswell (2008). Creswell states that content analysis has three main stages: the preliminary exploratory analysis, coding process and thematic analysis. In the preliminary exploratory analysis stage of the current study, the data were read twice to get an overview of the data. During the readings, some notes about concepts and ideas were taken and how the data could be organized within the framework of these notes was considered. In the coding process stage, the data were coded. After the completion of the coding performed one by one, similar codes were grouped and unnecessary codes were discarded. Afterwards, it was checked whether new codes would emerge and re-coding was performed to prevent any possible mistake. After the final coding, it was decided to exclude the codes represented by below 3% from the study. Finally, in the thematic analysis stage, it was tried to create related themes. Reliability coefficients were calculated between the coders to give the final form of the themes. While doing this, first, consistency was established between the main themes. Afterwards, the number of

participants thought to be under each theme was examined. Discussion continued until 100% consensus was reached in these reviews.

FINDINGS

Pre-Service Pre-School Teachers' Opinions about What Science Is

In the study, firstly, the pre-service pre-school teachers' understanding of science was questioned. As a result, it was seen that the opinions of the pre-service pre-school teachers about what science is gathered around the themes of the field of study of science, the purpose of science, the qualities of science, methodology, content of science, what science provides and what science resembles. The codes of the universe and the world in the theme of the study area of science, the codes of provable and reality in the theme of the qualities of science, the codes of experiment, observation, different techniques and methods in the theme of methodology and the code of information in the theme of what is in the content of science were expressed as opinions by more pre-service teachers. PT9 and PT30's opinions on what science is, respectively, are as follows:

"In my opinion, science is an effort to make sense of the universe and nature and consists of proven facts that always give the same result everywhere."

"The way of knowledge, consistent information, which reaches certain laws based on reality, by dealing with a part of the universe, phenomena and events in the universe, using some methods and experimental ways."

It is also seen that PT3 likens science to a light. PT3's opinion is as follows:

"Science is a light that illuminates the darkness of the unknown. It makes our lives easier in many areas by developing and renewing over time."

Pre-Service Pre-School Teachers' Opinions about What the Nature of Science is

It was examined what the participants understood from the expression "nature of science". In this connection, it was seen that the opinions of the participants about the nature of science are gathered around the themes of knowledge, scientific knowledge, science, research-study-inquiry, scientific processes, fields of study, method, what the nature of science provides, the characteristics of the nature of science, and people who are related to the nature of science. The code of the development of scientific knowledge within the theme of scientific knowledge, the codes of the functioning of science and what science is within the theme of science were reported as opinions by relatively more pre-service teachers. When the themes in this category are examined, it is seen that the participants produced too many codes. In other words, each participant made very different statements from each other. Opinions of participants PT26, PT30 and PT33 on what science is, respectively, are as follows:

"In relation to the nature of science, the first thing that comes to my mind is the structure that brought science into existence, the factors that were involved in the formation of science and that are constantly there. For example, man."

"What is meant by the nature of science is the sum of answers to questions such as what science is, how it works, how scientists organize their scientific research, how scientific knowledge emerges and how it develops, and what factors it is affected by."

"It is the answers to the questions such as what science is, how it works, how it came into existence and these answers have their own characteristics and these characteristics should be investigated to reach these answers."

In addition, the answer of PT8, who stated that the nature of science covers the time from past to present, is also interesting:

"The functioning of science from past to present within its own system."

Opinions of the Pre-Service Pre-School Teachers about How to Distinguish What is Scientific and Non-Scientific Knowledge

How the pre-service pre-school teachers distinguish between scientific and non-scientific knowledge; that is, their understanding of scientific knowledge, was examined. In this context, it is seen that the opinions are gathered around the themes of features of scientific knowledge, features of non-scientific knowledge, what is done to distinguish and what is used to distinguish. More opinions were expressed by the pre-service teachers on the codes of the provable and objective in the theme of the features of scientific knowledge, the code of the subjective in the theme of the features of non-scientific knowledge, the code of the experimental in the theme of those used to distinguish. The opinions of PT11, PT34 and PT35 about what science is are as follows:

"Its having been proven and reached through experimentation and observation."

"In my opinion, the way to distinguish scientific knowledge from non-scientific knowledge is its being reasonable and logical in the first place. In my opinion, any knowledge and fact that reason and logic do not accept is not scientific. And this is followed by testability, provability."

"Scientific knowledge is objective and provides evidence based on experiments and is universal. Non-scientific knowledge is not based on evidence."

The answers given by PT5 and PT23 are similar. The opinions of PT5 and PT23 are as follows, respectively:

"Scientific knowledge has been proven to be correct and is observable, measurable, and the fact that it gives the same result every time shows that it is scientific knowledge; otherwise, it is not scientific."

"In order for a piece of information to be scientific, it must be observable, measurable and give the same results in every measurement."

Opinions of the Pre-Service Pre-School Teachers about Scientific Knowledge being Open to Change

The pre-service re-school teachers were asked questions about whether scientific knowledge is open to change and why. While 31 of the pre-service teachers stated that science is open to change, 4 of them said that it is not open to change and one pre-service teacher stated that it is sometimes open to change. PT13, on the other hand, did not express his/her opinion on the reason for the change. It is seen that the opinions of the pre-service teachers who stated that science is not open to change are gathered around the theme of objectivity. Codes such as knowledge's being proven, unchangeable and certain, and certainty of its accuracy were expressed as opinions within the theme of objectivity by the pre-service teachers. The opinion expressed by PT30 in this regard is as follows:

"Science does not change. Scientific knowledge is proven knowledge. It does not change; it is certain."

There is only one pre-service teacher who said that some of the scientific knowledge is open to change. The opinion of this participant is as follows:

PT21: "I think some of it is open to change while some is not. For example, the fact that water boils at 100 degrees does not change, but when Pluto was once a planet, then new sources revealed that it was not a planet."

The opinions of the pre-service teachers who stated that scientific knowledge is open to change are gathered around the themes of innovations and changes in old ones, development, study and

research, time of change, differences, characteristics of change, progress, field of change, characteristics of science and knowledge. More opinions were expressed by the pre-service teachers on the codes of obtaining new information and changing old information within the themes of innovations and change of old ones. PT15 and PT34's opinions on this subject are as follows:

"Of course, it is open to change, in the developing and changing world, everything is changing rapidly at any moment. In this change, scientific knowledge cannot remain constant, there may be some that do not change, but all of them cannot remain constant."

"Yes, scientific knowledge should be open to change because, besides being objective, scientific knowledge should be provable with a number of methods. For example, while a scientist evaluates a phenomenon or a concept in his/her own mental perspective and presents a proof, another scientist can handle the same phenomenon and concept in very different ways."

Opinions of the Pre-Service Pre-School Teachers on the Subjectivity of Scientific Knowledge

The pre-service pre-school teachers were asked a question about whether the thoughts of the person revealing the knowledge and the way of his/her interpreting the knowledge affect scientific knowledge and why. While 28 of the pre-service teachers stated they would affect it, 7 of them stated that they would not and one pre-service teacher did not express any opinion. PT2, PT10 and PT20 did not state the reason for their opinions. The answers given by the pre-service teachers about the reasons for the subjectivity of scientific knowledge were examined in detail. In this context, it is seen that the opinions of the pre-service teachers who stated that they do not affect are gathered around the theme of objectivity. The opinions of PT7 and PT27 who think in this way are as follows:

"They should not affect. If they affect, it is problematic. Because there must be proven information. There should be no subjective opinion."

"The person presents his/her thoughts together with evidence. In my opinion, they do not affect. He/she presents objective information."

The opinions of the pre-service teachers who stated that they affect are gathered around the themes of subjectivity, characteristics of knowledge, type and direction of effect. More opinions were expressed by the pre-service teachers on the codes of personal opinions, different perspectives and the fact that the information is not independent from interpretations within the theme of subjectivity. Opinions of PT3, PT8, PT33 and PT34, who think in this way, are as follows, respectively:

"Of course, the information is affected by the thoughts of the person who reveals the information. A person expresses his/her knowledge together with his/her feelings and thoughts. Thus, it is somehow affected anyway."

"They affect because everyone's perspective is different. While perspectives present a wide range of perspectives, they can also lead to narrow thinking. Depending on the point of view, the resulting product can be affected positively or negatively. At the same time, scientific knowledge is not objective because knowledge is changeable."

"They affect because people may think differently on the different aspects of knowledge."

"Yes, they affect. Scientific knowledge is objective in terms of demonstrability and provability; however, how the people who reveal this evidence form the evidence, that is, the way they interpret it, also affect scientific knowledge. Some differences may emerge in the interpretations of different people with the effect of the characteristics of the society or culture they live in."

Opinions of the Pre-Service Pre-School Teachers about the Effect of Imagination and Creativity on Scientific Knowledge

The pre-service pre-school teachers were asked a question about whether imagination and creativity have an effect on the production of scientific knowledge, if so, how imagination and creativity affect scientific knowledge, or if not, what the reason for this is. While 33 of the pre-service teachers said it would affect, 1 said it would not and 2 pre-service teachers stated that it should not affect much. PT22 did not state the reason for his/her opinion. When the answers given by the pre-service teachers about the effect of imagination and creativity on scientific knowledge were examined, the opinion of the pre-service teacher who said that it would not affect was represented by the code of the existence of mathematical calculation. The opinion of PT1 who thinks in this way is as follows:

"No. Because everything has a mathematical calculation."

The opinions of the pre-service teachers who stated that it should not affect too much are based on the views that scientific knowledge is based on reality. Opinions of T20 and PT36 who think in this way are as follows:

"No, there is no effect. Imagination may be involved in the stage of emergence of scientific knowledge, otherwise it should not be involved."

"In my opinion, imagination and creativity do not have much effect on the production of scientific knowledge because scientific knowledge is mostly based on reality."

The opinions of pre-service teachers who stated that it affects are gathered around the themes of contributions of imagination and creativity, the stages where imagination and creativity are effective, the reasons for the necessity of imagination and creativity, the characteristics of imagination and creativity, the people who should have imagination and creativity, if there was no imagination and creativity, and the type of effect. More opinions were expressed by the pre-service teachers on the code of being able to look from different perspectives within the theme of the contributions of imagination and creativity and the code of scientists under the theme of people who should have imagination and creativity. The opinions of PT9 and PT15 are as follows:

"Yes, there is. Imagination and creativity will contribute positively to the process. Let me give an example of the invention of something new; if Edison had not tried different methods while trying to find the light bulb, or if he had not been able to use his creativity and rather used the existing knowledge like other people, he would not have come up with the invention."

"Yes, there is. People with developed imagination and creativity cannot remain where they are, they constantly want new things, and their sense of curiosity is at the forefront. This creativity and imagination is very important in the production of knowledge."

Opinions of the Pre-Service Pre-School Teachers on the Effect of Social and Cultural Lives on Science

The pre-service pre-school teachers were asked a question about whether science is affected by the social and cultural life of the scientist and why. Thirty-five of the pre-service teachers stated that it is affected while one of them stated that it is sometimes affected. PT12, PT13 and PT28 did not state the reason for their opinions. When the findings obtained from the answers given by the pre-service teachers about the effect of social and cultural life on science are examined, the opinion of PT7, who stated that social and cultural life sometimes affects science, is as follows:

"Which branch of science people will be directed to can be affected, but I don't think the content of science will change much."

It is seen that the opinions of the pre-service teachers who stated that they would affect are gathered around the themes of factors affecting, factors arising from the environment in which one lives, the things affected or not affected by social and cultural life, type and direction of effect, human characteristics, reasons arising from science and scientific knowledge, social reasons, reasons arising from needs. More opinions were expressed by the pre-service teachers on the code of environment in the theme of reasons arising from the environment in which one lives and the code of being a social being in the theme of human characteristics. The opinions of PT5, PT9, PT23 and PT34 are as follows:

"It is affected. Man is a social being, he/she is affected by society and naturally his/her work is also affected by this."

"It is affected. Living standards, certain taboos of society can affect positively or negatively. For example, due to a certain sexist perception attributed to women in the world, their professions are standardized. The number of male scientists is higher than that of female scientist (women's household responsibilities and maternity status, etc.)"

"All factors such as social structure, power centres, politics, socioeconomic level, philosophy, religion, etc., in the environment of the scientist affect science because science cannot be thought in isolation from society."

"Yes, it is affected. In which culture and social environment the person is brought up or which characteristics of the environment he/she is exposed to will have some reflections to a certain extent on the scientific information he/she is working on. This is inevitable."

Opinions of the Pre-Service Pre-School Teachers on the Existence of a Universal Scientific Method Used in Scientific Studies

The pre-service pre-school teachers were asked whether there is a scientific method that scientists use in scientific studies and that is accepted by everyone, and if there is, the reason for using this method. While 25 of the pre-service teachers stated that there is such a method, 4 of them stated that there is not and 7 pre-service teachers stated that they do not know. PT24, PT29, PT34 and PT36 stated that there is a scientific method, but they do not have adequate knowledge about it. PT2, PT20, PT22 and PT27 did not state the reason for their opinion. When the findings obtained from the answers given by the pre-service teachers about the existence of a universal scientific method are examined, the opinion of the pre-service teacher who said that there is no universally accepted method was coded as the studies containing a scientific method unique to them. The opinion of PT19 is as follows:

"I think everyone's work has its own scientificity, their common point is reaching valid results."

It is seen that the opinions of the pre-service teachers who stated that there is a universally accepted scientific method are gathered around the themes of the methods, tools and resources used, the characteristics of the methods, the usefulness of the study, acceptability by everyone, knowledge, and scientificity. More opinions were expressed by the pre-service teachers on the code of experiment and observation in the theme of methods, tools and resources used. The opinions of PT9, PT23 and PT32 are as follows, respectively:

"There is. Questionnaire and interview methods are largely preferred. I think the accuracy of scientific work is important in terms of improving the reality (The methods I have mentioned provide first hand data)"

"Scientists use generally accepted scientific methods in their studies because the studies carried out to prove the accuracy of scientific knowledge must be accepted by everyone."

"There is, there are measurement tools that are accepted by everyone or they can convince everyone with more concrete data."

The opinion of PT15, who stated that we cannot use the same method in every study even if there is a universal scientific method, is as follows:

"There might be. But I think that the same method cannot be applied to every piece of scientific knowledge all the time. There is a certain order, but we cannot try everything the same way."

Opinions of the Pre-Service Pre-School Teachers about the Concepts of Theory and Law

The pre-service pre-school teachers were asked a question about what the concepts of theory and law mean to them. When the answers given by the pre-service teachers are examined, it is seen that their opinions about the concept of theory are gathered around the themes of definition of theory, characteristics of theory, provability, certainty, explanation, methods of obtaining and testing. More opinions were expressed by the pre-service teachers on the codes of knowledge and opinion in the theme of definition of theory and the codes of the proven and unproven in the theme of provability. It is seen that the opinions of the pre-service teachers about the concept of law are gathered around the themes of definition of law, characteristics of law, provability, certainty and the methods used. The opinions of PT8 and PT9 are as follows:

"Theories are explanations obtained by the scientific method and repeatedly tested and confirmed through observations and experiments. Laws are statements based on repeated empirical observations that describe a particular phenomenon of nature."

"Theory: general scientific statements that have been proven to be true. Law: explains a single, narrower, more specific situation than theory."

The opinions of PT23 and PT30 on the concepts of theory and law are similar. The opinions of PT23 and PT30 are as follows:

"That is, a scientific law gives a very clear but narrow definition of a phenomenon or set of facts. The theory gives a holistic explanation of as many phenomena as possible."

"That is, while a scientific law gives a very clear but narrow definition of a phenomenon (or set of facts), a theory gives a holistic explanation of as many facts as possible. In short, law describes a phenomenon, theory explains many phenomena. The relationship between law and theory is as follows: A theory must obey existing scientific laws."

Opinions of the Pre-Service Pre-School Teachers about the Transformation of Theories into Laws

The pre-service pre-school teachers were asked a question about whether the theories would turn into laws over time and why. Twenty-eight of the pre-service teachers expressed their opinions as yes and 7 of them as no. PT34, on the other hand, stated that he/she did not have any knowledge on this subject. PT11, PT20, PT22 and PT30 did not state the reason for their opinion. When the findings obtained from the answers given by the pre-service teachers about the transformation of theories into laws are examined, it is seen that the opinions of the pre-service teachers who said that theories do not turn into laws are gathered around the themes of theory and laws being different, innovations and change and characteristics of theories and laws. The opinions of PT9, PT21 and PT35 on the subject are as follows:

"In our former education, we learned that it can transform, but I do not think that this is the case in undergraduate education. I don't think there is a hierarchical relationship between them. Because the law is a more specific situation, the situation will change with each experiment."

"It does not transform because the law maintains its reality independently of people. However, theories are a human product and are always bound to change with new information."

"No it does not transform because over time, a theory can lose its effect when new information is added."

It is seen that the opinions of the pre-service teachers who stated that theories turn into laws are gathered around the themes of the prerequisite for theories to turn into laws and the consequences of theories becoming laws. More opinions were expressed by the pre-service teachers on the code of if proven in the theme of prerequisite for theories to turn into laws. The opinions of PT4 and PT5 are as follows, respectively:

"After the theories are put forward by people, they can become laws by being proven over and over again. "

"Theories become laws after they are applied over time and their general validity is accepted."

DISCUSSION, CONCLUSION, RECOMMENDATIONS

Striking results were obtained in this qualitative study, which was conducted to examine pre-service pre-school teachers' understanding of the nature of science. It was concluded that the pre-service teachers limit science to the fields of study such as the universe, the world and nature, and that they see it as a tool that has methodologies such as experiment and observation, that facilitates and gives meaning to human life, and enables the unknown to be found. In addition, it was observed that science was defined in different ways such as including certainty, being independent of time and space, real and objective. When the answers given are examined, it can be said that the pre-service teachers have partially limited opinions on what science is and its definition and that they gave partially acceptable answers. Opinions on how science is defined and what science is are very important because these opinions reveal the opinions on the epistemology of science (Ryan and Aikenhead, 1992). In light of the results obtained in the current study, it can be said that the pre-service teachers' opinions and point of views on science should be developed. When the different answers given are examined in the current study, it is seen that there is no consensus, similar to many other studies in the literature (Arı, 2010; Aslan, 2009; Beşli, 2008; Kenar, 2008; Saraç, 2012). Yenice, Özden ve Balcı (2015), on the other hand, compared the views of pre-service science and primary teachers. As a result of the study, it was observed that a common decision could not be reached on the definition of science, but the pre-service teachers had an acceptable point of view to a large extent. Doğan-Bora (2005), on the other hand, found that the pre-service teachers who participated in the study did not have valid views on the definition of science and the epistemology of scientific knowledge.

Secondly, the pre-service teachers' understanding of the nature of science was examined. It was observed that the participants saw the nature of science as knowledge, science and scientific knowledge, and thought of it as an answer, field or structure that enables research, discovery and examination with its own characteristics. Although partially valid answers were given, it was observed that the views of the pre-service teachers were not sufficient in general and they had misconceptions. When the literature was examined, similar results were found in studies conducted on pre-service pre-school teachers (Abd-El-Khalick and Akerson, 2004; Öztaş, 2019; Türk, Yıldırım, Bolat and İskeleli, 2018). In addition, it is striking that similar results were obtained in studies conducted with the participation of pre-service teachers from different branches (Abd-El-Khalick and BouJaoude, 1997; Akerson, Morrison and McDuffie, 2006; Aslan, 2009; Aslan, Yalçın and Taşar, 2010; Cofre et al., 2014; Doğan and Abd-El-Khalick, 2008; Dorsah, 2020; Erdaş-Kartal and Ada, 2018; Mesci, 2016; Yenice and Ceren-Atmaca, 2017). The fact that generally similar results have emerged from the studies carried out with pre-service teachers and that this has continued from the old studies to the current studies show that there are deficiencies in the understanding of the nature of science and a problem is experienced in this regard. Abd-El-Khalick, Bell and Lederman (1998) emphasized this issue by stating that pre-service teachers do not have sufficient knowledge about the nature of science and therefore they do not prefer to integrate the curriculum into their lessons. Akerson, Buzzelli ve Donelly ise (2010) suggested that it is

necessary to cooperate with teachers who know the nature of science and can use it in the curriculum because it is thought that the wrong information that teachers have about the nature of science will cause them to reflect these misconceptions directly to their students and affect the students' perspectives on the nature of science (Mellado, 1998).

Another result obtained in the study is the opinions of the participants that scientific knowledge is provable and objective. Moreover, there are also statements indicating that science is certain, subjective, universal, and proven to be true. As for non-scientific knowledge, it was seen that they thought that it was subjective, non-evidence-based and hearsay information. It was concluded that they distinguish two types of knowledge by researching them with methods such as experiment and observation, and by looking at their accuracy. When these answers, which are also related to the epistemology of science, are examined, it can be said that the pre-service pre-school teachers have misconceptions in distinguishing scientific knowledge, and that these deficiencies are very important in terms of training individuals with 21st century skills and meeting reform expectations. When these answers, which are related to epistemological beliefs, are evaluated in general, they show that the participants have more naive epistemological beliefs about knowledge. When the literature is examined, it is seen that there are studies reporting results similar to the results obtained in the current study (Aslan, 2009; Doğan-Bora, 2005; Ryan and Aikenhead, 1992; Tanık Önal & Saylan Kırmızıgül, 2021).

In the current study, it was also seen that the pre-service pre-school teachers think that scientific knowledge is open to change. According to the participants, the reason for this change is that innovations, developments, differences, advances and scientific knowledge are not clear. Having valid beliefs and attitudes towards the development of scientific knowledge also indirectly influences views on the nature of science because the nature of science is a field that reveals beliefs about the epistemology of science and the development of scientific knowledge (Abd-El-Khalick, Bell, & Lederman, 1998; Lederman, 1992). From this point of view, it can be said that the pre-service teachers participating in the study have valid views on the change of knowledge. When the literature is examined, it is seen that similar results are obtained in studies conducted on pre-service teachers (Doğan-Bora, 2005; Küçük, 2006).

Another result obtained in the current study shows that the participants think that scientific knowledge is affected by the views of the person who reveals the knowledge. It was concluded that they think that personal ideas, feelings, interpretations and the changeable nature of knowledge cause subjectivity. Lederman (2007) and Lederman et al. (2002) mention that the work of scientists will be affected by their past experiences, lives and beliefs. For this reason, it is stated that objective observation cannot be mentioned in science. In a study conducted by Akerson, Abd-El-Khalick, and Lederman (2000) on pre-service teachers, the pre-service teachers' opinions, which were not valid in the first place about the subjectivity of scientific knowledge, changed slightly after the completion of the course and a positive progress was observed in their opinions. Similar results are also found in the study of Polat (2011).

In the current study, the opinions of the participants about the relationship between scientific knowledge and imagination and creativity were also investigated. As a result, it was seen that the participants generally think that imagination and creativity affect scientific knowledge. The participants think that imagination and creativity affect every stage of scientific studies, that they are generally more effective in the initial stage of the study, can make positive contributions to scientific knowledge and progress in science. Imagination and creativity are elements that scientists use to complete a missing piece of a puzzle, a painting, or bring new interpretations to new situations (Abd-El-Khalick, Bell and Lederman, 1998; Bell, 2009; Khishfe and Abd-El-Khalick, 2002; Lederman, 2007; McComas, 2004; Scwartz, Lederman and Crawford, 2004). Therefore, it is an important point in terms of beliefs and values about the nature of science. Polat (2011) reported results similar to the results of the current study. Akerson, Abd-El-Khalick, and Lederman (2000), on the other hand, showed in their study that

the pre-service teachers exhibited views that are not valid in the context of imagination and creativity influencing scientific knowledge before the lesson. However, as a result of the lesson given, it was observed that a positive progress was made and valid opinions were reported by the pre-service teachers. Similarly, Küçük (2006) found that while the participants initially obtained a low rate of valid answers about the imaginative and creative nature of scientific knowledge, a high percentage of valid answers were obtained after the study.

In addition, in the current study, all the pre-service teachers think that science is affected by social and cultural life. They explained the reason for this by stating that science is not independent from society and human beings, that humans are social beings, and that society and culture affect humans. It can be argued that social and cultural values affect scientific knowledge, since science is a human activity that is affected by the social and cultural values of the society in which it is practiced (Bell, 2009; Lederman, 2007, McComas, 2004; Scwartz, Lederman and Crawford, 2004). As a result of their research, Akerson et al. (2011) stated that while teaching the nature of science, it would be appropriate for teachers to start with more concrete elements such as observation and inference and move on to social and cultural ones, which are more abstract and complex elements. When the results of the current study are examined, it is seen that the pre-service teachers have valid views on this point. Akerson, Abd-El-Khalick, and Lederman (2000) observed that social and cultural values affect scientific knowledge, and that when they took the views of pre-service teachers before the lesson, they had opinions that were not valid, but after the lesson, it was stated that these opinions progressed in a slightly positive direction.

The opinions of the pre-service teachers who participated in the current study about the existence of a universal scientific method show that they think that there is such a method in general and that it is largely consisted of experiments and observations. In addition, it was concluded that they think that the reasons for using such methods are to increase the usefulness and acceptance of the study by everyone. Based on their answers, it can be concluded that the pre-service teachers have misconceptions at this point and they do not have valid opinions. “There is a general and universal scientific method” is among the myths identified by McComas (1998). Scientists do not follow a standard research plan and there is no universal scientific method. Scientists can use many different methods in their research (Bell, 2008).

Another striking result of the current study shows that the participants have misconceptions about the concepts of theory and law. The vast majority of the participants think that the theory is a concept that is unproven and changeable. They think that laws are a more precise and unchanging, proven and more effective concept than theories. From this point of view, it can be stated that a significant part of the participants have misconceptions about the concepts of theory and law, and some of them have partially valid views. Laws and theories play different roles in science. For this reason, an individual who has beliefs about the nature of advanced science should be aware that theories do not turn into laws (McComas, Clough and Almazroa, 2000). Küçük (2006) observed that the teacher involved in the study could not adequately explain the difference between theory and law.

Finally, some pre-service pre-school teachers think that theories turn into laws, that is, there is a hierarchical relationship between them. It was also observed that they think that there are some preconditions such as proving the theories and accepting their correctness by everyone in order for them to turn into laws. At this point, it is observed that the participants have an important misconception. Theories and laws are different kinds of scientific knowledge that do not transform into each other and have different functions. With new evidence emerging, both theories and laws can change (Abd-El-Khalick, Bell and Lederman, 1998; Akerson, Abd-El-Khalick, & Lederman, 2000; Bell, 2009; Lederman, 2007; Lederman et al., 2002; McComas, 2004; Scwartz, Lederman and Crawford, 2004). When the literature is examined, it is seen that there are studies having results concurring with the results of the current study (Doğan et al., 2011; Küçük, 2006). In addition, there are studies in the literature showing that the misconceptions at this point have been largely eliminated with the training

provided during the research process (Akerson, Abd-El-Khalick and Lederman, 2000; Lederman and Abd-El-Khalick, 1998; Schwartz and Lederman, 2002).

As a result, when the opinions of the pre-service pre-school teachers participating in the current study are taken into account in general, it can be stated that the participants have knowledge about the nature of science, but they also partially have misconceptions, erroneous information and deficiencies.

SUGGESTIONS

As a result of the current study, it was observed that the pre-service pre-school teachers mostly did not have correct views on the examined dimensions of the nature of science and that they had misconceptions. However, it is important for teachers to have sufficient knowledge and advanced views on the nature of science and scientific inquiry in order to train conscious individuals who are scientifically literate and have 21st century skills (Akerson, Cullen and Hanson, 2009; Lederman et al., 2014) For this reason, it is recommended to carry out new academic studies in order to eliminate the misconceptions of pre-service teachers and to improve their existing views. Thus, it can be made possible to organize undergraduate education by revealing the needs, deficiencies and misconceptions of pre-service teachers regarding the nature of science. In addition, steps can be taken for teachers and pre-service teachers to have more advanced views through postgraduate education and in-service training.

Research shows that the courses on the nature of science and scientific inquiry in the undergraduate program in Turkey are insufficient to achieve the desired results. However, there are studies showing that pre-service pre-school teachers who take courses on the nature of science and the nature of scientific inquiry have sophisticated views. For this reason, it may be suggested to improve the courses on the nature of science and scientific inquiry and/or add such courses to the undergraduate program. It can also be suggested that the courses on the nature of science should be given not only at the undergraduate level, but also at other levels of education in a way to be suitable for the relevant grade level.

With the current study, it was found out that the pre-service teachers have the perception that science is generally only for the benefit of human beings. By giving science and the nature of science to pre-service pre-school teachers as a separate course, the idea that science exists only for the benefit of human beings can be weakened and it can be ensured that pre-service pre-school teachers have more comprehensive knowledge about the nature of science. Moreover, the current study revealed that that the pre-service teachers have misconceptions about the concepts of theory and law. In the lessons to be given, these concepts can be especially emphasized and information can be given about other methods besides the experiment and observation methods. After giving theoretical information, pre-service pre-school teachers can be provided with opportunities to experience using these methods. Workshops to be focused on the nature of science will also be very effective.

Finally, it can be suggested to establish a platform for the nature of science prepared by the Ministry of National Education for primary, secondary and high schools, and by the Higher Education Council for universities. A platform that includes practices and trainings aimed at eliminating the misconceptions as well as informing about the developments and innovations revealed by new studies carried out in this field to the researchers can be beneficial in order to develop the opinions of pre-service teachers. The use of such a platform can contribute to the field in order to teach the nature of science in both formal and informal education processes.

LIMITATIONS

Like all scientific studies, this study has some limitations. First, in this study, data were collected with a questionnaire consisting of open-ended questions in order to include a relatively large number of pre-service teachers in the study. This prevented direct interaction with the participants. For this reason, it will be interesting to conduct semi-structured interviews and observations on the subject in future research, and perhaps to examine the diaries. Again, with a scale, quantitative data can be collected from a very large sample or a mixed method research can be preferred.

REFERENCES

Abd-El-Khalick, F., & Akerson, V. L. (2004). Learning as conceptual change: Factors mediating the development of preservice elementary teachers' views of nature of science. *Science Education, 88*(5), 785-810.

Abd-El-Khalick, F., & BouJaoude, S. (1997). An exploratory study of the knowledge base for science teaching. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 34*(7), 673-699.

Abd-El-Khalick, F., Bell, R. L., & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education, 82*(4), 417-436.

Akerson, V. L., Abd-El-Khalick, F., & 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: The Official Journal of the National Association for Research in Science Teaching, 37*(4), 295-317.

Akerson, V. L., Avsar Erumit, B., & Elcan Kaynak, N. (2019). Teaching nature of science through children's literature: An early childhood preservice teacher study. *International Journal of Science Education, 41*(18), 2765-2787.

Akerson, V. L., Buck, G. A., Donnelly, L. A., Nargund-Joshi, V., & Weiland, I. S. (2011). The importance of teaching and learning nature of science in the early childhood years. *Journal of Science Education and Technology, 20*(5), 537-549.

Akerson, V. L., Buzzelli, C. A., & Donnelly, L. A. (2010). On the nature of teaching nature of science: Preservice early childhood teachers' instruction in preschool and elementary settings. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 47*(2), 213-233.

Akerson, V. L., Cullen, T. A., & Hanson, D. L. (2009). Fostering a community of practice through a professional development program to improve elementary teachers' views of nature of science and teaching practice. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 46*(10), 1090-1113.

Akerson, V. L., Morrison, J. A., & McDuffie, A. R. (2006). One course is not enough: Preservice elementary teachers' retention of improved views of nature of science. *Journal of Research in Science Teaching, 43*(2), 194-213.

Altay, S. (2011). Preschool period and its current state in national educational council since the foundation of Turkish Republic. *Education Sciences, 6*(1), 660-672.

American Association for the Advancement of Science. (1990). *Science for all americans*. New York: Oxford University Press.

Arı, Ü. (2010). *Investigation of pre-service science teachers' and primary school teachers' views on nature of science.* Unpublished Master Thesis. Firat University, Elazig.

Aslan, O. (2009). *Science and technology teachers' views on nature of science and the reflexions of these views on classroom activities*. Unpublished doctoral thesis. Gazi University, Institute of Educational Sciences, Ankara.

Aslan, O., Yalçin, N. & Taşar, M. F. (2010). The Views of the Teachers of the Science and Technology on the Nature of Science. *Journal of Kirsehir Education Faculty, 10*(3), 181-197.

Baykara, H., & Yakar, Z. (2020). Preservice Science Teachers' Views about Scientific Inquiry: The Case of Turkey and Taiwan. *Turkish Online Journal of Qualitative Inquiry, 11*(2), 161-192.

Bell, R. L. (2009). Teaching the nature of science: Three critical questions. *Best Practices in Science Education, 22*, 1-6.

Beşli, B. (2008). *The effect of analyzing sections of the history of science on pre-service elementary science teachers' views of the nature of science.* Unpublished Master Thesis. Abant İzzet Baysal University, Bolu.

Cofré, H., Vergara, C., Lederman, N. G., Lederman, J. S., Santibáñez, D., Jiménez, J., & Yancovic, M. (2014). Improving Chilean in-service elementary teachers' understanding of nature of science using self-contained NOS and content-embedded mini-courses. *Journal of Science Teacher Education, 25*(7), 759-783.

Creswell, J. W. (2008). *Educational research planning, conducting and evaluating quantitative and qualitative research.* International Pearson Merril Prentice Hall.

Cumhur,T., Yıldırım, B., Bolat, M., & İskeleli, N. O. (2018). Opinions of Preservice Pre-School Teachers on the Nature of Science. *Anemon Mus Alparslan University Journal of Social Sciences,* 6(STEMES'18), 115-121.

Çakıcı, Y., & Bayır, E. (2012). Developing children's views of the nature of science through role play. *International Journal of Science Education, 34*(7), 1075-1091.

Dogan-Bora, N., & Abd-El-Khalick, F. (2008). Turkish grade 10 students' and science teachers' conceptions of nature of science: A national study. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 45*(10), 1083-1112.

Doğan N., Çakıroğlu J., Çavuş S., Bilican K. ve Arslan O. (2011). Developing science teachers' nature of science views: the effect of in-service teacher education program. *Hacettepe University Journal of Education, 40,* 127-139.

Doğan, N., & Özcan, M. B. (2010). Influence of Historical Perspective Approach on 7th Grade Students' Views about Nature of Science. *Journal of Kirsehir Education Faculty, 11*(4).

Doğan-Bora, N. (2005). *Investigating science teachers' and high school students' views on the nature of science in Turkey.* Unpublished Doctoral Thesis. Gazi University Institute of Educational Sciences, Ankara.

Dorji, K., Jatsho, S., Choden, P., & Tshering, P. (2022). Bhutanese science teachers' perceptions of the nature of science: a cross-sectional study. *Disciplinary and Interdisciplinary Science Education Research, 4*(1), 1-18.

Dorsah, P. (2020). Pre-service teachers'view of nature of science (nos). *European Journal of Education Studies, 7*(6).

Erdaş-Kartal, E. & Ada, E. (2018). Understandings of Preschool Teacher Candidates About Nature of Science. *Cumhuriyet International Journal of Education, 7*(1), 84-101.

Erdogan, R., Cakiroglu, J., & Tekkaya, C. (2006). Investigating Turkish Pre-service science teachers' views of the nature of science. *Research on education in Africa, the Caribbean and the Middle East,* 273-285.

Eshach, H. & Fried, M. N. (2005). Should science be taught in early childhood?. *Journal of Science Education and Technology, 14*(3), 315-336.

French, L. (2004). Science as the center of a coherent, integrated early childhood curriculum. *Early Childhood Research Quarterly, 19*(1), 138-149.

Gürses, A., Doğar, Ç. ve Yalçın, M. (2005). Nature of science and higher education students' thoughts on the nature of science. *Journal of National Education*, 166.

Johnson, B., & Christensen, L. (2014). *Education research: Qualitative, quantitative, and mixed methods.* (S. B. Demir, Trans.). Egiten Publishing, Ankara, Turkey.

Kaya, S. (2012). An examination of elementary and early childhood pre-service teachers' nature of science views. *Procedia-Social and Behavioral Sciences, 46,* 581-585.

Kenar, Z. (2008). *Prospective science teachers' views of the nature of science*. Unpublished Master Thesis, Balikesir University Institute of Science and Technology, Balıkesir.

Khishfe, R., & Abd-El-Khalick, F. (2002). Influence of explicit and reflective versus implicit inquiry-oriented instruction on sixth graders' views of nature of science. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 39*(7), 551-578.

Korkmaz, Ö., Altun, H., Usta, E., & Özkaya, A. (2014). The effect of activities in robotic applications on students' perception on the nature of science and students' metaphors related to the concept of robot. *Online Submission International Journal on New Trends in Education and Their Implications, 5*(2), 44-62.

Küçük, M. (2006). *A study toward teaching the nature of science for seventh grade primary students*. Unpublished Doctoral Thesis, Karadeniz Technical University, Institute of Science and Technology, Trabzon.

Leblebicioğlu, G., Metin, D., Çapkınoğlu, E., Çetin, P. S., Eroğlu Doğan, E., & Schwartz, R. S. (2017). Changes in students' views about nature of scientific inquiry at a science camp. *Science & Education, 26*(7), 889-917.

Lederman, J. S. (2009). Teaching scientific inquiry: Exploration, directed, guided, and opened-ended levels. *National geographic science: Best practices and research base, 8,* 20.

Lederman, N. (2007). Nature of science: Past, present, future. In S. Abell & N. Lederman (Eds.), *Handbook of research on science education* (pp. 831–879). Mahwah, NJ: Lawrence Erlbaum Associates.

Lederman, N. G., & Lederman, J. S. (2004). Revising instruction to teach nature of science. *The Science Teacher*, *71*(9), 36.

Lederman, N. G., & Lederman, J. S. (2012). Nature of scientific knowledge and scientific inquiry: Instructional capacity through professional development. In B. J. Fraser, K. Tobin, & C. J. McRobbie (Eds.), *Second international handbook of science education* (pp. 335– 359). Dordrecht, The Netherlands: Springer.

Lederman, N. G., & Lederman, J. S. (2014). Research on teaching and learning of nature of science. In *Handbook of research on science education, volume II* (pp. 614-634). Routledge.

Lederman, N. G., Bartos, S. A., & Lederman, J. S. (2014). The development, use, and interpretation of nature of science assessments. *International handbook of research in history, philosophy and science teaching*, 971-997.

Lederman, N. G., Lederman, J. S., & Antink, A. (2013). Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy. *International Journal of Education in Mathematics, Science and Technology*, *1*(3).

Lederman, NG. (1992). Students' and teachers' conceptions of the nature science. A review of the research. *Journal of Research in Science Teaching*, *29*(4), 331-359.

Lind, U. (2005). Identity and Power,'Meaning', Gender and Age: Children's creative work as a signifying practice. *Contemporary Issues in Early Childhood*, *6*(3), 256-268.

McComas, W. F. (1998). *The nature of science in science education: Rationales and Strategies*. Kluwer Academic Publishers.

McComas, W. F. (2004). Keys to teaching the nature of science. *The science teacher*, 71(9), 24.

McComas, W. F., Clough, M. P., & Almazroa, H. (2000). The role and the character of the nature of science. Bulunduğu eser: WF McComas (ed), *The Nature of Science in Science Education: Rationales and Strategies* (331-350).

Mellado, V. (1998). The classroom practice of preservice teachers and their conceptions of teaching and learning science. *Science education*, *82*(2), 197-214.

Mesci, G. (2016). *Preservice science teachers' pedagogical content knowledge for nature of science and nature of scientific inquiry: A successful case study*. Doctoral Dissertation.

Mesci, G., Çavuş-Güngören, S., & Yesildag-Hasancebi, F. (2020). Investigating the development of pre-service science teachers' NOSI views and related teaching practices. *International Journal of Science Education*, *42*(1), 50-69.

Mıcık, S. (2021). *Preschool teachers' views on the nature of science and the nature of scientific inquiry*. Doctoral Dissertation, Kastamonu Üniversitesi.

Ministry of National Education Board of Education and Discipline, MEB (2006). *Pre-School Education Program (For 36-72 Months-Old Children)*, Ankara: Directorate of State Books.

Ministry of National Education Board of Education and Discipline, MEB (2013). *Primary Education Institutions Science Course (3, 4, 5, 6, 7 and 8th Grades) Curriculum*, Ankara: Directorate of State Books.

NAAEE (North American Association for Environmental Education). 2019. *Guidelines for Excellence: K–12 Environmental Education*. Washington, DC: NAAEE.

National Research Council. [NRC]. (1996). *National science education standards*. Washington, DC: National Academy Press.

Olgan, R., Alpaslan, Z. G., & Öztekin, C. (2014). Factors Influencing Pre-Service Early Childhood Teachers' Outcome Expectancy Beliefs Regarding Science Teaching. *Education and Science*, *39*(173).

Öztaş, F. (2019). *Analysis of the scientific literacy levels of classroom teacher candidates and their views on the nature of science*. Unpublished Master Thesis. Kahramanmaras Sutcu Imam University, Kahramanmaras.

Polat, M. (2011). *Assessing views about the nature of science by vignettes: The case of prospective science teachers.* Unpublished Doctoral Dissertation, Gazi University Institute of Educational Sciences, Ankara.

Ryan, A. G. & Aikenhead, G. S. (1992). Students' Preconceptions about the Epistemology of Science, *Science Education, 76*, 559-580.

Saraç, E. (2012). *Views of the elementary teachers and preservice elementary teachers about the nature of science*. Unpublished Master Thesis. Akdeniz University, Antalya.

Schwartz, R. S., & Lederman, N. G. (2002). "It's the nature of the beast": The influence of knowledge and intentions on learning and teaching nature of science. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching, 39*(3), 205-236.

Schwartz, R. S., Lederman, N. G., & Crawford, B. A. (2004). Developing views of nature of science in an authentic context: An explicit approach to bridging the gap between nature of science and scientific inquiry. *Science Education, 88*(4), 610-645.

Sezer, E. (2019). *Investigation of the relationship between learning styles and scientific process skills of 60-72 months children.* Unpublished Master Thesis, Abant İzzet Baysal University Institute of Educational Sciences, Bolu.

Sorensen, P., Newton, L., & McCarthy, S. (2012). Developing a science teacher education course that supports student teachers' thinking and teaching about the nature of science. *Research in Science & Technological Education, 30*(1), 29-47.

Tanık-Önal, N. & Saylan-Kırmızıgül, A. (2021). Investigation of the preservice teachers' science-pseudoscience distinction and epistemological beliefs. *Journal of Pedagogical Research, 5*(3), 55-67. https://doi.org/10.33902/JPR.2021370582

WEF (2020). *World Economic Form "The Future of Jobs report"* Retrieved from https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf

Yenice, N. , Özden, B. ve Balcı, C. (2015). Examination of views about nature of science of preservice science and elementary school teachers'. *Journal of Erzincan University Faculty of Education, 17*(1) , 237-281.

Yenice, N. ve Ceren-Atmaca, A. (2017). Investigation of preservice science teachers' knowledge and views about nature of science and scientific knowledge. *Journal of Theoretical Educational Science, 10*(4), 366-393.