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Okul Öncesi Öğretmenlerinin Bilimin Doğası ve Bilimsel Sorgulamanın Doğası Hakkındaki Görüşlerinin İncelenmesi

Preschool Teachers' Views on The Nature of Science and Nature of Scientific Inquiry

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Öz

Bu çalışmanın amacı bilimin doğası ve bilimsel sorgulamanın doğası hakkında okul öncesi öğretmenlerinin görüşlerinin incelenmesidir. Araştırmanın örneklemini Türkiye'nin farklı şehirlerinde olan 20 okul öncesi öğretmeni oluşturmaktadır. Öğretmenlerin çalışmaya katılmalarında gönüllük esas alınmıştır. Verilerin toplanmasında kişisel bilgi formu, Bilimin Doğası Üzerine Görüşler Anketi-Form C (VNOS-C) ve Bilimsel Sorgulamaya İlişkin Görüş Formu (VASI)'ndan yararlanılmıştır. Araştırmada kullanılan açık uçlu anketlere paralel olarak katılımcılarla yarı yapılandırılmış görüşmeler gerçekleştirilmiştir. Anketler ve görüşmeler aracılığıyla toplanan veriler betimsel analiz yöntemi kullanılarak bütüncül bir şekilde analiz edilmiştir. Okul öncesi öğretmenlerinin bilimin doğasıyla ilgili görüşlerinin genellikle naif veya karmaşık olduğu sonucuna ulaşılmıştır. Öğretmenlerin en fazla naif görüşe sahip oldukları temaların "deneysellik", "bilimsel teori ve kanunlar' ve 'bilimde gözlem çıkarım ve teorik kabuller' olduğu görülmüştür. Bilimsel sorgulamanın doğasıyla ilgili öğretmen görüşlerinin ise genellikle bilgili düzeyde olduğu fakat öğretmenlerin görüşlerini kendi cümlelerini ile ifade edip örneklerle açıklayamadıkları ortaya koyulmuştur. En fazla bilgili görüşe sahip olunan temaların ise "çoklu bilimsel yöntemler" ve "veri ve delil" temaları olduğu bulgusuna ulaşılmıştır. Genel olarak bulgular incelendiğinde okul öncesi öğretmenlerinin bilimin doğası ve bilimsel sorgulamanın doğası konularındaki görüşlerinin istenilen düzeyde olmadığı söylenebilir.

Anahtar Kelimeler

Bilimin doğası
Bilimsel sorgulamanın doğası
Okul öncesi eğitimi
Okul öncesi öğretmenleri

Abstract

This research's aim is to examine the preschool teachers' views about the nature of science (NOS) and the nature of scientific inquiry (NOSI). The research's study group consists of 20 preschool teachers from different cities in Turkey. Volunteering was based on the participation of teachers in the study. Main data were collected with Opinions Questionnaire on the Nature of Science-Form C, and Scientific Inquiry Opinion Form. Parallel to the questionnaires used in the research, semi-structured interviews were conducted with the participants. Data collected through questionnaires and interviews were analyzed descriptive analysis method. Data were analyzed holistically. It has also been concluded that preschool teachers' views on the NOS are generally naive or mixed. It has been concluded that the themes with which the teachers had the naivest views were "empirical basis", "scientific laws and theories" and "observation, inference, and theoretical entities in science". It has been seen that teachers' views on the NOSI are generally informed level, but teachers cannot express their views in their own words and explain with examples. It was found that the themes with the most informed opinions were "multiple scientific methods" and "data and evidence" themes. When the findings were examined in general, it can be said that the preschool teachers' views on the NOS and NOSI were not at the desired level.

Keywords

Nature of science
Nature of scientific inquiry
Preschool education
Preschool teachers

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INTRODUCTION

In today's globalizing world, scientific studies continue constantly. In parallel with the ongoing scientific research, changes and developments occur in every field, and technological developments emerge (NRC, 1996). Thus, science and technology have gradually begun to dominate our lives day by day and take on a more important role in shaping the future of our world (NRC, 1996; MONE, 2005). Developments in science and technology have caused an increase in competition among countries (Huyugüzel-Çavuş, 2009). This international competition requires raising individuals more equipped with a better education for societies to develop and progress in a strong scientific and technological manner (Heckman, 2000). Science education is becoming increasingly important to keep pace with this competition (Sungur-Gül & Marulcu, 2014). For this reason, many countries, especially developed countries, carry out various reforms in science education. Turkey is among the countries that have implemented reforms in the science education program (MONE, 2005). The main aim of the reforms implemented is to raise scientifically literate individuals (Abd-El-Khalick et al., 2004; MONE, 2005).

Scientific literacy is defined as the combination of individuals' ability to understand scientific research and processes, as well as problem-solving, critical thinking and decision-making skills (NGSS, 2013). People who are science literate have an idea about the nature of science, how it is created, and how it is used (NRC, 1996). As can be understood from the definitions, two of the competencies of scientifically literate individuals are their understanding of the nature of science (NOS) and the nature of scientific inquiry (NOSI). The NOS and the NOSI are the two main components of scientific literacy (Lederman & Lederman, 2012; Lederman et al., 2013). To understand scientific literacy and to be scientifically literate, these two components must first be understood (Lederman et al., 2013).

Researchers define the NOS in different ways, so there are many different definitions (Bell et al., 2000; Lederman, 1992). The different definitions are because scientific knowledge has a dynamic structure and contains multiple structures (Khishfe & Abd-El-Khalick, 2002). In general, the NOS defines the characteristics of scientific knowledge and the values that play a role in improving scientific knowledge (Lederman, 1992). The NOS makes it possible to realize that science is testable and questionable, is supported by evidence, and can change over time (Schwartz et al., 2004). In addition to being one of the main components of scientific literacy, it has been shown that teaching the NOS makes students more interested in science and strengthens students' learning of science content (Bell & Clair, 2015; Lederman, 1999; Songer & Linn, 1991). Scientists believe that certain themes of the NOS should be emphasized in science education programs and taught to students starting from preschool (Akerson et al., 2011). These themes are as follows (Bell et al., 2000):

Table 1. Themes of NOS

Theme	Definition
Tentativenes	Scientific knowledge, no matter how reliable it is, is not certain and unchangable. The direction of research can be changed by reinterpreting the researches that have already been conducted by new developing thoughts, new observations that occur in time. The mutability of scientific knowledge includes scientific theories and laws (Lederman et al., 2002).
Empirical basis	Scientific is based on data obtained through observation and experiments (AAAS, 1990; Lederman et al., 2002). However, it is not possible to do experiments and observations in all cases. This requires the use of indirect means (Lederman et al., 2002).
Subjectivity in science	Information produced by scientists is subjective. Because the lives, experiences and perspectives of scientists have an impact on the work they do and determine how it will be stuctured (Lederman et al., 2002).
Scientific laws and theories	Theories are based on hypotheses and entities that cannot be observed in natural environments. For this reason, it cannot be tested directly (Lederman et al., 2002), and is supported by indirectly collected data (Morgil et al., 2009). Laws, on the other hand, are formed by describing the observations of events under certain conditions (Lederman & Lederman; 2012).

Observation, inference and theoretical entities in science	Observations and inferences made by scientists provide scientific knowledge (Lederman et al., 2002). While observation is descriptive expressions that reveal the relationships between events, predictions and interpretations made about events that we cannot perceive directly constitute inferences (Aydemir, 2006).
Creativity	Contrary to popular belief, science is not independent of creativity and imagination (Doğan et al., 2014). Creativity and imagination play critical role in the emergence and evolution of scientific knowledge (Lederman et al., 2002). Because scientists use their creativity and imagination at each stage of their research (Akerson & Donnelly, 2010).
Sociocultural embeddedness	Our thoughts are influenced by cultural factors (Lederman et al. 2002). Therefore, scientists can make different inferences based on the culture they have and the society they live in while creating scientific knowledge (Doğan-Bora, 2005; Lederman et al., 2002).

NOSI, the other component of scientific literacy, describes the characteristics of the processes by which scientific knowledge is produced and relates to the understanding of research (Lederman et al., 2014). Lederman and colleagues (2014) developed eight themes related to NOSI compatible with science education from preschool to undergraduate level. These themes are as follows (Table 2):

Table 2. Themes of NOSI

Theme	Definition
Begins with question	Scientific research have to begin with scientific questions and do not always need to test a hypothesis (Lederman et al., 2014).
Procedures by the question asked	The methods to be used should be chosen in a way that will lead to appropriate answers to the questions being investigated (Lederman et al., 2014).
Multiple scientific methods	There is no set methodology that scientists always use when conducting research, no single scientific method, or a set of rules that everyone must follow (NRC, 2000).
Inquiry procedures can influence results	In scientific investigations, the selected methodology will always have an impact on the findings (Lederman et al., 2014).
Same procedures may not same results	Scientific data does not have a single interpretation. Scientists using the same data can make different interpretations and inferences (Osborne et al., 2003).
Data and evidence	Scientific data are sources collected through the observations of scientists (Schwartz et al., 2008). Scientific evidence is created by analyzing and interpreting the collected data (Lederman et al., 2014).
Conclusions consistent with data	In order for the claims to be valid and reliable, the research question and the research method should be in accordance with each other (Lederman et al., 2014).
Explanations are developed from data and what is already known	Scientists make inferences by combining the data they have collected during their research with the knowledge they already have and try to reach new results (Schwartz et al., 2008).

NOSI and NOS can be integrated into science teaching as soon as science teaching starts. Research shows that young children can also learn NOS and NOSI, although developmental constraints play some role (Alan, 2014; Bell & Clair, 2015; Lederman, 2012). International documents state that students should be familiar with NOS and NOSI from an early age (AAAS, 1993; NRC, 1996; Akerson et al., 2000; Lederman, 2012). Therefore, starting from preschool, children should be educated about the NOS and NOSI (Abd-El-Khalick et al., 1998; Lederman, 2012; Lederman et al., 2019; NRC, 1996) because the preschool period has a critical effect on the development of children (Karoly et al., 2005). During this period, children develop rapidly and are open to learning (Karoly et al., 2005). Therefore, the education and experiences to be given to children in the preschool period are very important. These experiences and the quality of education allow children to develop positive attitudes towards school, learning, teachers, and themselves. Children's attitudes towards science from an early age form the basis of their scientific literacy (NRC, 1996). In the studies conducted with children in preschool and early childhood, researchers found that students did not have sufficient views; however, they revealed that students' views could be improved with appropriate education (Alan, 2014; Akerson et al., 2019; Quigley et al., 2010).

Teachers are critical in developing children's opinions on the NOS and NOSI (Hanuscin et al., 2011). Especially preschool teachers have a great responsibility in this regard (Aydemir et al., 2017). Teachers must have informed views to teach the NOS and NOSI from an early age and raise scientifically literate individuals (Akerson et al., 2010; Lederman et al., 2014). Studies show that education provided by more informed teachers improves students' views (Akerson et al., 2019; Lederman, 2002). For teachers to develop their views, studies that reveal their current views should be carried out. Although various kinds of research in the literature reveal teachers' views (Adisendjaja et al., 2017; Doğan & Abd-El-Khalick, 2008), studies investigating the pre-service teachers' views are limited. This study aims to examine preschool teachers' views about NOS and NOSI to close this gap in the literature.

METHODOLOGY

Research Design

This research is a case study to examine the views of preschool teachers about the NOS and NOSI. Case study is a qualitative approaches in which the researcher collects in-depth and detailed information (Creswell, 2013).

Study Group

Twenty preschool teachers from different parts of Turkey participated in this study. Nineteen of the participating teachers are female, and one is male. Their ages are different from each other, and their average age is 28. Eighteen of the teachers graduated from preschool education, two of them graduated from child development. The participants' professional experience periods vary. Some of these teachers continue their education with masters and Ph.D. programs. 5 of them stated that they had received in-service training or a course on the NOS and NOSI; 15 stated that they did not receive it. Seven teachers said they read about the NOS and NOSI, while 13 said they did not. In the study, code names such as T1, T2, and T3..... were used instead of teachers' names due to ethical principles.

Data Collection Tools

Questionnaires were used to determine teachers' views on NOS and NOSI, and separate semi-structured interviews were conducted per questionnaires. Semi-structured interviews were used for the teachers to explain what they meant in their answers to the questionnaires and to give examples, that is, to clarify their answers. To obtain teachers' opinions views about NOS, the Views of Nature of Science Questionnaire - Form C (VNOS-C) was used. VNOS-C was developed by Lederman et al. (2002) and adapted to Turkish by Ayvacı (2007). The form covers the seven themes of NOS (Table 1)) and consists of 10 open-ended questions. Each question was created to gather information on multiple themes related to the NOS. A semi-structured interview, lasting about 20-30 minutes, was conducted with each preschool teacher participating in the research based on their written responses to the VNOS-C.

To obtain teachers' views about NOSI the Views About Scientific Inquiry Questionnaire (VASI) was used. VASI was developed by Lederman et al. (2014) and adapted into Turkish by Mesci et al. (2020). The form covers the 8 themes of the NOSI (Table 2) and consists of 7 open-ended questions. A semi-structured interview, lasting about 20-30 minutes, was conducted with each preschool teacher participating in the research by taking the written responses to the VASI as a guide.

Data Analysis

Preschool teachers' answers to the questionnaires and data obtained from the interviews were analyzed holistically. That is, to make a judgment about the preschool teachers' views regarding each theme of NOS and NOSI put forward by the developers of the questionnaires, the teachers' answers to all questions in the relevant questionnaire were taken into account. Views of teachers about the NOS were analyzed using the rubric created by Lederman et al. (2002); views of teachers about NOSI were analyzed using the rubric created by Lederman et al. (2014).

The answers given by the teachers were classified as naive “-”, mixed “(+)” according to their views on the NOS and NOSI, and “+, ++, +++” according to the increasing understanding at the informed level (Schwartz et al., 2008). It was coded as naive "-" if the teachers' views contradicted the themes or were insufficient, and mixed "(+)" if they used conflicting expressions and were inconsistent. At the informed level, it is coded as “+” if it is limitedly compatible with the themes, “++” if the teacher can explain the theme in his own words, and “+++” if he can explain it in his own words and give correct examples (Schwartz et al., 2008). The researcher made codings, which were examined by expert science educators and revised in line with their comments.

Validity and Reliability Precautions

To increase the findings’ credibility (internal validity), the researcher worked with two field experts throughout the data analysis process. Semi-structured interview forms about the NOS and NOSI were used to provide the depth of the collected data. The data analysis process was explained in detail to increase the research’s transferability (external validity), and direct quotations from the books were used while presenting the findings. To evaluate the research’s consistency (internal reliability), the researcher and an expert analyzed 10% of the data independently (Neuendorf, 2002). Inter-coder reliability was calculated as 87% using the reliability formula of Miles and Huberman (1994) [Reliability = Consensus / (Agreement + Disagreement)]. An attempt was made to adopt a common opinion by taking the opinion of a field expert regarding the differences between the coders. To increase the confirmability (external reliability) of the research, information about the study group is presented in detail. The researchers who conducted this study are experts in science education and have knowledge and experience in conducting qualitative research.

Ethical Procedures

Ethical rules were followed in the research. Participation in the research was based on voluntary basis. Codes were used instead of the participants’ real names.

FINDINGS

Preschool Teachers' Views on The NOS

Preschool teachers’ views about the NOS were generally naive and mixed. Teachers mostly have naive views on the themes of "scientific laws and theories", "observation inference and theoretical entities in science" and "empirical basis" (Figure 1).

Empirical Basis

Considering preschool teachers’ views about the theme of "empirical basis"; 15 teachers (75%) demonstrated naive views. These teachers think that scientific knowledge depends on evidence and can only be proved with direct evidence. The view of T2, one of the teachers who had a naive view, was, “In other words, I think that for knowledge to be considered scientific or for an idea to be considered scientific, it must have been tried many times, verified, and based on proofs.” Five teachers (25%) exhibited mixed views, and their views were inconsistent. The view of T3, one of the teachers who had a mixed view, was “So how do I prove a theory or hypothesis? So, science progresses gradually. For example, we are doing a literature review. In other words, I said something about what was said before me in this way, and I proved what I said with experiments.” No teacher had an informed view.

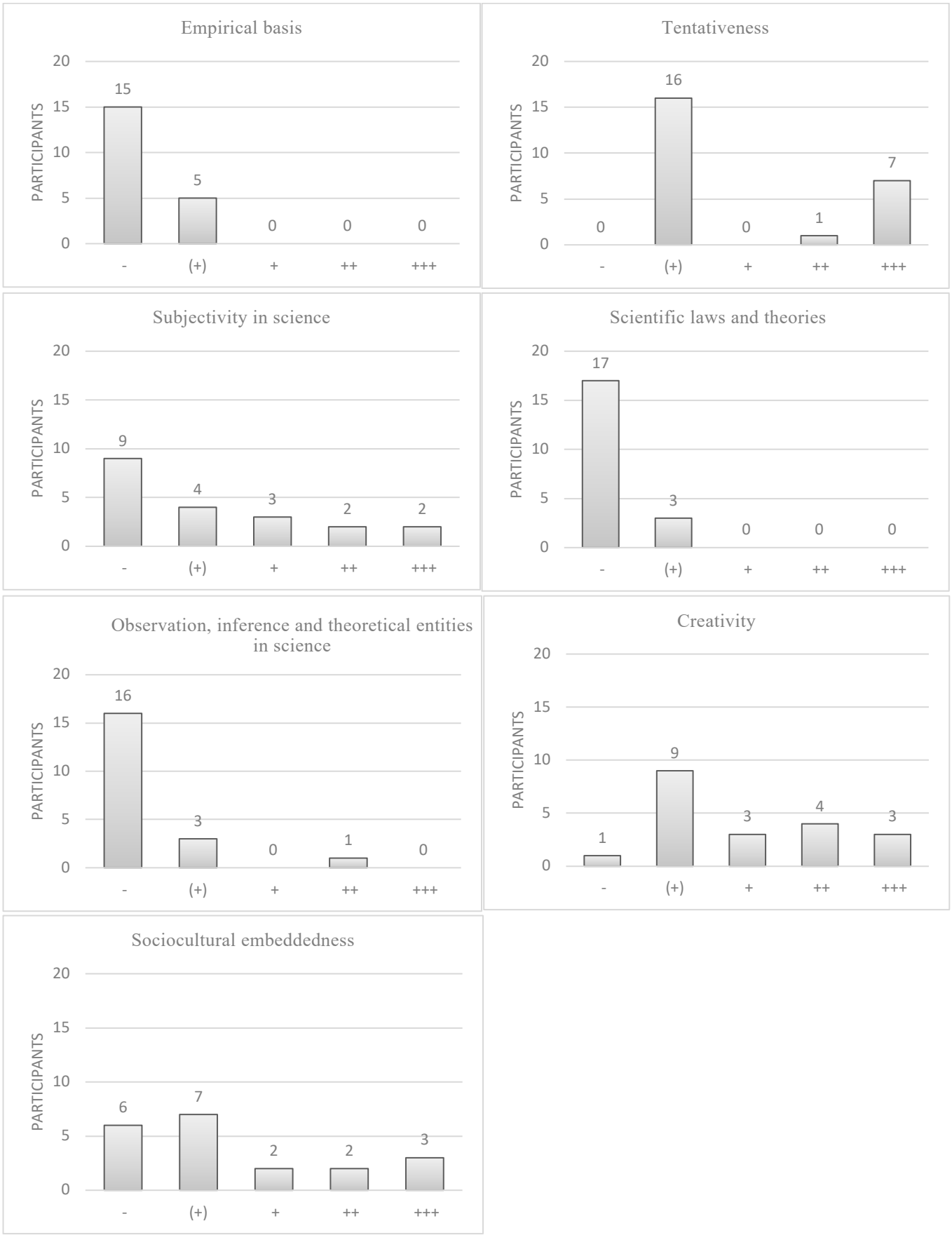

Figure 1. Percantage and frequence values of the NOS themes

Tentativeness

Considering preschool teachers' views about the theme of "tentativeness," there was no teacher with a naive view. Twelve teachers (60%) demonstrated mixed views. Teachers with mixed views stated that scientific laws cannot change, but scientific theories can. The view of T13, one of the teachers with mixed views, was, "Yes, it can change because science is not static. As long as the world exists and changes, it changes. This ensures that new ones replace the current information by developing or regressing. For example, the thought that the earth was flat before could be realized that it is round later." Eight teachers (40%) showed an informed view. There were no informed teachers who had a "+" view, there was 1 teacher (5%) with "++" and 7 teachers (35%) with "+++" view. These teachers stated that all scientific knowledge is changeable. Teachers with more conscious views explained their views by giving examples. The view of T13, one of the teachers with informed view, was, "Yes, it can change because science is not static. As long as the world exists and changes, it changes. This ensures that new ones replace the current information by developing or regressing. For example, the thought that the earth was flat before could be realized that it is round later."

Subjectivity in Science

Considering preschool teachers' views about the theme of "subjectivity in science", nine teachers (45%) demonstrated naive views. Teachers with naive views think scientists' studies should be objective, so they should not reach different conclusions. If different results are obtained, they think that the reason for this is due to the mistakes that can be made. The view of T2, one of the teachers who was naive, was, "It is not for the individual. It usually contains more objective information. It is acceptable to everyone." Four teachers (20%) had mixed views and stated that scientists' perspectives cause different research results. The view of T6, one of the teachers who held a mixed view, was "Every scientist looks at his own environment and directs the events from this aspect. For example, a scientist living in Turkey tries not to consider his traditions, but I think they somehow influence him." Seven teachers (35%) showed an informed view. Among the informed teachers, there were three teachers (15%) with "+" view, two teachers (10%) with "++", and two teachers (10%) with "+++" view. These teachers stated that the experiences of scientists, the education they received, and the influence of the societies they live in may differ from each other, and therefore they may reach different results. More informed teachers explain this by using examples. The view of K9, one of the informed teachers, was that "Science is open to different perspectives and interpretations. We can interpret an event differently with different perspectives and evidence and reveal new information. I mean, maybe they were even affected by the times they lived in, or they might have made different interpretations because of the information they got, I think."

Scientific Laws and Theories

Considering preschool teachers' views about the theme of "scientific laws and theories," seventeen teachers (85%) demonstrated naive views. These teachers stated that scientific knowledge cannot change. They believe that proven scientific theories form scientific laws and that there is a hierarchical relationship between scientific laws and theories. The view of T9, one of the teachers who had a naive view, was "Scientific law is more general, clearer concepts. I think scientific theories can change constantly. I think scientific theories should come first because science is something that is constantly changing and something that cannot be legalized." Five teachers (25%) exhibited mixed views. They believe that scientific theories can change as well as scientific laws, and they believe that there is a hierarchical relationship between them. The view of T18, one of the teachers with a mixed view, was "I think there is a difference. I think the law is more certain, that is, the general validity of which has been proved. The theory is as if it can change at any time. Although everything scientific can change, it is difficult to change the scientific law. But scientific theory is structures that can change when the opposite is put forward. Of course, the scientific law is more important; the theory lags a little more." No teacher possessed an informed view.

Observation, Inference and Theoretical Entities in Science

Considering preschool teachers' views about the theme of "observation, inference and theoretical entities in science," sixteen teachers (80%) demonstrated naive views. Teachers with naive views think indirect observation and modeling cannot be used in science. The view of T8, one of the teachers who held a naive view, was "A scientist who has proved and revealed the existence of the atom has not presented it to people without examining and proving what the atom is made of and what it contains. They have been observed and obtained by using many experimental methods. Various instruments are needed to observe atoms. They cannot be seen with the naked eye. So, they tried and tested it. They examined and proved it and presented it to people this way." Three teachers (15%) exhibited mixed views and stated that indirect observations or modeling can be used in science other than direct observation. The view of T15, one of the teachers who had a mixed view, was "Even if it is not a hundred percent, it is sure. The atom can be observed through the necessary materials. There are various methods and techniques in laboratories that we do not know or know. Through these techniques, they can do research, examine." Only one teacher (5%) showed an informed opinion. Among the informed teachers, there was no teacher with "+" and "+++" views; there was one teacher (5%) with "++" view. The teacher with this view thinks that models can be used and scientific knowledge can be formed through indirect observations, inferences, and predictions. Teacher T10, who had an informed view, said, "I think they described it correctly, assuming that there is no different claim or a different theory about this subject. They define the structure of the atoms they examine with their special microscopes. Atoms are particles too small to be seen with the naked eye. However, with the special atomic microscopes used, their shape can be estimated. I don't know much about this subject, but I think they integrate and combine according to the data they examine with a microscope."

Creativity

Considering preschool teachers' views about the theme of "creativity", only one teacher (5%) exhibited a naive opinion. Teachers with naive views stated that imagination and creativity do not affect scientific knowledge. Teacher T9, who was naive, said, "If we consider science general and universal, they should not reflect their imagination and creativity." Nine teachers demonstrated mixed views. They think imagination and creativity are used only at certain stages in science. The view of T17, one of the teachers who had a mixed view, was "Of course, yes. I think there is imagination and creativity behind every invention. Many scientists pursued their dreams as children and achieved success. We can count this as the planning part. I do not think that imagination is very useful in the application phase of scientific research and the experimental phase. It only works for raising a problem situation." Ten teachers (50%) showed an informed view. Among the informed teachers, there are three teachers (15%) with "+" view, four teachers (20%) with "++", and three teachers (15%) with "+++" view. These teachers stated that scientific knowledge was influenced by imagination and creativity at every stage of scientific research. Teachers with more knowledge explained the use of imagination and creativity at each stage with examples. The view of T4, one of the teachers who had an informed view, was "I think imagination and creativity can be used at all stages. Using their creativity and imagination makes their job easier and helpful. Using his imagination, the scientist can look at things from a much broader perspective and open up to different areas."

Sociocultural Embeddedness

Considering preschool teachers' views about the theme of "sociocultural embeddedness", six teachers (30%) demonstrated naive views. Teachers with naive views stated that science is universal. They also state that science should not be affected by socio-cultural and social values. The view of T11, one of the teachers who had a naive view, was, "I think that science is universal. Science goes on provable results, presents evidence, and collects data. Of course, there is such a thing that it can reach socially and culturally different data. In other words, a person living in Turkey and one living in Germany may not have the same ideas. It may collect different data, but since these data always go on proof, on evidence, it necessarily

reaches a universal conclusion." Seven teachers (35%) showed mixed views and stated that science could be affected by sociocultural values, but should not be affected, and that it should be universal. The view of T2, one of the teachers who had a mixed view, was "Science is affected by culture and environment, but scientific facts are universal." Seven teachers (35%) demonstrated an informed view. Among the informed teachers, there are two teachers (10%) with "+" view, two teachers (10%) with "++", and three teachers (15%) with "+++". These teachers stated that science will be affected by sociocultural values. Teachers with a more informed view gave various examples of the relationship between science and society. The view of T12, one of the informed teachers, was, "The society we live in affects everything. A structure that is not affected by society and culture is unthinkable. It is difficult for developing countries to fund research, find supporters, and conduct research without pressure. A person's point of view also shapes their comments by being influenced by the culture."

Preschool Teachers' Views on The NOSI

The views of preschool teachers regarding NOSI were generally at the level of knowledge, but they could not express their opinions in their own words and give examples. The themes with the most informed opinions are "multiple scientific methods" and "data and evidence" (Figure 2).

Begins With Question

Considering preschool teachers' views about the theme "begins with question", ten teachers (50%) şdemonstrated naive views. Teachers with naive views stated that scientific research may not always start with a question. The view of T5, one of the teachers who had a naive view, was "You don't always start with something scientific. Sometimes, it may arise out of a need or a purpose or result from something else. So, I don't think it should always start with a scientific question." Three teachers (15%) showed mixed views and seemed inconsistent on this theme. The view of T2, one of the teachers who had a mixed view, was, "No, scientific research may not always start with a scientific question. The scientific nature of the research is determined in the light of the methods used and the results achieved. But it may have initially started with a very simple question, just a little curiosity." Seven teachers (35%) exhibited an informed view. Among the informed teachers, there were two teachers (10%) with "+" view, two teachers (10%) with "++", and three teachers (15%) with "+++" view. These teachers hold the view that scientific research should begin with a question. The view of T9, one of the teachers who had an informed view, was "Yes, it should be started with a scientific question. If we start with a problem, we can reach the data we collect faster and start research."

Multiple Scientific Methods

Considering preschool teachers' views about the theme "multiple scientific methods", one teacher (5%) showed a naive view. With a naive view, the teacher stated that a single method should be used in scientific research and that there should not be more than one method. Teacher T9, who had a naive view, said, "In scientific investigation, one should go with a single method and reach its results with that method. In other words, if he uses more than one method, he may not reach a clear result, but I thought that they should proceed with a single method, reach a result, and then get a correct inference with this result. In other words, using two methods simultaneously may reach different results and confuse or not lead to an objective result. Try another method first, and then a different one is healthier." No teacher possessed a mixed view. Nineteen teachers (95%) showed an informed view. Among the informed teachers, there were 12 teachers (60%) with a "+" view, no teachers with "++", seven teachers (35%) with "+++" view. These teachers stated that more than one method should be used. More informed teachers stated that also explained their opinions by giving examples. The view of T10, one of the teachers who had an informed view, was "I think more than one research method can be used according to the type of research and the researcher."

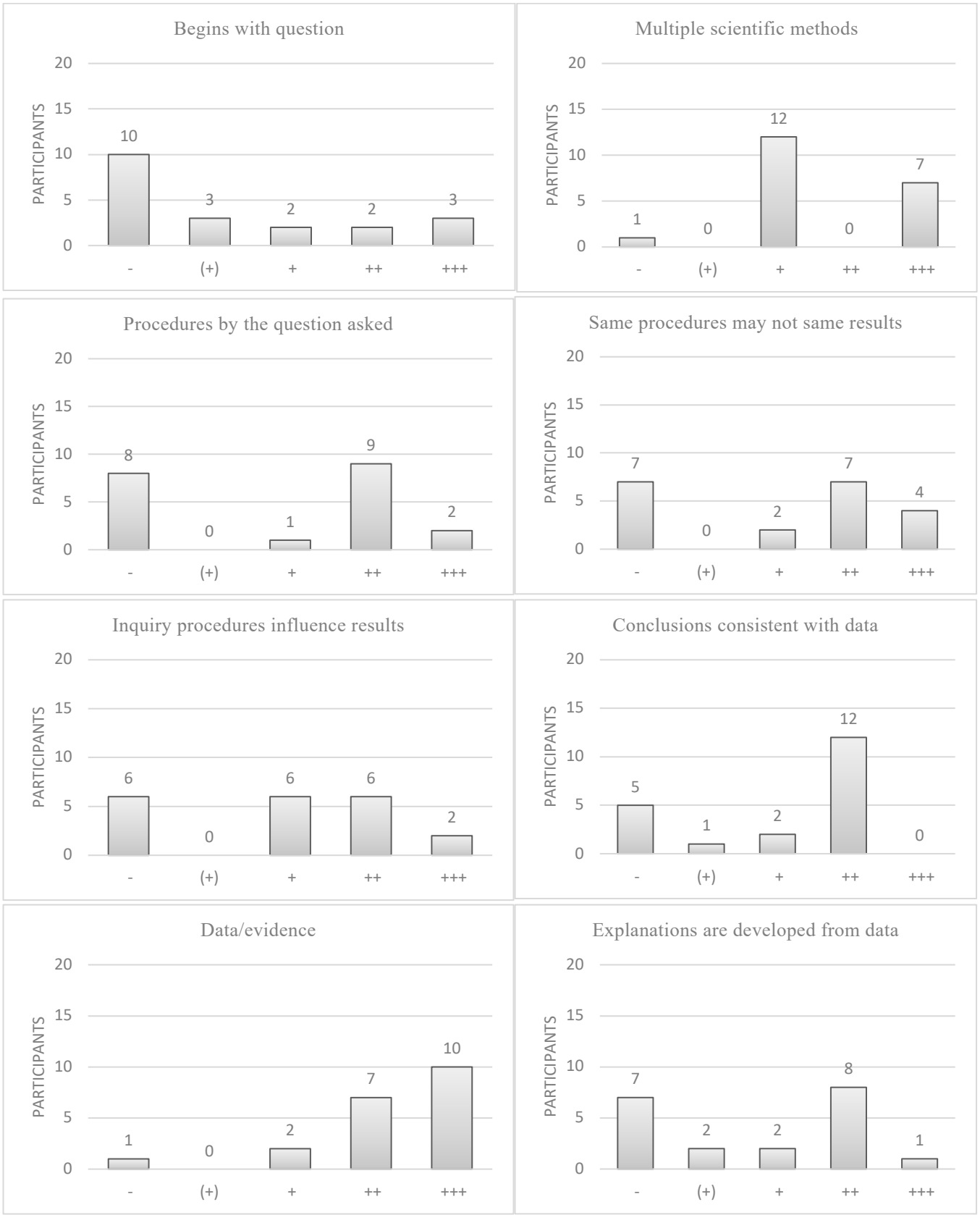

Figure 2. Percentage and frequency values of the themes of the NOSI

Procedures by The Question Asked

Considering preschool teachers' views about the theme of "procedures by the question asked", eight teachers (40%) demonstrated a naive view. It appears that teachers with naive views do not have sufficient knowledge about how questions direct the inquiry process in scientific research. The view of T16, one of the teachers who had a naive view, was “I think that one was not better than the other. I think it should be tried both ways. If we tried only one, the result would not be correct. I think we should try all kinds of methods and decide accordingly, so I think both should be tried, and a more accurate result can be achieved when both are tried.” No teacher possessed a mixed view. Twelve teachers (60%) showed informed views. Among the informed teachers, there was one teacher (5%) with a "+" view, nine teachers (45%) with "++", and two teachers (10%) with "+++" view. These teachers are also aware of the importance of the research questioning process. More informed teachers explained their opinions by giving examples. T6, one of the informed teachers, said, “Team A followed a better path by testing different brands. Because it's a more appropriate way to ask the question."

Same Procedures May Not Same Result

Considering preschool teachers' views about the theme "same procedures may not same results", seven teachers (35%) demonstrated a naive view. Teachers with naive views stated that scientific knowledge should be the same everywhere, that there is only one truth, and, therefore, the same results should be obtained in scientific studies. The view of T11, one of the teachers who had a naive view, was “I think that if they follow the same methods and investigate the same question, they will reach the same results. I think operations on the same thing on the same process will lead people to the same result.” No teacher possessed a mixed view. 13 teachers (65%) also demonstrated an informed view. Among the informed teachers, there were 2 teachers (10%) with "+" view, 7 teachers (35%) with "++", and 4 teachers (20%) with "+++" view. These teachers also think scientists can find different results even if they use the same procedures. It is seen that more knowledgeable teachers explain the subject with different examples. The view of T19, one of the teachers who had informed view, was “No, they may not reach it because the same data can be interpreted in different ways, as in the example of the extinction of the dinosaurs. I'm sure scientists who think convergent or divergent will say different things. There will inevitably be differences in interpretation.”

Inquiry Procedures Can Influence Results

Considering preschool teachers' views about the theme "inquiry procedures can influence results", six teachers (30%) exhibited a naive view. Teachers with naive views stated that the inquiry procedure would not affect the results because there was only one truth. The view of T16, one of the teachers who had a naive view, was "To have correct information, it should be able to reach the same result with different methods." There is no teacher with a mixed view. Fourteen teachers (70%) showed an informed view. Among the informed teachers, there were six teachers (30%) with "+" opinions, six teachers (30%) with "++", and two teachers (10%) with "+++" views. These teachers stated that inquiry procedures can influence the results. The view of T12, one of the teachers who had an informed view, was “They may not reach the same results. Where different methods will lead the person, how deep the research will get, and where they will carry the research cannot be known without using those methods, so we cannot say that they can reach the same result because we know the method, we know the question, but we do not know the progress of the method, so we do not know what the method will gain in the process, so they may not reach the same result.”

Conclusions Consistent with Data

Considering preschool teachers' views about the theme "conclusions consistent with data", five teachers (25%) showed naive views. It has been observed that teachers with naive views do not interpret the research results according to the data but try to interpret them based on their own knowledge. The view of T20, one of the teachers with a naive view, was “There is absolutely no proportion. According to

the ratio, it should have decreased by 20 minutes, but I think exceptions do not break the rule, so I say the 2nd option." One teacher (5%) exhibited mixed views and expressed his opinion with an inconsistent answer. The view of teacher T17, who had a mixed view, was "According to the data here, 3rd option. We do not know other variables or other factors necessary for a plant to survive, such as whether it was irrigated or its soil was sufficient. With only one variable, I couldn't make anything out of it, so that I couldn't comment. It didn't grow at all the last day it got more sunlight." Fourteen teachers (70%) had an informed view. Among the informed teachers, there were two teachers (10%) with a "+" view, 12 teachers (60%) with a "++" view, and no teacher possessing a "+++" view. It is seen that these teachers interpret the research results from the data. Those who are more informed are explained by giving various examples. In the view of T19, one of the informed teachers, "The growth of plants has nothing to do with sunlight. One of the six situations in the table prevents us from generalizing their relationship with sunlight. Because if such a generalization was to be made, it should be provided in all cases, at least for the data we have, because it would not be healthy for us to ignore the data we have."

Data and Evidence

Considering preschool teachers' views about the theme "data and evidence", one teacher (5%) demonstrated a naive view. The teacher, who has a naive view, stated that scientific evidence and data are the same. The view of teacher T15, who was naïve, was, "They are the same thing. But let me explain, it means proving something." No teacher possessed a mixed view. Nineteen teachers (95%) had an informed view. Among the informed teachers, there were two teachers (10%) with "+" view, seven teachers (35%) with "++", and ten teachers (50%) with "+++" view. Teachers who hold this view state that scientific evidence and data are different. Teachers with more informed views explain the difference between scientific evidence and data with examples. T11, one of the teachers who had an informed view, said, "Data is the information we collect when we start scientific research. So, we collect without knowing it. We have a problem or a question; we take everything that comes our way. We have never controlled the consequences of this before. We take it, we collect it, and we put it aside. But I think the evidence is clearer information that supports the research result."

Explanations are Developed from Data and What is Already Known

Considering preschool teachers' views about the theme "explanations are developed from data and what is already known", seven teachers (35%) had a naive view. Teachers with a naive view do not accept that explanations combine collected data and what is already known. The view of T15, one of the teachers who had a naive view, was "They reach it according to the data and evidence they have." 2 teachers (10%) had mixed views and made inconsistent explanations. The view of T20, one of the teachers who had a mixed view, was "I suppose they can look at the general situation in nature and explain it by basing it on evidence, or they can come to this conclusion with their thoughts by making use of their observations and experiences." 11 teachers (55%) had informed view. Among the informed teachers, there were two teachers (10%) with "+" view, eight teachers (40%) with "++", and one teacher (5%) with "+++" view. These teachers stated that the explanations would be based on combining the collected data with the previous knowledge. More informed teachers explained them with examples. The view of T3, one of the teachers with an informed view, was "They use the information they have learned before with the data they collect. In other words, they were going to research dinosaurs and already had information about them. Based on this information, they can make judgments like this is the bone structure of dinosaurs and the structure of their feet."

DISCUSSION, CONCLUSION AND SUGGESTIONS

The data analysis indicated that preschool teachers generally demonstrated naive and mixed views about the NOS and had various misconceptions. This research's results overlap with those of other studies (Cofre et al., 2014; Doğan & Abd-El-Khalick, 2008).

Preschool teachers exhibited more naive views about the NOS in the themes of "scientific laws and theories", "empirical basis" and "observation, inference and theoretical entities in science," compared to other themes. Teachers often point out that scientific theory and scientific laws are different. Teachers stated that laws are proven, certain, and unchangeable, but theories are not certain so that they can change. It is also obvious that teachers have misconceptions, such as that there is a hierarchical structure between law and theory, that laws come before theories, and that theories will turn into laws when proven. Teachers often mention that direct observations are used in science. They do not refer to indirect observations and maintain the belief that scientific knowledge needs to be proved with evidence. It is seen from the other research's results on the theme of "scientific theories and laws" are similar (Akerson et al., 2006; Liu & Lederman, 2007). The results of this research indicated that the themes on which the preschool teachers demonstrated the most informed view were "creativity" and "tentativeness" respectively. Many of the teachers stated that the use of imagination and creativity in science will provide an advantage. However, not many teachers express the use of imagination and creativity at every stage of science. On the other hand, it is seen that most of the teachers who had an informed view cannot explain their answers about the theme of imagination and creativity by giving examples. Regarding tentativeness, teachers stated that scientific knowledge is not static and open to novelties. They stated that science can evolve and change over time with the advancement of technology and studies. It is seen that most of the teachers possessing an informed view on the tentativeness explain their answers by supporting them with examples. However, teachers generally had mixed views on the changeability of scientific knowledge.

As a result, preschool teachers' views about the NOSI are generally "++" in the informed category. This means that teachers cannot explain the themes by giving examples. While this result shows similarities with some studies in the literature (Ayyılmaz-Çelik, 2019; Karışan et al., 2017), it differs from some other studies' findings (Adisendjaja et al., 2017; Mesci et al., 2020). According to the findings, preschool teachers mostly have a naive view of the theme of "begins with question". Teachers generally stated that scientific research may not start with a question. In line with the results of this study, Aydemir et al. (2017), Baykara et al. (2018), and Bostan-Sarıoğlan (2018) revealed that the participants had insufficient views on this theme. Contrarily, Karışan et al. (2017) stated that teacher candidates are mostly in the informed category in the theme of "begins with question". It is seen that some of the teachers who have a mixed view on this theme stated that scientific research should start with a question, but these questions do not have to be scientific and can be started by asking ordinary questions. Leblebicioğlu et al. (2020) encountered similar views in their studies. This shows that teachers do not consider ordinary questions as scientific. In the themes "procedures guided by the question asked", "multiple scientific methods", "data and evidence", "same procedures may not have same results", "explanations are developed from data, and what is already known", "conclusions consistent with data", and "inquiry procedures can influence results" teachers mostly exhibited informed view. More teachers have informed views on the themes of "multiple scientific methods " and "data and evidence". Preschool teachers stated that there is not single scientific method followed in research and that more than one method will be used, but many of them cannot explain their views with examples. In the theme of "data and evidence", it is seen that most of the teachers who gave informed opinions explained their opinions by supporting them with examples.

According to the research results, preschool teachers' views on the NOS and NOSI are not at the desired level and have various misconceptions. It is thought that teachers' views are not at the desired level and insufficient due to the education they receive. The research results indicated that the education given in the faculties of education is not at the desired level in providing pre-service teachers with competence on the NOS and NOSI (Heafner & Zembal, 2004; Aydemir, 2016). Therefore, it is recommended to provide in-service training to improve the current knowledge levels of in-service teachers. It is also recommended to improve the content of training programs.

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Ethics committee approval is required within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive," and all the rules stated to be followed were followed. In the meeting on 04.05.2020 numbered 36 of the Social and Human Sciences Research and Publication Ethics Committee of Kastamonu University was found to comply with the ethical principles.

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