THE EFFECTS OF PRE- AND IN-SERVICE TRAINING ON TEACHERS' UNDERSTANDING OF THE NATURE OF SCIENCE

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DECLARATION OF ORIGINALITY

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ABSTRACT

The Effects of Pre- and In-Service Training on Teachers' Understanding of the Nature of Science

This study is based on Reconceptualized Family Resemblance Approach to Nature of Science (RFN), which is the reconceptualized notion of NOS from Family Resemblance Approach (FRA) (Erduran & Dagher, 2014; Kaya & Erduran, 2016b). This study aims to investigate teachers' perceptions and understanding about the aims and values (AV), and social-institutional (SI) aspects of science, determine their educational applications and suggestions for teaching these aspects of NOS, determine their perceptions about their pre- and in-service teacher trainings, and also determine teachers' informal learning environments. A total 220 teachers participated in the quantitative part of the study; then 12 of them were selected according to their scores for the qualitative part. A 26-item NOS Questionnaire, Five Yes-No Questions, and 18 semi-structured interview questions are data sources of this study. The quantitative data analysis indicated that there is a significant difference among teachers' means considering their branches, but not for their teaching experiences, educational levels, and school types. Besides, the frequencies of 5 Yes-No Questions showed that the majority teachers do not think AV and SI categories of NOS are taught in pre-service and in-service teacher education. The qualitative data analysis showed that teachers have limited perceptions considering some categories of NOS. It was also found that even though teachers' educational applications are inadequate for teaching NOS, their suggestions for teaching NOS in school science, pre- and in-service teacher education are valuable.

ÖZET

Örgün ve Hizmet-İçi Eğitimlerin Öğretmenlerin Bilimin Doğasına İlişkin Anlayışlarına Etkisi

Bu çalışmanın teorik alt yapısı "Yeniden Kavramsallaştırılmış Aile Benzerliği Yaklaşımına Dayalı Bilimin Doğası" (RFN) yaklaşımına bağlıdır (Erduran & Dagher, 2014; Kaya & Erduran, 2016b). Bu çalışma fen branşındaki öğretmenlerin bilimin amaç ve değerleri ile sosyal ve kurumsal yönlerine ilişkin algılarını ve anlayışlarını, öğretmenlerin bilimin doğasına yönelik bu boyutlardaki eğitimsel uygulamalarını ve önerilerini, öğretmenlerin örgün ve hizmet içi öğretmen eğitimleri hakkındaki görüşlerini ve öğretmenlerin örgün olmayan öğrenim ortamlarını belirmeyi hedeflemektedir. Bu amaçlar doğrultusunda, nicel veri kaynakları için toplamda 220 öğretmen ve nicel veri sonuçlarına göre 12 öğretmen çalışmanın nitel bölümü için seçilmiştir. 26 maddeden oluşan Bilimin Doğası Anketi, 5 Evet-Hayır Soruları ile 18 yarı-yapılandırılmış görüşme soruları çalışmanın data kaynaklarıdır. Nicel veri analizlerine göre öğretmenlerin hizmet yılları, eğitim seviyeleri ve okul türleri açısından anlamlı farklılık bulunmazken, öğretmenlerin branşları açısından anlamlı fark bulunmuştur. 5 Evet-Hayır sorusuna verilen yanıtlar öğretmenlerin büyük bir çoğunluğunun bilimin amaç ve değerleri ile sosyal ve kurumsal yönlerinin öğretmen eğitiminde öğretilmediğini ortaya çıkarmıştır. Nitel analizlere göre, öğretmenlerin bilimin doğasına yönelik bazı kategorilerdeki sınırlı algıları vardır. Ayrıca, bilimin doğasına yönelik eğitim uygulamalarında yetersizlikler bulunmuştur. Ancak, öğretmenlerin bilimin doğasının fen derslerinde, örgün ve hizmet-içi öğretmen eğitimi uygulamalarındaki tavsiyeleri kayda değerdir.

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Dedicated to my dear parents, Metin Aksöz and Fatma Aksöz

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ABBREVIATIONS

AV	Aims and values of science
BIO	Biology teacher department
CHEM	Chemistry teacher department
H	High level understanding of NOS
L	Low level understanding of NOS
M	Moderate level understanding of NOS
MAG	Master graduated degree
MAS	Master student
NOS	Nature of science
PhDS	PhD Student
PHY	Physics teacher department
PRI	Private school
PU	Public school
RFN	Reconceptualized family resemblance approach to NOS
SCI	Science teacher department
SI	Social-institutional systems of science
TEACH1	0 to 5 years of teaching experience
TEACH2	6 to 10 years of teaching experience
TEACH3	11 to 15 years of teaching experience
TEACH4	16 and above years of teaching experience
UND	Undergraduate degree

CHAPTER 1

INTRODUCTION

Nature of Science (NOS) is one of the most significant issues discussed by many researchers during the history. They have different perspectives and definitions for the concept of NOS in accordance with philosophical, historical, sociological, and educational aspects (Abd-El-Khalick, Bell, & Lederman, 1998; Allchin, 2013; Duschl & Grandy, 2012; Erduran & Dagher, 2014; McComas et al., 1998). However, the framework of this study is based on a theory named Reconceptualized Family Resemblance Approach (FRA) to NOS (Erduran & Dagher, 2014) which is later named as "Reconceptualized FRA-to-NOS (RFN)" (Kaya & Erduran, 2016b). They claimed that RFN is an influential approach that advocates the importance of teaching and learning of nature of science in science education.

Erduran and Dagher, (2014) identify science as an epistemic-cognitive and social-institutional systems. The epistemic-cognitive aspects of science include the aims and values of science, scientific practices, scientific knowledge, and methods and methodological rules of science. On the other hand, the components of social-institutional aspects of are described as professional activities, scientific ethos, social certification, social values, organizational, political, and financial aspects of science. They also developed some holistic visual representations reflecting the characteristics of each category to NOS for science education. In this study, the aims and values of science and all categories in the social institutional aspects of science are the focus of the study.

Teaching and learning NOS has found one of the most significant objectives that should be gained in science education. At the beginning of the 20th century, the

American Association for the Advancement of Science [AAAS], for example, advocated that the NOS is also an important outcome in science education, with the aim of making students scientifically literate people (Howard, 1915). It is also claimed that scientific literacy requires an understanding of nature of science in school science (Allchin, 2011; Irzik & Nola, 2014). Learning NOS facilitates students' understanding of the scientific process and content of science, helps them to appreciate the value and different elements of science, enhances their sense of democratic citizenship and being part of a democratic community (Shen, 1975; Driver et al.,1996). It also orientates students to search for explanations about the events in the real world, interact with wider culture, and understand the nature of scientific knowledge (Driver et al.,1996). In that sense, understanding of nature of science by teachers is an essential and integral component of teaching it to students firstly and enabling public understanding of science secondly. So, teacher education programs have a great role in raising teachers' awareness about nature of science and developing their educational strategies to integrate NOS in science lessons.

Within this scope, the study was triggered by the questions of how science teachers understand the aims and values, and social-institutional aspects of the nature of science in accordance with their branches, teaching experiences, educational levels and school types. Besides, teachers' educational applications and suggestions for teaching these categories of NOS were also wondered. Moreover, teachers were expected to express their ideas about teaching and learning the aims and values (AV) and social-institutional (SI) aspects of science in their pre-service and in-service science educations. Finally, this study also focused on teachers' informal learning from each other.

1.1 Purpose of the study

The purpose of this study is to determine teachers' understanding and perceptions about the aims and values (AV) and social-institutional aspects (SI) of NOS considering different factors such as teachers' branches, teaching experiences, educational levels and school types by using quantitative and qualitative data sources, determine teachers educational applications and suggestions for both teaching AV and SI in school science, pre-service and in-service teacher education programs and identifying teachers' perceptions about their informal learning environments.

1.2 Significance of the study

Teaching and learning nature of science provide students to develop an understanding of how science works (Allchin, 2011). Erduran and Dagher (2014) also claimed that understanding science requires not just understanding of scientific knowledge and processes, but also understanding how we get to understand what science is. They also argue that without the inclusion of the social context of science in science education, students have limited understanding of how the scientific enterprise works and how social structures, relationships and issues influence the development of science. Hence, teachers, as a key factor in teaching and learning of these aspects of science, should be aware of how these factors affect the science and also how these factors of science can be taught in science lessons.

Even though there are many studies regarding in elementary, secondary and university level students' understanding of NOS in terms of different perspectives of NOS (Irez, 2009; Lederman et al., 2002; Murcia & Schibeci, 1999; Özden & Cavlazoğlu, 2015; Ryder & Leach, 1999; Schwartz et al., 2004). There are also considerably number of empirical studies regarding RFN based framework (Akgün, 2018; Aksoz et al., 2017; BaouJoude & Dagher, 2017; Cullinane & Erduran, 2015; Çilekrenkli, 2019; Erduran & Dagher, 2014b; Kaya & Erduran, 2016a; Kaya et. al., 2017; McDonald, 2017; Saribas & Ceyhan, 2015). However, because RFN is a fresh framework, RFN based empirical studies have generally been studied with pre-service science teacher education and elementary level science teacher education level through publishing articles and conference papers in literature. Hence, working with the science teachers with different branches, teaching experience, or educational level by focusing on their pre-service and in-service science educations makes important contribution to science education.

In the current study, two aspects of NOS were selected. The first one is the aims and values which is defined one of the epistemic-cognitive aspects of science, and the second one is social-institutional aspects of science (Erduran & Dagher, 2014). The first reason for selecting these categories is that these are more intertwined categories than others. Erduran and Dagher, (2014) were discussed social dimensions of the aims and values of science in to social-institutional aspects part of their book. Secondly, NOS based literature mainly based on epistemic-cognitive aspect of science such as scientific knowledge, methods etc. (Abd-El-Khalick, 2012; Ackerson & Donnelly, 2008; Lederman et al., 2002; Rubba & Anderson, 1978). Also, RFN based studies shows that there are deficiencies in social-institutional aspects of science in science books (Kaya & Erduran, 2016b). In order to analyze teachers' perceptions about social-institutional aspects of science focusing the issues of teachers' educational applications, education programs, and informal learning in depth by different data sources (questionnaire, interviews), only the aims and values, and social-institutional categories of RFN were focused.

It is also a well-known situation that students always wonder about why they have to learn science, the effect of learning science on their lives, or the process how scientific knowledge develops. They also wonder about scientists' lives, how they do science, in which environment science can be done, or what situations affected their studies. Because of the fact that I am also a science teacher in a public school, I always confront with these kinds of questions. I also notice that directing these kinds of questions to students also increases their learning motivations. Moreover, I have personally experienced that focusing the significance of teaching NOS in science lessons in pre-service teacher education provided me to integrate these aspects of science in my science lessons. Besides, I noticed that content of in-service teacher education programs has limited the number of science-based issues. Hence, teachers' perceptions and suggestions about their pre-service and in-service teacher education programs provide a significant contribution to organize teacher education programs. Moreover, learning more about teachers' informal learning environments enables educators to organize in-service teacher education programs in more effective ways.

1.3 Research questions

Considering the purpose of this study, the following main and sub-research questions are aimed to answer.

1. What are the science teachers' understanding of the aims and values of science and the social institutional aspects of science?

    1.1 Are there any significant differences in science teachers' understanding of the aims and values of science, and the social institutional aspects of science in accordance to science teachers' branches?

1.2 Are there any significant differences in science teachers' understanding of the aims and values of science, and the social institutional aspects of science in accordance to science teachers' teaching experiences?

1.3 Are there any significant differences in science teachers' understanding of the aims and values of science, and the social institutional aspects of science in accordance to science teachers' educational levels?

1.4 Are there any significant differences in science teachers' understanding of the aims and values of science and the social institutional aspects of science in connection with science teachers' school types?

2. How do teachers perceive the aims and values, and the social-institutional aspects of science?

2.1 How do teachers' branches, educational levels, teaching experiences, and school types have an effect of their perceptions about the aims and values of science and social institutional categories of NOS?

3. What are the teachers' perceptions about their educational applications and suggestions while teaching the aims and values and the social institutional aspects of NOS?

3.1 What are the teachers' perceptions about their educational applications and suggestions considering learning and teaching the aims and values and the social-institutional aspects of NOS in school science?

3.2 What are the teachers' perceptions about the learning and teaching the aims and values and the social-institutional aspects of NOS in pre-service and in-service teacher education programs?

3.3 What are teachers' perceptions about their informal learning environments?

1.4 Definition of key terms

Some key terms in the study are described as following:

- Nature of science (NOS): Nature of science defined in different ways by many philosophers, historians, scientists, and educators thorough history (Erduran & Dagher, 2014; Kimball, 1968; Lederman et al., 2002; Osborne, Collins, Ratcliffe, Millar, & Duschl, 2003; Irzik and Nola, 2014). However, the theoretical background of the study based on the unique definition of Erduran and Dagher's framework which defines science as an inclusion of epistemic, cognitive, and social aspects of science (Erduran & Dagher, 2014).
- Reconceptualized family resemblance approach to NOS (RFN): Erduran and Dagher (2014) reconceptualized Irzik and Nola’s (2014) “Family Resemblance Approach (FRA)” for science education by extending and adding new categories to it and they bring new definition to the nature of science. Then, Kaya and Erduran (2016b) used the term RFN (Reconceptualized Family Resemblance Approach to NOS) by synthesizing some educational applications of nature of science in science classrooms. According to RFN framework, science is defined as a epistemic-cognitive and social-institutional systems.
- Aims and values of science (AV): Erduran and Dagher (2014) explained the aims and values of science in terms of epistemic-cognitive and social dimensions. According to these researchers, objectivity, novelty, accuracy, empirical adequacy can be examples of epistemic-cognitive dimensions of the aims and values while decentralizing power, honesty and, equality of intellectual authority can be social dimension of the aims and values of science.

- Social-institutional aspects of science (SI): Erduran and Dagher (2014) explained social-institutional aspects of science by the terms of social values, scientific ethos, social certification and dissemination, professional activities, social organization and interactions, political power structures, and financial systems. All these factors enable people to learn social norms that scientist work in.
- Informal learning: Marsick and Watkins (2001) defined informal learning as the contrast of formal education that it may occur in institutions, but it is not typically classroom-based or highly structured, and control of learning rests primarily in the hands of the learner. Informal learning can be deliberately encouraged by an organization or it can take place despite an environment not highly conducive to learning.

CHAPTER 2

LITERATURE REVIEW

What is the nature of science (NOS)? How NOS can be taught in science lessons? How teaching and learning NOS affect students' understanding of science? How can NOS be taught, learned, or integrated to science lessons. These are some fundamental questions directed by science philosophers and science education researchers to understand the definition of the nature of science and possible educational strategies that can be used in science teaching context. In this context, the first section of the chapter gives information about the definition of the nature of science (NOS) by providing the major ideas, and the theoretical framework of the study which is ''Reconceptualized Family Resemblance Approach (FRA) to Nature of Science (NOS)'' (RFN). This section provides information about two aspects of RFN which are the aims and values, and the social-institutional aspects of science. The second section provides information about science teacher education programs which are pre-service and in-service teacher trainings. The third section covers the information about some implication of nature of science in science teacher education. Finally, fourth part presents teachers' informal learning environments.

2.1 Nature of science (NOS)

There have been many different views on NOS based on different philosophical views. Because of the fact that there is not a certain definition of NOS among researchers, it would be beneficial to look in depth some major perspectives about NOS. Thus, in this part ''Consensus View" (Abd-El-Khalick & Lederman, 2000), "Whole Science" (Matthews, 2012), ''Features of Science" (Allchin, 2011), and

"Reconceptualized Family Resemblance Approach to Nature of Science (RFN)" (Erduran & Dagher, 2014) are discussed to understand the definition of science.

2.1.1 Consensus view

It is one of the most dominated approach given the definition of NOS regarding to science education context. Lederman (1992) proposed some arguments based on the features of scientific knowledge. These arguments were listed by Lederman et al. (2002) as the following statements:

1. The tentative nature of scientific knowledge: Scientific knowledge, although reliable and durable, is never absolute or certain. This knowledge, including facts, theories, and laws, is subject to change.
2. Observation, inference, and theoretical entities in science: Observations are descriptive statements about natural phenomena that are directly accessible to the senses (or extensions of the senses). By contrast, inferences are statements about phenomena that are not directly accessible to the senses.
3. The theory-laden nature of scientific knowledge: Scientific knowledge is theory-laden. Scientists' theoretical and disciplinary commitments, beliefs, prior knowledge, training, experiences, and expectations actually influence their work.
4. The creative and imaginative nature of scientific knowledge: Science is empirical. Nonetheless, generating scientific knowledge also involves human imagination and creativity.

5. The social and cultural embeddedness of scientific knowledge: Science as a human enterprise is practiced in the context of a larger culture and its practitioners are the product of that culture.
6. Scientific theories and laws: Scientific theories are well-established, highly substantiated, internally consistent systems of explanations. Laws are descriptive statements of relationships among observable phenomena. Theories and laws are different kinds of knowledge and one does not become the other.
7. Myth of the scientific method: The myth of the scientific method is regularly manifested in the belief that there is a recipelike stepwise procedure that all scientists follow when they do science. This notion was explicitly debunked (Lederman et al., 2002, pp. 500–502).

Even though, many researchers agree with the seven tenets related to NOS, some researchers have pointed out some deficiencies and problems of "consensus view" of NOS (Allchin, 2011; Duschl & Grandy, 2011; Grandy & Duschl, 2007; Irzik & Nola, 2011; Matthews, 2012). For example, Allchin (2011) and Matthews (2012) were criticized the consensus view being dominantly focused on epistemological aspects of science under the NOS umbrella. According to these authors, Consensus View did not cover the sociological aspects of science in a comprehensive way. That means the issues of the politics, aims and values, professional structures, advertising, commerce and education were not mentioned in the view. Grandy and Duschl (2007) have also argued that although consensus view address observation and theory, it ignored models which have a key role in science. It can be said that consensus view provided an influential viewpoint on NOS in terms of epistemological sense, and it provided an instrument for measurement of NOS learning to researchers (Abd-el

Khalick & Lederman, 2000). However, the inadequacies of the view and the well-defined alternative perspectives provide more effective perspective to NOS research.

2.1.2 Whole science

Allchin (2011) claimed that there are also some concepts related to science such as an enterprise, motivations, fundings, peer review, validation of scientific methods, and cognitive. The author mentioned epistemic and cultural values of science as whole science. The author also noted that while the epistemic values are that "guide the pursuit and methods of science"; cultural values provided through the work of individual scientists. Allchin (2011) argue that values and science are interconnected in terms of three aspects. The first one is that epistemic values guide research, the second one is that novelty can guide scientists in their judgmental process about knowledge claims. The third one is that science itself can provide values that can contribute to society, and ethics.

2.1.3 Features of science (FOS)

Matthews (2012) changed the notion of Lederman's consensus view to features of science (FOS). The author (2012) added some new categories to FOS which are experimentation, idealization, models, mathematization, values and socio-scientific issues, technology, worldviews and religion, explanation, theory choice and rationality, feminism, realism and constructivism. By this way, it can be said that FOS focused on the epistemological, psychological, technological, historical, social, and economic aspects of NOS. Overall, the most influential approaches and alternative perspectives on the consensus view were mentioned throughout the section. Features of Science (FOS) brought a sociological sense to the concept of

NOS besides the epistemological characteristics. Moreover, the concept of Whole Science raised an awareness in terms of the social and cultural values of science.

Finally, Reconceptualized Family Resemblance Approach to Nature of Science (RFN) is introduced as a most comprehensive version of the characterization of NOS that the framework of this study is based on.

2.1.4 Reconceptualized family resemblance approach to nature of science (RFN)

Erduran and Dagher (2014)'s Family Resemblance Approach is a meta level perspective which provides a holistic picture about NOS. Erduran and Dagher (2014) identified NOS as cognitive-epistemic and social-institutional systems. They developed Irzik and Nola's (2014) FRA idea for science education by integrating some categories such as political power structures, financial systems, and social organizations and interactions. Moreover, they also developed some instructional and learning purposes to teach NOS for K-12 curriculum. Then, Kaya and Erduran (2016b) used the abbreviation of ''Reconceptualized FRA-to-NOS'' (RFN) to show the reconceptualization of FRA to NOS. This study is based on RFN due to being comprehensive and holistic approach, and also having pedagogical and instructional insight for science education.

Erduran and Dagher (2014) developed "FRA Wheel" (Fig. 1) to show the cognitive-epistemic and the social-institutional aspects of science. This wheel consists of three circles that the inner circle shows cognitive-epistemic aspects of science. These are the aims and values of science, scientific practices, methods and methodological rules of science, and scientific knowledge. On the other hand, second and third circle represent social-institutional aspects of science which are scientific ethos, social certification and dissemination, social values, professional activities, political power structures, social organization and interactions and financial systems (Erduran & Dagher, 2014). This wheel also emphasizes that there is a fluid movement across the categories of NOS which are shown as porous among the categories.

Fig. 1 FRA Wheel: Science as a cognitive-epistemic and social-institutional system

Source: Erduran & Dagher, 2014, p.28

As can be seen, FRA Wheel presents a holistic view by showing different components of NOS in a visual. Because of the fact that current study is only about the aims and values of science, and social-institutional categories of RFN, the next section provides detailed information about these categories of NOS.

2.1.4.1 Aims and values of science

Teaching and learning the aims and values of science refer to find the answer of some questions such as “What are the aims and values of science?”, “How do values function?”, “ What values are followed by scientists while doing science?”, or “How do values affect the development of scientific knowledge?" etc. Through history, the aims and values of science discussed by different perspectives (Allchin, 1999; Erduran & Dagher, 2014; Hempel 1965; Irzik & Nola, 2011; Kuhn, 1977; Popper, 1975). For example, Allchin (1999), distinguishes between epistemic and cultural values that epistemic values are those that guide the pursuit and methods of science, while cultural values enter science through the work of individual scientists. On the other hand, Irzik and Nola (2014) classify the aims and values of science as a cognitive and epistemic system.

Erduran and Dagher (2014) explained the aims and values of science considering epistemic, cognitive, social, cultural, political, ethical and moral perspectives. According to them, cognitive epistemic values have potential to guide research and because of the fact that science is a social enterprise values have role in scientists' interactions and their theory choice. By the way, the aims and values have great role in the development of knowledge production. It was interesting that according to RFN approach, science does not aim to establish moral codes or ethical norms. However, morality and ethics are considering significant in terms of making connections to socio-political contexts of science.

Erduran and Dagher (2014) developed a triangular visual to show epistemic, cognitive and social dimension of the aims and values of science as Figure 2. According to this figure, each corner of the triangular present different dimensions of the aims and values of science. This figure also emphasizes that these dimensions of the aims and values are not easily separable, so these dimensions are continuous in terms of the functions of it.

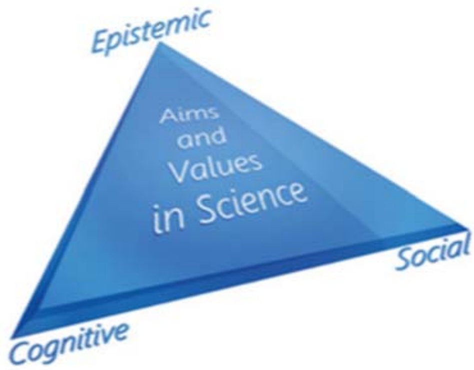

Fig. 2 Aims and values in science

Source: Erduran & Dagher, 2014, p.49

Table 1 shows that Erduran and Dagher (2014) used these terms of the concepts of objectivity, novelty, accuracy, empirical adequacy, and critical examination as epistemic-cognitive values of science by considering teaching these concepts in science education. However, addressing human needs, honesty, equality of intellectual authority and decentralizing power are the social values. Table 1 also provides information about the educational application of these concepts in science education.

According to Erduran and Dagher (2014), teaching epistemic values of science enables students to understand the importance of conducting accurate measurement and make careful observations. As a result of this, students' cognitive levels, awareness about the issues about science and also their explanatory power level increase. Besides, teaching and learning of these dimensions of science provide having a common language while doing science or engaging scientific activities. Hence, teachers as the key factors who are promoting these aspects of science should have higher level understanding regarding the different aspects of NOS.

Table 1. Application of Epistemic-Cognitive and Social Dimensions of the AV of Science in Science Education

	Aims/ Values	Educational application
Epistemic-Cognitive	Objectivity	Seeking neutrality and avoiding bias
	Novelty	Searching for new explanations
	Accuracy	Ensuring that explanations are accurate
	Empirical Adequacy	Basing claims on sufficient, relevant and plausible data
	Critical Examination	Giving reasons to justify claims
	Addressing anomalies and counter instances	Recognizing opposite ideas and responding to objections
	Taking challenges seriously	Taking opposition to own ideas seriously
Social	Addressing human needs	Considering and respecting human needs
	Decentralizing power	Making sure nobody controls ideas to favor particular group biases
	Honesty	Being honest and acting honestly in all aspects of scientific activities
	Equality of intellectual authority	Respecting all ideas as long as they are evidence-based regardless of whose ideas they are

Source: Erduran & Dagher, 2014, p.52

2.1.4.2 Social-institutional aspects of science

Social-institutional aspects of science may be seen as the newest component of the nature of science. It includes scientists' activities in both individual and in social groups, in social institutions, and exercising some social values. Irzik and Nola (2014) identify four components of science as a social-institutional system, which are professional activities, scientific ethos, social values and social certification and dissemination of scientific knowledge. On the other hand, Erduran and Dagher (2014) added some new categories to Irzik and Nola (2014)'s depiction of social-institutional systems of NOS. These are economic, political and institutional aspects of science. As a result, they describe social-institutional aspects of science by the concepts of professional activities, scientific ethos, social certification, social values, organizational, political, and financial aspects of science.

Social and institutional categories of science seen significant in school science that learning the social norms, understanding the impact of social context, social structures and scientific enterprise may promote students' holistic understanding on science (Erduran & Dagher, 2014).

The Figure 3 presents the components of social-institutional aspects of science which the visual looks similar to FRA Wheel including the all components except epistemic-cognitive categories of RFN. The core features of social-institutional aspects of science are presented by the inner circle which includes professional activities, social certification and dissemination, scientific ethos, and social values. On the other hand, broader features of social-institutional aspects of science are presented by outer circle that covers are social organizations and interactions, political power structures, and financial systems of science. Because of the fact that finance, politics, and institutions are the fundamental components of the larger society, these are elaborated components of social-institutional aspects of science. The Figure 3 shows the components of SI aspects of NOS as:

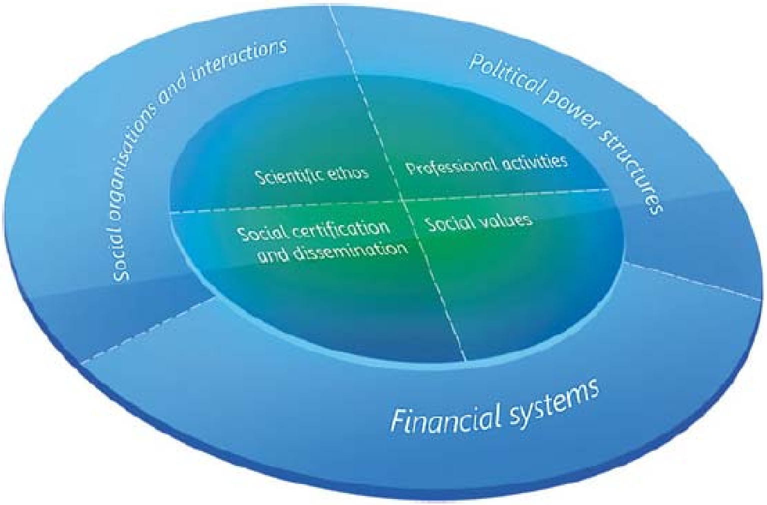

Fig. 3 Science as a social-institutional system

Source: Erduran & Dagher, 2014, p.143

The following sub-titles summarize the key aspects of the social-institutional aspects of nature of science from Erduran and Dagher (2014).

- Professional activities. Scientists produce knowledge by engaging some professional activities such as attending conferences, making presentations, writing research proposals, reviewing papers, or searching about funding (Erduran & Dagher, 2014). According to the writers, constructivist teaching approach promotes the development of scientific norms in classrooms and increase students' skills in talking and doing science.
- Social certification and dissemination: It refer to the collective and collaborative work of scientists while reviewing, criticizing and evaluating of other scientific studies.

- Scientific ethos: It refers to some attitudes that scientists are expected to display in their interactions. Nondiscrimination, animal acre, human subjects protection, respects for the intellectual property are some of them (Resnik, 2007).
- Social values: It includes the concepts of freedom, respect for the environment and social utility (Erduran & Dagher, 2014).
- Social organizations and interactions: It refers to some institutions such as universities, research centers, or some institutions such as National Aeronautics and Space Administration (NASA), Conseil Européen pour la Recherche Nucléaire (CERN), Türkiye Bilimsel ve Teknolojik Araştırma Kurumu (TÜBİTAK), the Scientific and Technological Research Council of Turkey (TUBITAK) that scientists work together. Besides, this category also emphasizes the effects of the dynamics among the scientists due to their professional or employee status on scientific study.
- Political power structures: This category covers the effects of gender, race, economic or other interests, governments' ideologies, cultural, political or social structures on the process of science. According to Erduran and Dagher (2014) understanding this category of NOS would provide students to more sophisticated understanding about how science is work.
- Financial systems: This category of RFN refers to provide funding for scientific studies and institutions. Financial resources have great role in conducting studies, meeting the needs of scientists and finding sources. Besides, governments' ideologies and attitudes towards scientific studies may affect their allocating budgets to scientific studies. Commodification and commercialization of science also consist of this category of RFN.

All in all, it is advocated that teaching social-institutional aspects of science can increase students' interests to science, enable them to understand science as a system which is affected by politic, economic, cultural and social aspects of the governments. Moreover, students' awareness towards various aspects of science such as professional activities of scientists, social values or some certification and dissemination process of scientific knowledge may increase. The following section provides information about the teacher education system in Turkey considering pre-service and in-service teacher education programs.

2.2 Teacher education in Turkey

It can be claimed that the success of any education is predominantly based on the quality of teachers (Kurbanoğlu & Akkoyunlu, 2007). Hence, teacher education programs play a significant role in developing teachers' knowledge, teaching skills, and abilities. By the developments in technology, science, and society, teacher education programs also need to be reorganized by adding some courses to formal education and also increasing the number of informal teacher education programs considering the need of societies. Hence, in the history of teacher education, some regulations were done to keep up with the requirements of the information age (Çakıroğlu & Çakıroğlu, 2003). Teacher education programs are introduced as pre-service and in-service programs as the following sections.

2.2.1 Pre-service teacher education programs

Teacher education programs are determined in Turkey by the Yükseköğretim Kurumu (YÖK), Higher Education Council, according to competencies defined by the Milli Eğitim Bakanlığı (MEB), Ministry of National Education, since 1981.

Science education programs changes four years to five years according to the fields. For example, science teacher programs are planned as four years while secondary science programs such as physics, chemistry, and biology are planned as five years as non-thesis master's programs. Science teachers generally take some science content-based lessons in their first years teaching such as general chemistry, biology, physics, astronomy, socio-scientific issues etc. according to their departments. They also take some pedagogical based lessons on their third and fourth years such as laboratory application in science, teaching chemistry, school experience in physics, assessment in science, practice teaching in biology etc. Additionally, senior students have to take many micro-teaching courses and do internship to complete their programs (YÖK, 2018).

Teachers who successfully graduated from education programs needed to obtain a sufficient score from the Kamu Personeli Seçem Sınavı (KPSS), Public Personnel Selection Examination held by Ölçme Seçme ve Yerleştirme Merkezi (ÖSYM), Measurement, Selection and Placement Center, an institution connected to the state in order to work in state schools. After fulfilling the condition of the required score, they are appointed by the MEB, which is responsible for the educational policies of the country, and they begin as science teachers in state schools. They can also apply private schools to work as science teachers (Kurbanoğlu & Akkoyunlu, 2007).

2.2.2 In-service teacher education programs

Teachers continue their vocational and professional training by in-service teacher trainings after they start their vocation (Akıllı, 2017). In-service training is the term used to describe a set of activities and requirements generally forcing on professional development (Akıllı, 2017). In-service training activities are planned and carried out by the Department of In-Service Training in the Ministry of National Education in Turkey. Saiti and Saitis (2006) claim that in-service training is the key factor in influencing the professional development of teachers and contributing to the improvement of their knowledge through an active role. In-service training activities used to be conducted solely at the national level until 1993. Then, the Ministry decided to share its authority with the cooperation of universities and non-governmental organizations in order to enhance the in-service training programs and professional development of teachers (Bayrakcı, 2009). Hence, teachers' in-service teacher trainings can show diversities according to opportunities of schools. In the current study, the effects of teachers' school types on teachers' understanding and perceptions of the aims and values and the social-institutional aspects of science are investigated.

Professional developments of teachers showed an increase after 2005 to provide adaptation to new curriculum. It was seen that the topics of in-service teacher education have mainly technological competence with the effect of Fatih Project, which started in 2010 (Günel & Tanrıverdi, 2014). Besides, distance education programs were initiated by Ministry of National Education in 2005 to support in-service teacher education programs.

Teachers have also access to the in-service teacher education programs via Millî Eğitim Bakanlığı Bilişim Sistemleri (MEBBIS), In-service Teacher Training Modules. Teachers may see the list of in-service activities they apply on the screen. They can select the type of the trainings, regular or distance trainings way, duration and district where training will be given. After the application to MEBBIS, teachers' participation must be approved by the school principle, the district national education directorate, the provincial national education directorate, and the ministry. Besides, teachers may evaluate the quality of in-service trainings they participated through MEBBIS. They can also obtain their certificates without performing an activity evaluation process. The content of the in-service teacher trainings mainly covers the topics of educational technology, teaching methods and approaches, special education, and personal development (Tunca, Alkın, & Aydın, 2015).

2.3 NOS in science teacher education

Teaching and learning NOS have been always a fundamental need in science education (Abd-El-Khalick, Bell, & Lederman, 1998; Driver, Leach, Millar, & Scott, 1996; Lederman, 1992; McComas, Clough, & Almazroa, 1998; Rubba & Anderson, 1978; Smith, Lederman, Bell, McComas, & Clough, 1997). It was seen as one of the most significant components for increasing science literacy. Hence, American Association for the Advancement of Science (AAAS) and National Research Council (NRC) supported teaching NOS and the significance of understanding science from philosophical and historical aspects by students to increase science literacy in the society (AAAS, 1989; MEB, 2018; NRC, 2012). They also emphasized teaching the process of scientific knowledge production for exploring nature and increasing the understanding between the relation between science and societies. Hence, some scientific skills such as observation, evaluation, classification, recording data, changing variables and testing, and experimentation aimed to be improved in science lessons. It was claimed that improving science literacy skills mainly depends on how much attention is paid to the nature of science in science lessons because it is seen as the essence of science literacy (Lokollo, Hermani, & Mudzakir, 2019).

Govett (2001) claimed that there is a direct relationship between the values and the ways in which they obtained the scientific knowledge. Hence, science teachers' perceptions, attitudes and knowledge about NOS have directly effects on their education, even science itself. In the literature, it was seen that there are many studies, which support teaching the NOS as a lesson in pre-service science teacher education programs (Can, Ünlü & Yıldırım, 2018; Scharmann & Haris, 1992). Tuan and Chin (1999) also proposed that teachers should develop their both understanding about NOS and educational strategies to teach NOS with an effective way, which is seen significant to training students as science literacy. Similarly, Tekin, Aslan and Yağız (2016) found that there is a correlation between the level of science literacy and critical thinking of teachers. According to them, teachers who have high level NOS understanding also have high levels critical thinking skills. So, they found that if students are aimed to gain these high level skills, teachers should have first these kinds of skills. Thus, teacher education programs play a key role in training teachers.

According to Özdemir (2007) if teachers have a positivist science approach, science would be perceived by objective, universal, observational approach, reaching knowledge by proving phenomenon with scientific methods, and not being affected by socio-cultural values. On the other hand, in order to teach students to the properties of scientific knowledge, students should provide opportunities to discover them by creating discussion environments instead of presenting them the properties of scientific knowledge directly (Wheeler-Toppen, 2005). In that sense, this study also focused on determining teachers' existence perceptions about teaching NOS in science lessons and also their suggestions to develop their educational applications.

There are also many empirical studies conducted with pre-service teachers and students to teach some concepts about the NOS determine their perceptions about NOS or develop teaching models while teaching NOS (Gücüm, 2000; Kaya & Erduran, 2016a; Kaya & Erduran, 2016b; Kaya et al., 2019; Khishfe, 2008; Lederman et al., 2002; Murcia & Schibeci, 1999; Ryder & Leach, 1999; Saribas & Ceyhan, 2015; Schwartz et al., 2004; Yakmacı & Güzel, 2000). These studies show diversities considering different NOS approaches and focus of issues. For example, Khishfe (2008)'s study was conducted with seven grade students to investigate the development in the students' NOS perceptions in terms of explicit inquiry-oriented instructional approach. It is found that the intervention provided more informed and intermediary views about NOS. On the other hand, another study (Abell & Smith, 1994) with pre-service science teachers aimed to construct understand about NOS. They used written responses of teachers about NOS questions and they found that preservice teachers have realist and positivist ideas about scientific enterprise. They also reached the conclusion that these participants have NOS based implications for their first teaching experiences.

However, there has also been research focusing on RFN based framework on NOS in science education. It was seen that significant number of RFN based studies, which are about application of FRA Framework to science lessons, curriculum analysis studies, and teacher education, pre-service teacher education studies. For example, Alayoğlu (2018) applied RFN framework into school science as an empirical study. She focused on only social-institutional aspects of science for fifth grade students for a unit as an empirical based study. It was found that students' attention to science topics and also different aspects of science increased. On the other hand, Çilekrenkli (2019) focused on teaching all epistemic-cognitive, and social-institutional aspects of science for fifth grade students as a horizontal way for a semester by using quantitative and qualitative data sources. The results indicated that the experimental group students' understanding and perceptions in experimental group about nature of science developed comparing the control group.

There are also some studies conducted with pre-service science teachers, and university students with science and non-science branches (Akgün, 2018; Aksoz, Kaya, Erduran, & Akgun, 2017; Sarıbaş & Ceyhan, 2015). For instance, Sarıbaş and Ceyhan (2015) applied scientific practices components of epistemic-cognitive aspects of NOS by using a heuristic visual, which was developed by Erduran & Dagher (2014) into science teacher education programs. They investigated pre-service science teachers' perceptions and representations of scientific practices (Kaya et. al, 2019; Sarıbaş & Ceyhan, 2015). In addition, Sarıbaş and Ceyhan (2015) conducted an auto-ethnographical study where the researchers reflected their teaching experiences for the scientific practices component of NOS and students' reactions to scientific practices represented by Benzene Ring Heuristic (Erduran & Dagher, 2014). They found that integrating scientific practices component of the NOS in pre-service teacher education programs contributed pre-service science teachers' holistic understanding about scientific practices as well as help them to see their misconceptions about ethics, the utility of scientific practices etc.

Akgün (2018), on the other hand, worked with university students with different departments as science and non-science. She reached the conclusion that even though university students' understanding does not show a significant difference in terms of their faculties, university students who are in non-science departments have higher score for many dimensions of RFN. Thus, undergraduate courses play a significant role in these results.

Moreover, Kaya, Erduran, Akgün and Aksöz (2017) have conducted an empirical study based on the RFN framework. After 14 weeks of intervention, they determined the changes in pre-service science teachers' understanding for each category of the NOS. In order to test pre-service science teachers' understanding on the NOS, they used different data sources. They have found that teaching and learning the NOS in a holistic way developed pre-service science teachers' NOS understanding. They suggested that science teacher education programs should integrate the components of RFN in their lessons. Besides, in-service science education programs based on practice of RFN should be prepared to raise awareness of science teachers.

There are also some studies about curriculum analysis based on RFN framework (BouJaoude et al. 2017; Erduran & Dagher 2014b; Kaya & Erduran 2016). The results showed that science books generally do not systematically and adequately address components of the NOS. For example, Kaya and Erduran (2016) reach the conclusion by the comparative analysis of a textbook from the USA, Ireland and Turkey that there was limited coverage of the categories of professional activities, financial systems, and political power structures in all documents. The results showed that social organizations and interactions were present only in the Turkish curriculum, and the scientific ethos category was only present in the Irish curriculum (Erduran, Dagher, & McDonald, 2019).

As a result, there are many NOS based studies considering different approaches. Even though RFN is seen as a new approach, there are many remarkable number of studies conducting a different context. This study, on the other hand makes significant contributions by focusing on teachers' perceptions about RFN based perceptions, teachers' educational applications, teacher education programs, and teachers' learning environments.

2.4 Teachers' informal learning

Informal leaning is a fundamental part of adult education because it mainly has learner-centered focus, and experiences play a key role in this type of learning. Because of the fact that experiences can be so diverse, researchers in the literature used different concepts to explain informal learning such as social modeling, self-directed learning, workplace learning, experiential learning etc. (Bandura, 1986; Candy, 1991; Eraut, 2004; Mezirow, 1991; Scribner, 1986; Wenger, 1998). On the other hand, Marsick and Watkins (2001) defined informal learning by the contrast of formal learning, which is defined in their previous study as;

> Formal learning is typically institutionally sponsored, classroom-based, and highly structured. Informal learning, a category that includes incidental learning, may occur in institutions, but it is not typically classroom-based or highly structured, and control of learning rests primarily in the hands of the learner (as cited Marsick & Watkins, 1999).

It can be said that although formal leaning is usually structured and intentional, informal leaning is based on practice, no need structured environments and can be unintentional ways. Hence, there are many studies conducted in different environments to determine the role practice informal learning of adults such as schools, museums, hospitals, universities, or different communities (Carter, 1995; Marsick and Watkins, 1999; Watkins & Cervero 2000). For example, Marsick and Watkins (2001) developed a model named "Informal and Accidental Learning Model" to enhance informal learning environments, to help people identify their learning conditions to stand effectively in the way of learning. According to them

(2001) adult educators might provide a structure within which to take advantage of the learning opportunities and gain insight into oneself as learner.

When the advantages of informal learning settings are considered, determining teachers' informal learning strategies play a key role for their professional developments. It was found that teachers' learning based studies are generally based on formal learning settings. However, some studies provided information about teachers' learning in the absence of a learning environment (Hoekstra, et. al, 2009; Richardson & Placier, 2001).

Hoekstra, Brekelmans, Beijaard, and Korthagen (2007)'s study put emphasis on teachers' informal learning. They aimed to search about the relation between teachers' learning outcomes and their learning activities in an informal learning environment. They worked with 32 experienced teachers in an informal learning environment and analyzed changes in their conceptions and behaviors in relation with teachers' learning activities. They used both quantitative and qualitative based data sources and reached the conclusion that a number of teachers contributed to a change in conceptions or behavior. According to them, a meaning-oriented mental level of activities provided the change in their conceptions as well as behavior.

There are also studies about informal leaning in the workplace. For example, Ünlühisarcıklı (2018) worked with 12 graduate student employees by face-to-face in-depth interviews. The results showed that graduate student employees learn at work by participating in various work practices, collaborating with colleagues and advisers, and meeting new challenges. All these situations provide a social learning environment where people can learn implicit knowledge by completing a particular task.

The study conducted with the professional developments of teachers showed that discrete activities such as workshops, local and national conferences, college courses, special institutes, and centers have a great effect on teachers' views (Putnam & Borko, 2000). Besides, formal and informal learning communities among teachers can act as powerful mechanisms for teacher growth and development. Desimone (2009) claimed that if teachers are provided opportunities for active learning, the effectiveness of professional development programs increases. The examples of active learning are listed as listening to a lecture, can take a number of forms, including observing expert teachers or being observed, followed by interactive feedback and discussion; reviewing student work in the topic areas being covered; and leading discussions (Desimone, 2009). Moreover, in the same study, collective participation of teachers was found effective that informal teacher educations programs.

It is crucial to understand that learning environments and methods are quite effective for teachers' professional developments while organizing teacher education programs. Studies show that informal learning environments are one of fundamental parts of adult education where teachers mostly construct their knowledge by interacting with colleagues, gaining experiences though collaborative working (Desimone, 2009; Putnam & Borko, 2000). Hence, in the current study, it is wondered about teachers' perceptions about their informal learning sources. By this way, pre-service and in-service teacher education programs may be organized considering the teachers' awareness about their learning sources, and teaching approaches, and methods.

CHAPTER 3

METHODOLOGY

This section covers the information about the research design, features of participants, the instruments, data collection and data analysis process, and some ethical considerations.

3.1 Research design

In this study, a mixed method approach is used as a research design. The definition of mixed method varies among the researchers (Greene, 2007; Johnson, Onwuegbuzie, & Turner, 2007; Rossman and Wilson, 1985). For example, some of the researchers use the terms of integrating, synthesis, quantitative and qualitative methods, multimethods or mixed methods to identify this design (Cresswell, 2014). This study focuses on the Cresswell's (2014) approach that is explained by ''mixed method approach'', which means the study consists of the collection and integration of both quantitative and qualitative data. Cresswell (2014) listed the elements of mixed method approach based on the Johnson, Onwuegbuzie, and Turner's (2007) study as involving the collection of qualitative and quantitative data in response to research questions, including analysis of both forms of data, integrating two forms of data in design analysis through merging the data and connecting the data, incorporating these procedures into a distinct mixed methods design by a philosophical theory.

Cresswell and Plano Clark (2007) also explained three types of mixed methods designs in terms of the aims of the study and the types of gathering data. These are Convergent Parallel Mixed Method, Explanatory Sequential Mixed methods, and Exploratory Sequential Mixed methods. In the current study, the Explanatory Sequential Mixed method is used to gather and analyze the data. This design involves two phases in which the first phase includes collecting quantitative data and analyzing the results, and the second one includes to use results for planning the qualitative part. By this way, it is aimed that qualitative data help to provide more depth explanation into the quantitative results (Cresswell, 2014). The next section gives information about the quantitative and qualitative parts of the mixed methods of this study in detail.

3.1.1 Quantitative research design

In the quantitative part of the study, a questionnaire was used to determine science teachers' understanding on NOS, specifically the aims and values and the social-institutional aspects of science. Cresswell (2014) describes quantitative study as an unrelated set of variables formed into propositions that specify the relationship among the variables (typically in terms of magnitude or direction). Thus, for this study, the criterion variable are science teachers' understanding on the above mentioned two aspects of NOS. On the other hand, the unrelated variables that might be their branches, teaching experiences educational levels, and school types in understanding NOS.

3.1.2 Qualitative research design

In the qualitative part of the study, semi-structured interviews referring to four dimensions of the study were conducted to participants. These are the questions on the aims and values, and the social-institutional aspects of science, teachers' educational applications, and suggestions for teaching those aspects of science, teachers' perceptions about their pre-service and in-service teacher education programs; and finally, their informal learning from each other. The framework of the qualitative study is based on the phenomenological approach which is defined as exploring in detail how participants are making sense of their personal and social world (Smith, 2015). By this way, it is aimed to reveal science teachers' perceptions of these above mentioned two aspects of science, determine their educational applications and suggestions about them, determine their perceptions about the pre-service and in-service science teacher education programs and their learning environments. In this sense, qualitative data provides a good explanation to this association.

In the current study, quantitative and qualitative data are used together to explain the results of the data. Creswell and Plano (2007) claimed that using mixed method enables a greater degree of understanding comparing to using a single approach because collecting and analyzing both quantitative and qualitative data and making connections the results of them provide philosophical outlook to researchers.

3.2 Participants

The participants of this study constitute from teachers physics, chemistry, biology and science departments in Turkey who are working in both public and private schools with different teaching experiences and educational levels. Teaching experiences vary from one to five years to 16 years and above. The educational levels also change from undergraduate to post graduate.

In the current study, different sampling methods were used for different part of the study. For the quantitative part of the study, 220 teachers participated the NOS Questionnaire by convenience and snowball sampling. Convenience sampling is a type of nonrandom sampling where members of the target population that meet certain practical criteria, such as easy accessibility, geographical proximity, availability at a given time, or the willingness to participate are included for the purpose of the study (Etikan, Musa, & Alkassim, 2016).

There were three ways in reaching the participants for quantitative part of the study. Firstly, because of the fact that the researcher is a science teacher at a public school, the NOS questionnaire was applied to science teachers who the researcher knew. The researcher also visited some schools near to her working area and applied the NOS Questionnaire by hard copies. They were all together 40 participants in this part. Researcher also expected these teachers to send the Online NOS Questionnaire to other teachers by snowball sampling. Snowball sampling is identified as a cost-effective and practically useful method that researcher asks a limited number of relatively easily accessible participants to participate other people whom the researcher has no access (Marcus, Weigelt, Hergert, Gurt, & Gelléri, 2017). By this way, about 20 more teachers participated in this study. Thirdly, the online form of the NOS Questionnaire was announced in schools by the District Directorate of National Education for the voluntary participation to this study. By this way about 70 more teachers were reached. Fourthly, the online form of the NOS Questionnaire was shared to science teacher groups by the social channels by the researcher. By this way, about 90 more teachers participated in this part of the study. Hence, in total 220 teachers constituted the participants of quantitative part of this study through convenient and snowball sampling. Table 2 shows participants' numbers and percentages who participated in the quantitative part considering some factors such as their branches, teaching experiences, educational levels and school types.

Table 2. Participant List of the Quantitative Part of the Study

Factors	Sub-categories	*n*	%
Branches	BIO	12	5.45
	CHEM	11	5
	PHY	14	6.36
	SCI	183	83.1
Teaching Experience	TEACH1	119	54.1
	TEACH2	52	23.6
	TEACH3	26	11.8
	TEACH4	23	10.45
Educational Level	UND	171	77.7
	MAS	27	12.3
	MAG	16	7.27
	PHDS	6	2.7
School Types	PRI	30	13.6
	PU	190	86.4

As it seen in Table 2, 5.45% of the participants are biology teachers, 5% of the participants are chemistry teachers, 6.36% of the participants are physics teachers, and 83.15% of the participants are science teachers. It was found that 54.1% of the participants have zero to five years of teaching experience, 23.6% of the participants have six to 10 years of teaching experience, 11.8% of the participants have 11 to 15 years of teaching experience and 10.45% of the participants have 15 and more years of teaching experiences. Besides, Table 2 gives information about teachers' educational levels. It was found that the highest ratio belongs to the undergraduate degree teachers (77.7%). Besides, 23.6% of the participants are still master students, 11.8% of the participants have master degrees, and finally 10.45% of the participants are PhD students. Additionally, in terms of school types, while 13.6% of the participants are working in private schools and 86.4% are working in public schools.

For the qualitative part of the study, 12 science teachers were selected by purposive (judgment) sampling according to their total scores on the NOS

Questionnaire. This sampling is a nonrandom technique described as the deliberate choice of a participant considering their qualities (Etikan, Musa, & Alkassim, 2016). In other words, the researcher decides the needs expected from the participants and then find the participants who provide these qualifications. In the current study, science teachers were selected based on their scores on the NOS Questionnaire as high, moderate and low. Besides, it was considered to select the participants as much as diverse in terms of their branches, teaching experiences, educational levels and school types to represent the population in a better way. Table 3 shows the participants list of the study for the qualitative part.

Table 3. Participant List of the Qualitative Part of the Study

Participant Number	Branches	Teaching Experiences	Educational Levels	School Types	NOS Questionnaire Levels
1	PHY	TEACH 2	PhDS	PRI	H
2	BIO	TEACH 4	MAG	PU	H
3	PHY	TEACH 2	UND	PU	H
4	SCI	TEACH 2	UND	PU	H
5	SCI	TEACH 2	UND	PU	M
6	CHEM	TEACH 3	UND	PU	M
7	BIO	TEACH 4	MAG	PU	M
8	CHEM	TEACH 1	MAS	PU	M
9	SCI	TEACH 2	UND	PU	L
10	SCI	TEACH 1	UND	PU	L
11	SCI	TEACH 4	UND	PU	L
12	SCI	TEACH 1	MAS	PU	L

As it seen in Table 3, there were two physics teachers, two biology teachers, two chemistry teachers, and six science teachers in accordance to their branches. Besides, three teachers had zero to five years of teaching experience, five teachers had six to 10 years of teaching experience, one teacher had 10 to 15, and finally three teachers had 15 and more years of teaching experience. In accordance with their educational level, seven teachers were undergraduate degrees, two teachers were master students, two teachers had master degrees, and one teacher was a PhD student. Finally, 2 out of 12 teachers were working in private schools and 10 of them were working in public schools. The next section provides information about the instruments, which were used for both quantitative and qualitative part of the study.

3.3 Instruments

In this study, informed consent form, quantitative and qualitative based instruments were used.

3.3.1 Informed consent form

This study was found appropriate by the INAREK/SBB Ethics Sub-Committee of Boğaziçi University (Appendix A) in terms of the health and safety of researchers, the health, safety, welfare, dignity, human rights and privacy of research participants, and the reputation of the Institute for Graduate Studies in Social Sciences as a center for properly conducted and high quality research.

Informed Consent Form (Appendix B), on the other hand, provided to participants to explain that the participation of the study is voluntarily, and participants have a right to give up any part of the study. By this way, psychological concerns of science teachers aimed to be eliminated.

3.3.2 Nature of science (NOS) questionnaire

Quantitative data was collected through Nature of Science (NOS) Questionnaire (Appendix C and D) as a hard copy or online form. The NOS Questionnaire consisted of three parts, which are "Demographic Information" (Appendix C-1), "NOS Questionnaire" (Appendix C-2), and "Yes-No Questions" (Appendix C-3), sections.

‘‘NOS Questionnaire’’ includes 26 items with five points Likert scale type were used as a quantitative instrument for this study. In the questionnaire, teachers were given five options, which are "totally agree", ‘agree’, "not sure", ‘disagree’, and "totally disagree", referring to the aims and values and the social-institutional aspects of science. Thus, it was be aimed to determine science teachers' understanding on the nature of science, specifically the above mentioned two aspects of science with the effect of some demographic variables. The questionnaire also provided some demographic information about participants, which are teachers' branches, teaching experiences, school types, and their e-mail addresses at the beginning of the questionnaire (Appendix C-1).

This questionnaire is actually a part of a survey developed by Kaya, Erduran, Aksöz, and Akgün (2019) based on the framework ‘‘Reconceptualized Family Resemblance Approach to Nature of Science (RFN)’’. In the original survey, there are 70 items which reflects five different aspects of the NOS. These aspects of NOS are the aims and values with seven items, scientific practices with 13 items, scientific knowledge with nine items, methods and methodological rules of science with nine items, and social-institutional aspects of science with 16 items. Moreover, 16 items consist of the educational application of these five categories in the science lessons. Moreover, the Cronbach's Alpha of the original NOS Questionnaire is given as .8.

However, in the current study, two aspects which are the aims and values and social-institutional aspects of nature of science constituted the focus of the study (Appendix C-2). Hence, there are 26 items which six of refer to the aims and values of science, 15 of them refer to the social-institutional aspects of science, and five of them refer to the educational applications of these two aspects of NOS. “The diversity of scientists solving a problem together means less biased results.”, “Scientists socially interact with other scientists while doing research.”, and “Internalizing scientific the aims and values enables students to understand scientific knowledge.” are some items in the NOS Questionnaire which represent the aims and values, the social-institutional aspects of science, and the educational applications of these aspects in science lessons (Kaya, Erduran, Aksöz, & Akgün, 2019). For the reliability analysis of the questionnaire, Cronbach’s Alpha value of the questionnaire reflecting the aims and values and the social-institutional aspects of NOS was measured as .65 which proves instrument’s internal consistency. Besides, for the validity of the questionnaire, two experts in science education checked the items in terms of appropriateness of the items in NOS context.

The third part (Appendix C-3) of the questionnaire includes 5 Yes or No questions which aims to calculate the frequency of participants’ voluntary participation in the in-service teacher education programs and the numbers of teachers who think the aims and values and the social-institutional aspects of science are taught in pre-service and in-service science teacher education programs as a quantitative measure.

3.3.3 Semi-structured interview questions

Qualitative data were collected by semi-structured interviews (Appendix E and F) according to results of the quantitative data. Eighteen semi-structured interview questions constitute the qualitative part of this study. The first question is an introduction question which aims to derive the demographic information about the participants. The eight interview questions are related to the aims and values, and the social-institutional aspects of science (Appendix E-1); teaching the aims and values, and the social-institutional aspects of science in science lessons (Appendix E-2); and teacher education (Appendix E-3) consisting of teaching and learning of the aims and values, and the social-institutional aspects of science in pre-service and in-service teacher education programs and also teachers' informal learning from their colleagues. "What comes to your mind when I say aims and values of science?" is the example question of determining teachers' perceptions about the aims and values aspects of science. On the other hand, "Do you believe social-institutional aspects of science are taught in pre-service teacher education programs? If yes, how is it taught? If no, how can it be taught?" are the example questions to determine teachers' perceptions about teaching the social-institutional aspects of science in their pre-service teacher education programs. The original responses of the participants are also presented in the Appendix G. The following section provides information about data collection process.

3.4 Data collection

The data collection process involves two distinct phases, quantitative, and qualitative. However, before the gathering both data sources, all participants were provided with informed consent form (Appendix B) including the general purpose of the study, the type of the data that will be collected, what teachers are expected to participate and their rights such as the option of voluntary participation, leaving the study, or keeping their names anonymously. Then, all participants were conducted to NOS Questionnaire as a hard copy or an online version. Completing the questionnaire lasted about 15 minutes.

Then, teachers' total scores of NOS were calculated for each participant, and three intervals were determined which represents high, moderate and low levels of understanding from NOS Questionnaire. The Table 4 shows the scores of the intervals, the number of participants and their frequency. Because of the fact that NOS Questionnaire has 26 items, the lowest score can be 26 and the highest score can be 130. However, when the total scores of teachers are calculated, the lowest score was found 51 and highest one was calculated 130 and the mean score was found 94. Thus, the intervals were decided considering the distribution of the number of participants and the mean score of NOS Questionnaire as it shown in Table 4.

Table 4. Teachers' Understanding of the AV and the SI Aspects of the NOS Questionnaire (*N*=220)

NOS Understanding	Score Interval	*n*	%
Low	40 - 69 points	25	11.3
Moderate	70 - 99 points	162	73.6
High	100 -130 points	33	15

According to Table 4, teachers who have low-level understanding from the NOS Questionnaire have a total NOS score between 40 - 69 points. The teachers in the moderate group have a total NOS score between 70 - 99 points, and the teachers who have high level NOS understanding have scores between 100 - 130 points.

In the second part of the study, semi-structured interviews were conducted with 12 teachers who were selected purposely in accordance with their scores as low, middle, and high levels. Also, some factors such as teachers' branches, teaching experiences, educational levels, and school types were considered in selecting the process to provide diversity among the participants. Each interview session lasted about 30 minutes. During the interview process, interviews were audio-recorded. Besides, in order to strengthen the content validity of the interview questions, a pilot study was conducted with two teachers. By this way, appropriate and non-repetitive questions were determined, and interview questions were reorganized. The next section provides information about data analysis process for different data sources.

3.5 Data analysis

Quantitative and qualitative data sources were analyzed separately. The NOS Questionnaire as a quantitative data was analyzed according to the quantitative research approach. On the other hand, the semi-structured interviews and open-ended questions in the NOS Questionnaire were analyzed according to qualitative research approach. The information about the analysis of each data source is provided following sections.

3.5.1 Quantitative data analysis

The quantitative analysis of the research includes some statistical procedural steps on the NOS Questionnaire. The questionnaire data was analyzed in terms of descriptive and inferential statistics through Statistical Program for Social Science (SPSS). Descriptive statistics was used to calculate standard deviation, kurtosis, skewness, minimum and maximum values of the questionnaire, and also the frequency of Yes or No questions in the NOS questionnaire. There are also some descriptive findings considering teachers' Yes or No answers about teaching the aims and values and the social-institutional aspects of science in pre-service and in-service teacher education programs. Besides, ANOVA was used as an inferential-statistics to compare teachers' NOS scores in terms of their branches, teaching experiences, educational levels and school types. Necessary assumptions of the ANOVA test according to Pallant (2007) are level of measurement, random sampling, independence of observations, normal distribution, and homogeneity of variance. It was found that some assumptions were not satisfied, which were normal distribution and homogeneity of variance. Hence, Brown-Forsythe Test was used as an alternative test to Levene's Test to determine equality of variance. They show differences considering the usage of dependent variables in an ANOVA Test. Such that Levene's Test uses deviation from group means which usually lead to highly skewed set of data, on the other hand, Brown-Forsythe Test makes to correct for this skewness by using deviations from group medians (Hill et al., 2006). It was also suggested by Glass and Hopkins (1996) that it is hard to determine how much data is robust when there are significant differences in variances and unequal sample sizes. So, non-parametric tests were also suggested.

3.5.2 Qualitative data analysis

The interview data was analyzed by using qualitative research approach. In order to analyze interview questions, content analysis and thematic analysis were conducted together. Content analysis is based on the contexts of the texts, which may provide to determine the general patterns of the large amount of textual information (Weber, 1990). It also enables to calculate frequency of these codes and their relationships

(Mayring, 2000). On the other hand, thematic analysis is explained by Marshall and Rossman (1999) as six steps which are organizing data, generating themes, coding data, testing emergent understanding of the data, searching for alternative explanation of the data, and writing up the data analysis. It is different from content analysis in terms of having pre-determined codes or themes which are coming from previous studies. In this study, some themes and codes showed consistency with some studies, which are based on the RFN framework (Akgün, 2018; Kaya et. al., 2019). On the other hand, some themes were formed considering the contexts of codes by open coding.

During the qualitative data analysis process, first of all, interview data was transcribed. Then, quotations were reorganized by extracting unrelated examples, words and sentences without changing the themes and codes. Marshall and Rossman (1999) proposed that this provides the content integrity in quotations to help readers to comprehend main themes and codes. Then, related categories were determined in relation to RFN framework and research questions. For example, aims and values, financial systems, political power structures etc. were the categories based on the framework. Hence, these are examples of thematic coding. However, themes were constructed considering common properties of codes by open coding. For example, TÜBİTAK, universities, technology research center, schools, private sectors, or technology parks are the codes under the theme of scientific institutions which is example of content analysis. The literature was also used as a source for additional coding to increase reliability of the study. For the reliability of the results, coding study was conducted with an expert who is familiar with RFN approach. The researcher and the expert made coding independent for the same interview. Then, the similarities and differences were contrasted. The similarity ratio was found .85.

3.6 Research permission and ethical consideration

It was paid attention that this study will not lead to any psychological, physical, sociological, legal or financial risks or problems while conducting the questionnaire and the interview questions to participants. Therefore, the possible risks tried to be eliminated or decreased by taking permission to the INAREK/SBB Ethics Sub-Committee of Boğaziçi University (Appendix A) and providing participants to Informed Consent Form (Appendix B).

The ‘‘NOS Questionnaire’’ includes a demographic information section which reflects participants’ school types, branches, teaching experiences, their educational level, and e-mail address. All the information expected from the participant is necessary to make an analysis and comparisons on science teachers’ understandings of NOS in terms of their branches, teaching experiences, etc. In the questionnaire, participants’ names were not requested. It was aimed to make the participants partially anonymous. However, in order to select the participants for interview process, participants’ e-mail addresses were requested. It was not shared with anybody and only used for asking their participation in the interview. Moreover, for the qualitative part of the study, after the interviews, names of the teachers were coded such as P1, P2, P3. Teachers’ responses were not shared with anyone.

The ‘‘NOS Questionnaire’’ was distributed to participants by hard or soft copy versions. Developed online survey program provided to keep all the survey results in a safe way. Besides, all the materials were filed and locked an online private storage channel which provides only the researcher to access to these files.

CHAPTER 4

RESULTS

This chapter includes the results of quantitative and qualitative data analysis in separate sections. Findings about each data source are presented under these sections considering the main research questions and their sub-research questions.

4.1 Quantitative results

Quantitative results include the descriptive and inferential statistics results for the two sections of NOS Questionnaire. These are 5 Likert-type scale part (Appendix C-2) and Yes-No answer questions (Appendix C-3). The results were presented under the following sections.

4.1.1 Descriptive statistics results

Descriptive statistics results include two parts. The first part is related to the first research question, namely "What is the science teachers' understanding for the aims and values and the social-institutional aspects of science?" In order to answer this research question science teachers' NOS Questionnaire scores are calculated for each category both separately and totally. Descriptive analyses are presented in Table 5 by minimum (min), maximum (max), mean, standard deviation (SD), skewness, and kurtosis values. It was found that the total "NOS Questionnaire" scores are ranged from 51 to 130 with the mean of (M = 94.17, SD = 8.309). When we look at the "Aims and Values" category of RFN, the scores ranged from 12 to 30 with the mean of (M = 20.77, SD = 3.140). For the "Social-Institutional Systems" category, the scores range from 27 to 75 with the mean of (M = 51.45, SD

= 5.299). As a final category of “Educational Application of NOS”, the scores range from 10 to 25 with the mean of (M = 21.95, SD = 2.341). That means teachers have the highest score in educational application (EA) dimension of NOS Questionnaire which is about 87.8% while two others have similar percentages, which are the aims, and values of science (AV) as 69.2% and the social-institutional aspects of science (SI) as 68.2%.

According to Tabachnick and Fidell (2007), if the skewness and kurtosis values are between -1.5 to +1.5, then the data is normally distributed. The Table 5 also shows the Skewness Value as .180 and the Kurtosis Value as .417 for the AV aspects of science, which means the means scores of AV is normally distributed. On the other hand, for SI aspects of science Skewness Value as -.357 and the Kurtosis Value as 4.912 were found. For EA aspects of science Skewness Value as -1.419 and the Kurtosis Value as 4.950 were found. Finally, for the Total NOS Scores Skewness Value as -.652 and the Kurtosis Value as 6.927 were found. Hence, it can be said that the data is not normally distributed.

Table 5. Descriptive Statistics Analysis for Total and Category Based NOS Questionnaire (N=220)

	Number of items	Min	Max	Mean	SD	Skewness	Kurtosis
Aims and Values (AV)	6	12	30	20.77	3.140	.180	.417
Social- Institutional Systems (SI)	15	27	75	51.45	5.299	-.357	4.912
Educational Application of NOS (EA)	5	10	25	21.95	2.341	-1.419	4.950
Total NOS Scores	26	51	130	94.17	8.309	-.652	6.927

When the mean scores are compared for different dimensions of the NOS Questionnaire, teachers' understanding about each AV, SI, and EA dimensions of the NOS Questionnaire are higher from the moderate level (which represent taken 3 for each item in the Likert type questionnaire). However, the highest rate belongs to EA category of NOS Questionnaire which the mean score is 21.9 out of 25.

The second part of the descriptive study includes the descriptive analyses of five questions directed to science teachers in the third part of the NOS Questionnaire. The first question is "Did you participate voluntarily in any in-service training except for compulsory in-service training?" (Q1). The second question is "Do you think that science teachers are taught the aims and values of science in undergraduate science education programs?" (Q2). The third question is "Do you think teachers are taught the aims and values of science in in-service trainings?" (Q3). The fourth question is "Do you think that teachers are taught social-institutional aspects of science in undergraduate science education programs?" (Q4). Finally, fifth question is "Do you think that teachers are taught the social and institutional aspects of science in in-service training?" (Q5). The table 6 shows the frequencies and percentages of teachers answered above questions as 'Yes' and 'No'.

Table 6. Descriptive Analysis for Teachers' Responses to 5 Yes – No Questions (N=220)

	Q1		Q2		Q3		Q4		Q5	
	f	%	f	%	f	%	f	%	f	%
Yes	100	45.5	107	48.6	51	23.2	85	38.6	51	23.2
No	120	54.5	113	51.4	169	76.8	135	61.4	169	76.8
Sum (N)	220	100	220	100	220	100	220	100	220	100

Table 6 presents that 45.5% of the teachers have participated voluntarily in an in-service training except for compulsory in-service training. That means more than half of the participants do not prefer to participate in an in-service teacher training voluntarily. For the second question, only 48.6% of the teachers also think that the aims and values of science are taught in undergraduate science education programs. It was interesting finding that this ratio decreases for in-service teacher educations that only 23.2% of the teachers think that the aims and values of science are taught in in-service trainings. Additionally, for the fourth question, only 38.6% of teachers think that the social-institutional aspects of science are taught in undergraduate science education programs. On the other hand, this ratio decreases for in-service teacher education to 23.2% for both teaching the aims and values and the social-institutional aspects of science. It is seen in the following sections that qualitative data analyses support the quantitative findings by providing justifications ideas.

4.1.2 Inferential statistics results

This section includes the inferential analyses of four sub-questions of the first research question which aims to determine whether there is a significance difference in teachers' mean scores considering their branches, teaching experiences, educational levels, and school types. One-Way ANOVA test was aimed to use for comparing the mean scores of teachers in regard to their branches, teaching experiences, educational levels, and school types. Before applying the One-Way ANOVA, some assumptions were checked before testing the research questions. Pallant (2007) explains the assumptions of one-way ANOVA by the items of level of measurement, random sampling, independence of observations, normal distribution, and homogeneity of variance.

The first assumption (a) was satisfied because independent variables are teachers' branches, teaching experiences, educational levels, and school types which are interval level variables while dependent variables are the AV, SI, EA or Total NOS scores obtained from the NOS Questionnaire which are continuous variable. The second assumption (b) was also provided by selecting science teachers randomly from different schools, branches, teaching experiences and educational levels. Especially, online channels in sampling provided random sampling. The third assumption (c) was also satisfied because each participant takes the questionnaire separately and they have not interaction in both between and within groups. On the other hand, the fourth assumption (d) was not satisfied due to the data were not normally distributed. Besides, five assumption (e) was also not satisfied by Levene's test due to the variance of the population were not equal. Hence, Brown-Forsythe Test were used to violate the assumption of equality of variances (Hill, et. Al, 2006). On the other hand, the usage of this test may lead to robust when there is a significant difference in variances.

Four sub-questions of the first research question were answered by using ANOVA to compare means of groups which teachers' branches, teaching experiences, educational levels, and school types. All results about these categories are presented in the following sub-titles.

4.1.2.1 Inferential analysis of teachers' branches

"Are there any significant differences in science teachers' understanding of the aims and values and social-institutional aspects of science in accordance to science teachers' branches?" was the first sub-research question of the first main research question. Table 7 provides the findings of ANOVA test for teachers' branches according to each dimensions of NOS Questionnaire.

Table 7. One Way ANOVA Test for the Teachers' Branches in terms of Each Dimension of NOS Questionnaire (N=220)

Category	Source	SS	df	MS	F	Sig.
Aims and Values (AV)	Between Groups	45.742	3	15.247	1.559	.200
	Within Groups	2112.895	216	9.782		
	Total	2158.636	219			
Social-Institutional (SI)	Between Groups	170.228	3	56.743	2.050	.108
	Within Groups	5980.118	216	27.686		
	Total	6150.345	219			
Educational Applications (EA)	Between Groups	122.010	3	40.670	8.146	.000
	Within Groups	1078.440	216	4.993		
	Total	1200.450	219			
TOTAL	Between Groups	701.117	3	233.706	3.501	.016
	Within Groups	14417.660	216	66.748		
	Total	15118.777	219			

The results indicated that there was no significant difference among the teachers who work in biology, chemistry, physics, and science departments in terms of the scores taken AV (F(3, 216 = 1.559, P > .05) and SI (F(3, 216 = 2.050, P > .05) dimension of NOS Questionnaire. On the other hand, there was found a significant difference among the teachers who had different branches in terms of the scores taken EA (F(3, 216 = 8.146, P < .05) and Total NOS Scores (F(3, 216 = 3.501, P < .05). Tukey's *HSD* was used to determine the nature of differences between branches. This analysis revealed that biology teachers (*m* = 19.08, *sd* = 4.77) scored lower than chemistry (*m* = 23.27, *sd* = 1.85), physics (*m* = 22.43, *sd* = 2.14), and science teachers (*m* = 22.02, *sd* = 2,01), which made significant difference for EA dimension of NOS Questionnaire. It is similar for Total NOS Scores that biology teachers (*m* = 87.08, *sd* = 17.88) scored lower than chemistry (*m* = 95.64, *sd* = 9.37), physics (*m* = 96.36, *sd* = 7.65), and science teachers (*m* = 94.38 *sd* = 7.13).

4.1.2.2 Inferential analysis of teachers' teaching experiences

"Are there any significant differences in science teachers' understanding of the aims and values and the social-institutional aspects of science in accordance to science teachers' teaching experiences?" is the other second sub-research question of the first main research question. Table 8 provides the findings of ANOVA test for teachers' teaching experiences according to each dimensions of NOS Questionnaire.

Table 8. One Way ANOVA Test for the Teachers' Teaching Experiences in terms of Each Dimension of NOS Questionnaire (N=220)

Category	Source	SS	df	MS	F	Sig.
Aims and Values (AV)	Between Groups	67.264	3	22.421	2.316	.077
	Within Groups	2091.372	216	9.682		
	Total	2158.636	219			
Social-Institutional (SI)	Between Groups	114.341	3	38.114	1.364	.255
	Within Groups	6036.004	216	27.944		
	Total	6150.345	219			
Educational Applications (EA)	Between Groups	4.453	3	1.484	.268	.848
	Within Groups	1195.997	216	5.537		
	Total	1200.450	219			
TOTAL	Between Groups	89.576	3	29.859	.429	.732
	Within Groups	15029.202	216	69.580		
	Total	15118.777	219			

The results indicated that there was no significant difference among the teachers who have teaching experiences between zero to five years, six to 10 years, 11 to 15 years, and 16 and more years in terms of the scores taken AV (*F*(3, 216 = 2.316, P > .05), SI (*F*(3, 216 = 1.364, P > .05), EA (*F*(3, 216 = .268, P > .05), and Total NOS Scores (*F*(3, 216 = .429, P > .05).

4.1.2.3 Inferential analysis of teachers' educational levels

"Are there any significant differences in science teachers' understanding of the aims and values and the social-institutional aspects of science in accordance to science teachers' educational level?" is the third sub-research question of first main research question.

Table 9. One Way ANOVA Test for the Teachers' Teaching Educational Levels in Terms of Each Dimension of NOS Questionnaire (N=220)

Category	Source	SS	df	MS	F	Sig.
Aims and Values (AV)	Between Groups	65.371	3	21.790	2.249	.084
	Within Groups	2093.265	216	9.691		
	Total	2158.636	219			
Social-Institutional (SI)	Between Groups	25.335	3	8.445	.298	.827
	Within Groups	6125.011	216	28.357		
	Total	6150.345	219			
Educational Applications (EA)	Between Groups	.816	3	.272	.049	.986
	Within Groups	1199.634	216	5.554		
	Total	1200.450	219			
TOTAL	Between Groups	156.128	3	52.043	.751	.523
	Within Groups	14962.649	216	69.272		
	Total	15118.777	219			

Table 9 gives information about the findings of ANOVA test for teachers' educational levels according to each dimensions of NOS Questionnaire. The results indicated that there was no significant difference among the teachers who are undergraduate degree, master student, master graduated, and PhD level students in terms of the scores taken AV (F(3, 216 = 2.249, P > .05), SI (F(3, 216 = .298, P > .05), EA (F(3, 216 = .049, P > .05), and Total NOS Scores (F(3, 216 = .751, P > .05).

4.1.2.4 Inferential analysis of teachers' school types

"Are there any significant differences in science teachers' understanding of the aims and values and the social-institutional aspects of science in connection with science teachers' school types?" is the final sub-research question for the first main research question. Table 10 enables to see ANOVA results according to teachers' school types, which are private and public.

One-way between-subjects ANCOVA was calculated to examine the effect of science teachers' school types on their understanding of the aims and values of science, the social-institutional aspects of science, the educational applications of the NOS and total understanding of RFN related categories of NOS. The results indicate that there was no significant difference among the teachers who are working in private and public schools in terms of the scores taken AV (F(3, 216 = .679, P > .05), SI (F(3, 216 = .003, P > .05), EA (F(3, 216 = .142, P > .05), and Total NOS Scores (F(3, 216 = .813, P > .05).

Table 10. One Way ANOVA Test for the Teachers' School Types in terms of Each Dimension of NOS Questionnaire (N=220)

Category	Source	SS	df	MS	F	Sig.
Aims and Values (AV)	Between Groups	6.707	1	6.707	.679	.411
	Within Groups	2151.930	218	9.871		
	Total	215.636	219			
Social-Institutional (SI)	Between Groups	.072	1	.072	.003	.960
	Within Groups	6150.274	218	28.212		
	Total	6150.345	219			
Educational Applications (EA)	Between Groups	.782	1	.782	.142	.707
	Within Groups	1199.668	218	5.503		
	Total	1200.450	219			
TOTAL	Between Groups	3.895	1	3.895	.056	.813
	Within Groups	15114.882	218	69.334		
	Total	15118.777	219			

In summary, descriptive analysis provided information about the number of the items with minimum, maximum, mean, skewness and kurtosis. It was seen that the number of items show diversities, and this results in data were not distributed normally. On the other hand, the highest mean ratio belongs to EA dimension of the NOS Questionnaire. The frequency of Yes-No questions on the other hand, provided information about what percentages of the teachers think the aims and values of science and the social-institutional aspects of science are taught in pre-service and in-service teacher education. It was interesting that more than half of the teachers do not believe these aspects of NOS are taught in teacher education. Qualitative study provides more information about the reasons for these results.

On the other hand, inferential statistics showed that there is no significance difference in the mean scores of teachers' considering their teaching experiences, educational levels, and school types. However, it was found there is only a significant difference in teachers' branches in terms of EA and Total NOS score categories of the NOS Questionnaire. The reasons maybe due to the fact that there is limited number of items for each categories of the NOS Questionnaire and also the diverse number of teachers considering their branches, teaching experiences, educational levels, and school types. The next section presents the findings of the qualitative data sources by referring the third, fourth, fifth, and sixth main research questions.

4.2 Qualitative results

This section includes the results of the qualitative data analyses through the interviews conducted with 12 science teachers. After directing 17 questions to participants, the main themes, codes and sub-codes were constructed considering teachers' responses. The responses of the participants are analyzed under four parts. The first part includes (4.2.1) science teachers' perceptions about the aims and values, and the social-institutional aspects of science. The second part represents (4.2.2) science teachers' educational applications and suggestions for teaching the aims and values and the social-institutional aspects of science in science lessons. The third part includes (4.2.3) teachers' perceptions about the teacher education programs teaching the aims and values, and the social-institutional categories of science in pre-service and in-service teacher education programs. Finally, the fourth section (4.2.4) covers teachers' perceptions about their informal learning from each other. In each section, some related tables and quotes are also given to show the effects of science teachers' branches, educational levels, teaching experiences, or school types on their perceptions. Table 11 also reminds the information about the abbreviations that are used in the end of each quotes to describe the characteristics of the science teachers.

Table 11. Abbreviations for the Participants

Abbreviation	Categories	Explanation
H	NOS understanding	High level understanding of NOS
M		Moderate level understanding of NOS
L		Low level understanding of NOS
BIO	Branches	Biology
CHEM		Chemistry
PHY		Physics
SCI		Science
MAG	Educational level	Master Graduated
MAS		Master Student
PhDS		PhD Student
UND		Undergraduate
PRI	School Types	Private School
PU		Public School
TEACH1	Teaching experience	0 to 5 years
TEACH2		6 to 10 years
TEACH3		11 to 15 years
TEACH4		16 and above

For example; P8 –- M-CHEM-MAS-PU-TECH1 represent participant 8 who has a moderate level NOS understanding through NOS Questionnaire, is chemistry teacher, master student, works in public school, and have between zero to five years of teaching experiences. The following section present the results obtained through qualitative data sources.

4.2.1 Science teachers' perceptions about the aims and values and the social-institutional aspects of science

This section aims to answer of second main research question which is "How do teachers perceive the aims and values, and the social-institutional aspects of science?", and also sub-research question of the second main question. It is "How teachers' branches, educational levels, teaching experiences, and school types have an effect of their perceptions about the aims and values of science and the social institutional categories of NOS?". In order to answer these above research questions, teachers were directed eight questions to determine their perceptions about the aims and values and the social-institutional aspects of science. In the following sections science teachers' perceptions about the aims and values and the social-institutional aspects of science are presented separately by sub-titles.

4.2.1.1 Science teachers' perceptions about the aims and values of science

Teachers were asked to "What comes to your mind when I say the aims and values of science? Could you give some examples?" to determine their perceptions about the aims and values of science. This question intends to answer the second main research question as written above.

Table 12 shows the most frequent themes and codes obtained from science teachers' responses from the above questions. This table gives the information about the general trends about the science teachers' perceptions about the aims and values of science. Table 12 includes the explanation of the themes, which were written considering the participants' responses for the related codes. This table also informs the readers about the response rates for each code in terms of science teachers' NOS understanding obtained from NOS Questionnaire which are high, moderate, and low. By this way, it is aimed to present the coherence between quantitative and qualitative results by comparing the response rates for each level. Because of the fact that this study is also wonder about the effects of teachers' educational level, branches, teaching experiences, and school types on their NOS understanding, some other tables were also formed to show if the rates of codes change considering these factors.

As it seen in the Table 12, most of the teachers held similar ideas about the aims of science. Serving the humanity, understanding the universe and reaching certain knowledge are the most common themes obtained from teachers' responses regarding the first question. It is found that 88.33% of the teachers explained the aims of science as serving the humanity. This meant that science can be done for meeting the needs of society, solving the problems, providing a better future, making life easier by the development of technology, satisfying one's the sense of curiosity, or increasing the development of a country. For example, one of the chemistry teachers explained the aims of science as:

> When you say aims of science, health is coming up to my mind as a first thing, then research about healthiness. Treatment of people and diseases... It seems to me more like science. Actually physics, biology, of course, all of them are important things, but I see the studies on health as more valuable. (P8 –- M-CHEM-MAS-PU-TEACH1) (Appendix D1)

The above teacher thought that the aim of science mainly is based on serving to humanity by health services. On the other hand, understanding the universe was found as the second most general theme for describing the aims of science. Eight out of 12 teachers explained the aims of science as explaining the natural phenomenon, exploring the unknown aspects of the nature, reaching certain rules and facts, and making sense of the events of their surroundings.

Table 12. The Codes for the Teachers' Perceptions of the AV of Science (N=12)

Themes	Explanation of the codes	High		Moderate		Low		Total	
		N_H=4	%	N_M = 4	%	N_L=4	%	N_T	%
Serving the humanity (aim)	Meeting the needs of society, solving the problems, providing a better future, making life easier by the development of technology, satisfying one's the sense of curiosity, or increasing the development of a country	3	75	4	100	3	75	10	83.3
Understanding the universe (aim)	As explaining the natural phenomenon, exploring the unknown aspects of the nature, reaching certain rules and facts, and making sense of the events of their surroundings.	3	75	3	75	2	25	8	66.6
Increasing science literacy (aim)	Preventing dogmatic thinking, enable people to develop their thinking skills, to make concerns about their environment, to make inferences based on scientific data, and to live without metaphysics ideas	1	25	2	50	0	0	3	25
Ethics (values)	A set of moral issues or values that include concerns about human and animal rights, convenience level of the human behavior in terms of the related context	3	75	3	75	4	100	10	83.3
Objectivity, being realistic, Accuracy and honesty. (values)	The characteristic of scientific claims which are independent from cultural and religious values	2	50	3	75	0	0	5	41.6
Pragmatism (values)	Considering the benefits of society	2	50	1	25	1	25	4	33.3
Universality (values)	Being consistent in everywhere	0	0	1	25	1	25	2	16.6
Total		14		17		11			

It was found that physics teachers explained the aims of science by understanding nature and also serving the humanity. On the other hand, three out of 12 of teachers though that science aims to increase science literacy in the society. According to them, science should be done to prevent dogmatic thinking, enable people to develop their thinking skills, to make concerns about their environment, to make inferences based on scientific data, and to live without metaphysics ideas. For instance, one of the science teachers explained the aims of science as;

> Science aims to reach true information so it must be based upon scientific data than rumors. However, it is not enough. Those truths should be told to people. So, what we call science literacy goes through here. When a person makes science, he thinks more realistically, he does not believe what he heard, ask questions and search about them. Thus, he does not shape his life according to unreal rumors.
> (P12 –L-SCI-MAS-PRI-TEACH1) (Appendix D2)

As it seen in the above quotation, the main reason for doing science is to reach certain knowledge and increase the science literacy in the society.

When science teachers were asked to their ideas about values of science, it was seen that 83.3% of the teachers perceived the values of science as ethics. Ethics meant that some rules for respecting the environment, human nature, animal care, human rights, and also caring some procedures while conducting research such as taking permission to participation, preventing plagiarism, or accurate reporting etc. For example, one of the teachers explained the values of science as,

> Science has ethical values, so science does studies, finds something but it has to use them for the benefit of the people. In other words, it should not harm others just for their own interests. It would be against science if it harms others just for their own benefit.
> (P6—M-CHEM-UND-PU-TEACH3) (Appendix D3)

According to above teacher, science should have some ethics rules to serve humanity. Otherwise, scientists may consider their interests. On the other hand, it was interesting result that one the teachers disagreed with the idea that science does not have some certain rules such as ethics. According to him, rules can prevent the development of science so the rules should be changeable based on the development of technology and civilization. Teacher explained his ideas as the following excerpt,

> I'm not sure whether science should have an ethics or not. Because if it has, where will it take us, is it good for people? If we stop the construction of weapons, if we forbid it, that tomorrow we will need a weapon in the product of a meteorite or even a clever extra-terrestrials (even if it is very low, a thousand possibility) during the invasion of the world and it will be very difficult to produce from scratch. There must be rules of science, but they can changeable. From what I've read, a very rapid artificial evolutionary process is waiting for us in the next 100 years, 200 years.
> (P10—L-SCI-UND-PU-TEACH2) (Appendix D4)

On the other hand, eight out of 12 teachers explained the values of science by the properties of scientists should they have which are objectivity, being realistic, accuracy, and honesty. According to them, if scientists have some characters such as being objective, honest, and realistic, science becomes more scientific. For instance, one of the teachers explained the properties of scientists should have as following,

> There should be honesty as values of science. Honesty and reliability need to be at the forefront. There should be for different opinion or information, regardless of language, religion or race. And I think it has to be impartial to tell it to the public. Is it affected? Of course, it has to be affected because we are human beings, I think that we have to reduce our personal views to a little less, leave it at the door and enter it while doing these things, that is, trying to reach scientific information or performing a scientific activity.
> (P12 –L-SCI-MAS-PRI-TEACH1) (Appendix D5)

Moreover, five out of 12 teachers explained the values of science as it being pragmatistic. This meant that the values of science should be benefit of societies. Science should not harm the nature and its existence. Besides, only two participants pointed out the universalism as the values of science. According to them, values of science should be consistent and universal in the world to reinforce scientific studies.

The following excerpt shows the pragmatic aspects of the values of science by a high-level NOS understanding teacher,

> Values of science... We can evaluate in terms of society and human. It could be objective. Do not harm people or work in a way that ensures the continuity of nature or people.
> (P1—H-PHY-PhD-PRI-TEACH2) (Appendix D6)

When the frequency of the codes obtained from the first question was examined, it was seen that teachers in each level have similar rates (H = 14; M = 17; L = 11) but the moderate group has the highest one to describe the aims and values of science. It can be concluded that the branches of teachers did not have an effect on their perception of the aims and values of science. Besides, the frequency of codes was parallel with the number of teachers in each branch (PHY = 7; BIO = 8; CHEM = 7; SCI = 23). It was the same for the teaching experiences of teachers that teaching experience did not have effect on their perceptions (TEACH1 = 10; TEACH2 = 20; TEACH3 = 4; TEACH4 = 11). Because of the fact that the number of teachers with the teaching experience of six to 10 years are higher than the others, the frequency of the codes obtained were parallel with them. On the other hand, it was found that teachers' educational levels have an effect on their perception for the aims and values of science. Table 13 shows the correlation between the number of teachers and the codes obtained from them that when teachers' educational levels increase from undergraduate to PhD Student, the number of codes about the aims and values also increase (UND = 22; MAS = 1; MAG = 8; PhDS = 7). Finally, teachers' school types were not found as an effective factor on their perceptions (PRI = 8; PU = 38).

Table 13. The Number of Teachers and the Frequency of the Codes from the AV of Science

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2	BIO=8
	CHEM=2	CHEM=7
	PHY=2	PHY=7
	SCI=6	SCI=23
Teaching Experiences	0-5=3	0-5=10
	6-10=5	6-10=20
	11-15=1	11-15=4
	16 and over=3	16 and over=11
Educational Levels	UND=7	UND=22
	MAS=2	MAS=11
	MAG=2	MAG=8
	PhDS=1	PhDS=7
School Types	PRI=2	PRI=8
	PU=10	PU=38

In summary, it was found that teachers identified the aims and values of science by the codes serving to humanity, understanding the universe, increasing science literacy, ethics, by the terms of objectivity, being realistic, accuracy, honesty, pragmatism and universality. Although the types of codes obtained from teachers show diversities, the frequencies of them were not high. Besides, the codes show similarities with previous studies (Akgün, 2018; Kaya, et al 2019). Discussion section provides information about the coherence and differences about the codes obtained from the aims and values of science. On the other hand, the educational levels of the teachers are considered an effective factor on generating more diverse codes. In order to answer second research question, teachers' perceptions about the social-institutional aspects of science were also investigated in the following section.

4.2.1.2 Science teachers' perceptions about social-institutional aspects of NOS

In order to determine the teachers' general perceptions about the social-institutional aspects of science, teachers were directed following question; "What comes to your mind when I say social-institutional aspects of science?" Then, in order to determine their perceptions about each sub-category of the social-institutional aspects of RFN, seven questions were also directed to the participants. This section presents teachers' first general and then, category-based perceptions about the social-institutional aspects of science.

4.2.1.2.1 Science teachers' general perceptions about the social-institutional aspects of science

Table 14 shows teachers' general perceptions about the social-institutional aspects of science that five out of 12 teachers thought that the social aspects of science should be related to society. They claimed that science should be a part of people's life. People in the society should organize their life in the light of science. Besides, according to them, science should be done considering the needs of society which is about the social aspects of science. On the other hand, one of the participants also emphasized that social aspects of science also include doing science against the society such as misuse of science as a weapon of war. The following excerpt presents how a science teacher perceives social aspects of science:

> I think it's the spread of science into society. If we or the society direct our lives based on the science, I think there is more comfortable and happy society. I understand that. That means science needs to settle in society. (P4 –H-SCI-UND-PRI-TEACH2) (Appendix D7)

In the above quotation, the science teacher presents his ideas about the social aspects of science by making connection to society. According to him science should reflect the life of societies. Moreover, five out of 12 of the participants perceived that social aspects of science are related to technological products generated though science and their advantages of the interaction of them in the society. By this way, people have found opportunity to benefit from the technological devices in every part of their

Table 14. The Codes for the Teachers' General Perceptions about the SI Aspects of Science (N=12)

Themes	Explanation of the codes	High N_H=4	%	Moderate N_M = 4	%	Low N_L=4	%	Total N_T	%
Science for society (Social aspects of science)	Doing science for the society, engaging scientific knowledge into life	2	50	1	25	2	50	5	41.6
Technological products of science (Social aspects of science)	Benefits of technological devices, the effects of technology on interaction of people	1	25	2	50	2	50	5	41.6
Dissemination of scientific knowledge (Social aspects of science)	Talking about science, sharing scientific knowledge in conferences, congress etc. writing articles	2	50	2	50	1	25	5	41.6
Scientific institutions (Institutional aspects of science)	TÜBİTAK, universities, Technology Research Center, schools, private sectors, ERASMUS, technology parks	3	75	3	75	4	100	10	83.3
Political power structures Financial Systems (Institutional aspects of science)	The effects of decision-making mechanisms, interference of political power structures, financing scientific organizations, need for funding,	2	50	0	0	0	0	2	16.6
In-service trainings about science (Institutional aspects of science)	In-service trainings, workshops,	1	25	1	25	0	0	2	16.6
Total Number of themes		11		9		9			

lives such as operations in hospitals, vehicles in transportations, and communication. For instance, one of the participants explained the social aspects of science as the following quote,

> By doing scientific work, you invent something. You bring people together; you bring them together. That is, for example, an airplane, you get on a plane, you go, this is the social aspect of science. It brings communities together. (P6—M-CHEM-UND-PU-TEACH3) (Appendix D8)

According to above participant, science makes inventions and by the help of these inventions communication among people becomes easier. Besides, as it is seen on Table 14, the other common theme obtained from the answers of the participants is dissemination of scientific knowledge. It refers to two social categories of RFN which are professional activities, and social certification and dissemination. About half of the participants explained social aspects of science as talking about science, sharing scientific knowledge in conferences, congress etc. and also writing articles for informing society about the developments of science. By this way, people have an opportunity to learn about the contemporary scientific issues, studying in cooperation with colleagues, and providing a social learning environment. The following excerpt presents how a master student perceives social aspects of science,

> When you say social aspects of science, meeting the needs of society comes to my mind. Then, seminars, conferences come to my mind. People can disseminate their studies each other. This provides social learning. (P12 –L-SCI-MAS-PRI-TEACH1) (Appendix D9)

The teacher above made a connection to scientific activities that scientists do, and also emphasized the dissemination of scientific knowledge. On the other hand, teachers have predominantly a common idea about the institutional aspects of science. Ten out 12 participants explained the institutional aspects of science as scientific institutions which are doing science in institutions as TÜBİTAK, universities, technology research centers, schools, private sectors, ERASMUS programs, technology parks, and R&D departments of the institutions etc.

On the other hand, it was an interesting result that only three participants mentioned the effects of a decision-making mechanisms in scientific institutions, interference of political power structures while doing science, the need for financing scientific organizations, funding projects, and also private grant funding. These issues are about two RFN categories, which are political power structures and financial systems. On the other hand, a few participants also perceived institutional aspects of science as in-service trainings about science. According to them, scientific institutions should have vision to inform society by different in-service programs. The following excerpt represents how a science teacher perceives institutional aspects of science,

> If what I am thinking is true, science should not be left to certain boards and should not be controlled under certain boards. Of course, the audit, management, or correctness of science must be done by certain commissions, but the science can be done also by the public. For example, TUBITAK 4007 projects are in the foreground nowadays, science festivals are held for the public. In other words, I think that many studies should be done for the participation of the public. I think it can only be a control mechanism for social aspects of science. however, the problems that Kepler or Galileo faced, can be happen to all of us if we leave it to an institution.
> (P1-- H-PHY-PhD-PRI-TECH2) (Appendix D10)

This participant focused on many diverse issues in the above quotation. According to him, scientific studies should not be administrated by only determined scientific institutions; while there should also be some communities. The teacher also mentioned the need for dissemination of scientific knowledge in society.

When teachers' general perceptions about social-institutional aspects of science were analyzed, it is found that limited number of participants made connection to RFN while defining the social-institutional aspects of NOS. It was seen in Table 15 that connection to RFN categories was made mainly by the participants who have a high score in the NOS Questionnaire. On the other hand, as it is seen in the table 15, no relationship was found among the frequency of the codes and the factors which are teachers' branches, teaching experiences, educational levels and school types while defining teachers' general perceptions about social-institutional systems of science.

Table 15. The Number of Teachers and the Frequency of the Codes from the Teachers' General Perceptions about the SI Aspects of Science

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2 CHEM=2 PHY=2 SCI=6	BIO=7 CHEM=4 PHY=7 SCI=17
Teaching Experiences	0-5=3 6-10=5 11-15=1 16 and over=3	0-5=7 6-10=17 11-15=2 16 and over=10
Educational Levels	UND=7 MAS=2 MAG=2 PhDS=1	UND=15 MAS=11 MAG=7 PhDS=4
School Types	PRI=2 PU=10	PRI=8 PU=28

These findings were consistent with the quantitative data source that teachers' branches, teaching experiences, educational levels and school types have not an effect on their general perceptions about social-institutional aspects of science. However, in order to determine teachers' perceptions about sub-categories of about social-institutional aspects of science, each category was analyzed separately under following sub-titles.

4.2.1.2.2 Professional activities

In order to determine teachers' perceptions about professional activities category of the SI aspects of science, teachers were asked, "What kinds of professional activities do scientists do?" When the responses of the teachers were analyzed, as is seen in Table 16, half of the participants perceived professional activities as following scientific steps while producing scientific knowledge. According to them, scientists mainly identify a scientific problem, construct the hypothesis, test the hypothesis, and reach the scientific knowledge. For example, one of the participants explained the professional activities as the following excerpt,

> First of all, the problem should be determined. Scientific steps must be followed. Then, solutions should be generated considering the problem. At the end, the scientific knowledge will be produced or will produce a new product using that scientific knowledge. If it cannot be solved by existing scientific methods, there must be found new methods.
> (P10 -- SCI-UND-PU-TECH2) (Appendix D11)

It was seen in the above quotation, most of the participants perceived professional activities as scientific methods or a set of procedures used for the generation of scientific knowledge. However, 10 out of 12 teachers mentioned professional activities as attending conferences, disseminating scientific knowledge, writing and publishing articles, and conducting projects. According to them, scientists follow current developments of their fields, conduct projects, develop ideas, and work as a team. The following excerpt shows how a master level chemistry teacher perceived professional activities of science.

> A conference can be arranged. We think as if conferences are done in another cities or countries, however, they can be organized at the end of the semester in the universities by the participation of teachers. For instance, we do TUBITAK science exhibitions. I am sure that for example, if the chemistry teacher department presents the work done by them in each university, it will attract the attention of the children.
> (P8 -– M-CHEM-MAS-PU-TEACH1) (Appendix D12)

Table 16. The Codes for the Teachers' Perceptions about the Professional Activities Category of the SI Aspects of Science (N=12)

Themes	Explanation of the codes	High N_H=4	%	Moderate N_M = 4	%	Low N_L=4	%	Total N_T	%
Following research steps	Addressing problems, determining hypothesis, testing hypothesis, generating scientific knowledge,	2	50	1	25	3	75	6	50
Attending conferences	Organizing conferences, attending congress, seminars, following current developments of their fields, cooperative working	1	25	3	75	0	0	4	33.3
Dissemination of scientific knowledge	Share of scientific knowledge, sharing scientific ideas by social media,	1	25	2	50	0	0	3	25
Writing and publishing articles	Sharing scientific knowledge by written documents	0	0	1	25	1	25	2	50
Total Theme Number		4		7		4			

In the above quotation, the teacher mentioned the conferences as professional activities and that conferences were perceived fundamental components of the dissemination of scientific knowledge. It was also seen that gaining experiences through projects such as TÜBİTAK enables teachers to understand the SI aspects of science in a more concrete sense. Table 16 also shows the frequencies and the percentages of each code. It also shows that teachers' perceptions about professional activities of science are very limited. Table 16 presents the frequency of the codes for each level of teachers that no difference was found between high and low levels groups; on the contrary, the moderate group was found higher than others (H = 2; M = 6; L = 1).

On the other hand, Table 17 also shows the effects of the factors such as teachers' branches, educational levels and teaching experiences on teachers' perceptions about the Professional Activities category of the SI aspects of science. However, a remarkable difference was not found among the teachers considering their branches, teaching experiences, educational levels, or school types.

Table 17. The Number of Teachers and the Frequency of the Codes from the Professional Activities Category of the SI Aspects of Science

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2	BIO=2
	CHEM=2	CHEM=5
	PHY=2	PHY=2
	SCI=6	SCI=8
Teaching Experiences	0-5=3	0-5=4
	6-10=5	6-10=7
	11-15=1	11-15=3
	16 and over=3	16 and over=3
Educational Levels	UND=7	UND=10
	MAS=2	MAS=4
	MAG=2	MAG=2
	PhDS=1	PhDS=1
School Types	PRI=2	PRI=2
	PU=10	PU=15

4.2.1.2.3 Social values and scientific ethos

Table 18 presents the themes and codes obtained from the question “Do you think there are some social values and scientific ethos that scientists should pay attention? If there are, what do these values consist of?” When the codes were analyzed, it was seen that most of the codes are seen under the theme of ‘ethics’ which refers to paying attention to animal care, human subjects protection, no harm to living things, respect for the environment, paying attention to objectivity, accuracy, universality, honesty, avoiding plagiarism, intellectual honesty, disinterestedness which Erduran and Dagher (2014) explained as scientists’ independence from their personal interests and ideologies making it possible for them to reach conclusions that run against their own preferences” and also paying attention to cultural values by not doing gender or race discrimination. It was found that 91.6% of the participants explained the scientific values and scientific ethos by the codes under the theme of ethics. It was found that almost each level of the groups mentioned at least one code under the theme of ethics. However, the number of the codes shows diversity among the groups. For example, as it seen in Table 18, the high level group has the most diverse codes for the ethics theme (H = 16; M = 10; L = 14). For example, a physic teacher with nine years of teaching experience explained scientific values as;

> At first, I want to think that they obey ethics. I want to think that they work by paying attention to it, but the news we read and the things we see show that we have suffered a little more at this point. For example, she wrote her article, she's a good scholar, but the article, which she is working on, is stolen. We don't want to hear news like them, we want that article to be entirely his own. They should pay attention to ethical values. (P3—H-PHY-UND-PU-TEACH2) (Appendix D13)

As it seen in the quotation, the participant emphasizes the significance of intellectual honesty while doing science. That means scientists should pay attention to avoid plagiarism, writing original articles and paying attention to ethics rules.

The second theme was found serving to humanity that this theme includes the codes of conducting scientific studies considering future, preventing misuse of science, solving problems, increasing the development of the country, not doing science for personal interests, and doing science for satisfying themselves. Table 15 shows that 66.6% participants made connection to scientific values and scientific ethos by the theme of serving the humanity. When the rates of the themes were examined, it was found that the lower level group has the highest ratio (H = 75; M = 25; L = 100). Also, the diversity of the codes were parallel to ratio of this theme in each group. For instance, a biology teacher who has over 15 years of teaching experience explained the values of science as the following quotation;

> If there are studies to solve some problems in the society, of course, they can provide an emotional satisfaction in terms of their own benefit. But it will not be easy to do a new study without accumulation of knowledge in the field. Each study related to their own knowledge will benefit to the science world. Perhaps today, it will not be put into use very clearly, it will not be beneficial to humanity for now, but maybe it will help with new studies after a while. Or even create a solution to a problem or to solve environmental problems. (P2—H-BIO-MAG-PU-TEACH4) (Appendix D14)

As it seen in the quotation, the teacher perceived the values of science as doing science for the benefit of the society. That means scientists should pay attention to solving problems, conducting studies for the cumulative of the scientific knowledge, publishing them for serving the science area.

The last theme is determined as methodological concerns that 33.3% of the participants explained social values and scientific ethos as some scientific steps that scientists should pay attention while doing science. Hence, methodological concern

Table 18. The Codes for the Teachers' Perceptions about the Scientific Ethos and Social Values Categories of the SI Aspects of Science (N=12)

	Explanation of the codes	High N_H=4	%	Moderate N_M = 4	%	Low N_L=4	%	Total N_T	%
Theme	Ethics	3	75	4	100	4	100	11	91.6
Related Codes	Animal care, human subjects protection, No harm to living things, respect for the environment, objectivity, accuracy, universality, honesty, intellectual honesty, disinterestedness, paying attention to social and cultural values, no gender, race discrimination,	10		8		4		22	
Theme	Serving to humanity	3	75	1	25	4	100	8	66.6
Related Codes	Considering future, preventing misuse of science, solving problems, not supporting gun making, developing economy of the country, not doing science for only personal interests	5		1		6		12	
Theme	Methodological concerns	1	25	1	25	2	50	4	33.3
Related Codes	Not conducting same study, searching about existing studies, collecting accurate data, presenting the population, paying attention to number of the participants	1		1		4		6	
Total Theme Number		7		6		10			
Total Codes Number		16		10		14			

includes not conducting the same study, searching about existing studies, collecting accurate data, presenting the population, paying attention to number of the participants etc. It was found that each level of the groups mentioned methodological concerns in similar rates, but lower level group has the highest frequency (H = 1; M = 1; L = 4). For example, the participant in low-level group explained the social values as the following quotation;

> Following scientific steps comes to my mind as scientific values in my opinion. In other words, the studies should not be done before, if it has been done then should be aimed at proving it. When collecting data, the results should reflect not only the 1-2 people around but also represent the public. Again, the scientist should write the results correctly and not distort the results. (P10--SCI-UND-PU-TECH2) (Appendix D15)

The participant explained social values and scientific ethos by noticing the scientific steps that scientists follow while conducting a study. According to this participant, scientists should pay attention to the number of the participants in their studies to reflect the society, accurate reporting, and searching about existing studies to not conduct same study.

In order to see the effects of the factors of teachers' branches, teaching experiences, educational levels and school types on their perceptions of the categories of social values and scientific ethos categories of SI aspects of science, the frequencies were calculated and presented on Table 19. It was found that all branches have similar percentages of codes considering the number of teachers, but physics and science teachers have higher than others (BIO = 5; CHEM = 4; PHY = 7; SCI = 31). When the other factors were analyzed it was found that there was not direct relationship between the factors and their perceptions about the categories of Social Values and Scientific Ethos.

Table 19. The Number of Teachers and the Frequency of the Codes from the Social Values and Scientific Ethos Categories of the SI Aspects of Science

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2 CHEM=2 PHY=2 SCI=6	BIO=5 CHEM=4 PHY=7 SCI=31
Teaching Experiences	0-5=3 6-10=5 11-15=1 16 and over=3	0-5= 11 6-10=25 11-15=2 16 and over=10
Educational Levels	UND=7 MAS=2 MAG=2 PhDS=1	UND=28 MAS=11 MAG=6 PhDS=3
School Types	PRI=2 PU=10	PRI=8 PU=40

4.2.1.2.4 Social certification and dissemination

In order to determine teachers' perceptions about the social certification and dissemination category of the SI aspects of science, teachers were directed the question of "What do you think how scientists share scientific knowledge they generated? Or could they share?" Teachers were focused on three general themes (Table 20). The most prominent theme was found dissemination problems that about 75% of the teachers thought that scientists have some obstacles to share their findings. These obstacles can be sometimes due to the nature of the studies that if the results of the studies have some potential risks for the society, scientists should avoid them with the society. For example, the results of a study can be misused for the society such as gun making. Besides, personal interests can be perceived as another obstacle for the dissemination of scientific studies. Such that scientists sometimes can prefer to improve their studies by themselves instead of enabling others to develop them. Personal interests can be financial, political or gaining status.

Moreover, some teachers claimed that if scientists reach certain knowledge, then they have found opportunity to disseminate their findings to society. That means if the results of the study do not include certain knowledge then, it is not seen meaningful for disseminating. Finally, limited access to reach published sources and using so much academic language in the studies prevent the dissemination of scientific studies in the society. The following excerpt shows a teacher's perception about the dissemination of scientific knowledge;

> Depending on the content and results of the work, if the work is harmful enough, there will be obstacles, but if it is extremely useful, I don't think there will obstacles come out, but they say "We found a cure for cancer, drugs we were found for curing it but authorities don't release, it is advanced technology, but they are not released." I hope this kind of thing is a rumor. People can behave differently according to the results of their studies. They can behave differently to take more money or etc. This type of obstacles may appear in front of them.
> (P3—H-PHY-UND-PU-TEACH2) (Appendix D16)

The participant stated that dissemination of the scientific knowledge can based on the nature of the study. Hence, if the results of the study harm the society, some problems can occur. Besides, scientists' personal needs or interests can have an effect on their attitudes.

The second theme is determined dissemination channels that 66.6% of the participants mentioned at least one example of the ways that scientists use while sharing their findings. These sources can be articles, institutions, social media, news, teleconferences, conferences, seminars, or by citation to others. For instance, a master graduated teacher in high level group explained her idea about the dissemination of the scientific knowledge as the following excerpt;

> They probably share by publishing. Obviously, I don't know the ethical assessment criteria of publishing institutions.… Everyone is publishing his/her work, but I don't know the difficulty in publishing them for the journals in respected journals that we know them literature.
> (P2—H-BIO-MAG-PU-TEACH4) (Appendix D17)

Table 20. The Codes for the Teachers' Perceptions about the Social Certification and Dissemination Category of the SI Aspects of Science (N=12)

	Explanation of the code	High N_H=4	%	Moderate N_M = 4	%	Low N_L=4	%	Total N_T	%
Theme	Dissemination problems	3	75	3	75	3	75	9	75
Related Codes	Dependency on the nature of the study, confidentiality of scientific findings, personal interests, institutional interests, preventing the misuse of science, obstacles due to academic language, limited access to articles, political, cultural, economic concerns, depending on the reaching certain knowledge, sharing science as a product, sharing only with colleagues	9		7		5		21	
Theme	Dissemination channels	4	100	2	50	2	50	8	66.6
Related Codes	Sharing publishing articles, via institutions, social media, news, teleconferences, conferences, seminars, by citation to others,	9		4		4		17	
Theme	Social certification	1	25	1	25	0	25	2	16.6
Related Codes	Verification, certification, testing,	3		1		0		4	
Total Theme Number		8		6		5			
Total Code Number		21		12		9			

As it seen in the quotation, even though the teacher has no idea about the certification criteria in publishing, she perceived publishing articles as the fundamental channel for sharing scientific knowledge. The last theme was about the interesting finding that even though most of the teachers mentioned different dissemination channels like articles, social media, conferences, or consulting colleagues, only a few participant (16.6%) mentioned the need of social certification for dissemination of scientific knowledge. That means scientists engage in investigations, review, criticize and evaluate the work by collaborative efforts. When the answers of the teachers were examined, it was found that two out of 12 teachers mentioned the needs for certification, validation and testing before publishing any scientific study. For example, the teacher who take the course NOS in her pre-service teacher education explained the certification criteria as the following quotation;

> We currently have many national and international scientific journals. They have communities who examine everything. The reliability of social media has not been proven, so it is not very attractive. The national press may be; if the knowledge is proven.
> (P11—L-SCI-UND-PU-TEACH4) (Appendix D18)

As it seen in the quotation, the participant mentioned social certification as the fundamental part of the dissemination of scientific knowledge. Moreover, the participant was also aware of the science communities, their collective work and some certification criteria for the reliability, which they have not found in social media. Table 20 shows that the rate of total themes for each group do not have similar ratio (H = 8; M = 5; L = 5). Similarly, the frequency of total codes was also found higher than the other groups for the category of social certification and dissemination.

Table 21. The Number of Teachers and the Frequency of the Codes from the Social Certification and Dissemination Category of the SI Aspects of Science

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2 CHEM=2 PHY=2 SCI=6	BIO=6 CHEM=4 PHY=13 SCI=23
Teaching Experiences	0-5=3 6-10=5 11-15=1 16 and over=3	0-5= 7 6-10=28 11-15=3 16 and over=8
Educational Levels	UND=7 MAS=2 MAG=2 PhDS=1	UND=24 MAS= 9 MAG=4 PhDS=7
School Types	PRI=2 PU=10	PRI=10 PU=36

Table 21 provides information about the effects of factors of teachers' branches, teaching experiences, educational levels and school types on teachers' perceptions about the Social Certification and Dissemination Category of SI aspects of science. As it seen in table 21, the total frequency of codes shows diversities among the branches (BIO = 6; CHEM = 4; PHY = 13; SCI = 23). Such that physics teachers have the highest total frequency compared to others for this category. Then, science, biology and chemistry teachers follow the order. It was found that the number of codes does not have direct relationship with teachers' teaching experience. Teacher who are six to10 years of teaching experience have the highest score than others. On the other hand, teachers who are zero to five years old teaching experience have the lowest one comparing the number of teachers (TEACH1 = 7; TEACH2 = 28; TEACH3 = 3; TEACH4 = 8). Moreover, even though the frequency of total codes was not parallel with the degree of teachers' educational levels, the highest frequency belongs the PhD student comparing the number of teachers (UND = 24;

MAS = 9; MAG = 4; PhDS = 7). Additionally, teachers' school types may have an effect on teachers' perception about the category of Social Certification and Dissemination that teachers in private school mentioned more codes compared to teachers in public schools in comparing to their numbers (PRI = 10; PU = 36).

4.2.1.2.5 Political power structures

In order to determine teachers' perceptions about the political power structures category of science, teachers were directed the question of "Do you think there is a relationship between scientists' race, nationality, gender, beliefs, cultural values or their hierarchical dynamics between science? If yes, what kinds of relationship, can you explain?". Three themes were found which are bias towards differences, political ideologies, and university-based factors. Table 22 shows the frequency of themes and codes that when the grade level of teachers increased, their perceptions about the component of Political Power Structures category of science also increased (H = 10; M = 8; L = 6 / H = 20; M = 18; L = 12).

The first theme includes the effects of gender, race, nationality, beliefs, religion, language, cultural values, and scientists' characteristics on science. According to 75% of the teachers, there is a discrimination or bias towards scientists' gender, race, nationality, or religion in science. Thus, both scientists and scientific studies are affected from this situation. The following excerpt shows the perception of a master student teacher about political power structure of science;

> There are also perceptions related to gender, even if we are aware that we call it a science man. We constantly think that it is men who produce science. I think this is a serious reason for distinction. …. For example, there become big developments in technology or medicine but when there is something about pigs or contains anything related with them Turkish people say "Oh, we can't use it, it is sin, I don't use it even if it dies." So, I think that beliefs also affect science, but they affect negatively.
> (P8 –– M-CHEM-MAS-PU-TEACH1) (Appendix D19)

In the above quotation, the participant emphasized the effects of gender discrimination in science on our perceptions towards scientists. She mentioned that this situation affected even our language to call scientists by gender-based terminologies. Moreover, according to the participant, cultural values and beliefs also have an effect on selecting the topic of scientific studies. If the selected topic is not suitable for the cultural norms of the society, scientists prefer to change their studies or prefer to select topics, which have potential to accepted by the society.

On the other hand, four out of 12 participants did not agree with the idea that there is an effect of gender, race or cultural values on science. According to them, scientists can be valued in everywhere regardless their gender, race or belief. If they contribute to the science literature and serve the humanity by their studies then, they do not confront with problems while doing science. For instance, a chemistry teacher who has 17 years of teaching experience explained his ideas as;

> I don't think that they affect too much. The language of science is unique, it doesn't change according to gender, it doesn't change according to race, it is not change according to appellation either professor or assistant professor. Science can offer you something if you can understand it, if you follow it. If a scientist wants to do science, nothing can stop him.
> (P6—M-CHEM-UND-PU-TEACH3) (Appendix D20)

It was interesting to find the participant thought that science could not be affected by gender, race, or hierarchical based problems. According to him, science is done without any negative factors that scientists live in.

The second theme was political ideologies that nine out of 12 teachers thought governments' political ideologies have a great effect on the development of scientific knowledge. This theme includes the codes of political interests, governments' care to scientific development, development level of countries, competitions among countries, governments' support, allocating funds, economic concerns, meeting the need of societies, the effects of governments on curriculum.

These codes mean that governments can have some political, economic, and cultural concerns or interests; and all these concerns have some effects on scientists' selection topics, conducting projects, or finding financial support by the governments. Such that because of the fact that artificial intelligent became one of the most popular and profit based investment for many countries in last years, governments tend to support these kinds of studies more than others. Besides, according to teachers, the developmental level of the countries affects their attitudes towards science because meeting fundamental needs of the society enables developed countries to allocate more funds to scientific studies. Moreover, some participants think that political ideologies have also an effect on science curriculum. For example, a science teacher explained her perception about political power structures of science as the following excerpt;

> Government policies reflect themselves to in terms of supporting scientific studies. In other words, the more governments appreciate scientific studies, being neutral as scientists, paying attention to scientific studies, the more they support scientific studies. However, if they have political concerns, as a result of their political concerns, they may say that this scientific work fits me better or not at all. Or if the governments have economic concerns, they may not invest in certain sectors because of economic concerns. For example, it's more like making investments in construction industry. Then, if governments have political concerns, which I observe it so much in my country, for instance teaching evolution is so problematic.
> (P10--SCI-UND-PU-TECH2) (Appendix D21)

As it seen in the quotation, teacher thought that governments have some political and economic concerns, and this reflects their choice of investments. He also though that the curriculum also was affected by the politics of the governments. The participant gave the example of the science topic 'Evolution' that according to him it was a kind of political concerns of government.

Table 22. The Codes for the Teachers' Perceptions about Political Power Structures Category of SI Aspects of Science (N=12)

	Explanation of the code	High N_H=4	%	Moderate N_M = 4	%	Low N_L=4	%	Total N_T	%
Theme	Bias towards differences	4	100	3	75	2	50	9	75
Related Codes	The effects of gender, race, nationality, beliefs, religion, language cultural values, the effects of scientists' characteristics on science	11		10		3		24	
Theme	Political ideologies	3	75	3	75	3	75	9	75
Related Codes	Political interests, governments' care to scientific development, the effects of development level of countries, competitions among countries, allocating funds, economic concerns, need of the societies, the effects of governments on curriculum	4		3		8		15	
Theme	University based factors	3	75	2	50	1	25	6	50
Related Codes	Hierarchy problems, obstacle to some studies, bias toward a scientist and his/her study, problems in ranking, problems selecting students/researchers, collaboration of scientists, scientists' interests	5		5		1		11	
Total Theme Number		10		8		6			
Total Code Number		20		18		12			

Additionally, 50% of the participants mentioned some university-based factors or problems considering political power structures of science. They made connection to hierarchy problems among the academics in the universities. According to them, academics may have some personal problems with each other and this may have an effect on doing science. Besides, academics again may have some bias towards a scientist or his/her study thus, this situation may lead to decrease in the motivation of scientist or their collaboration working on it. Additionally, some teachers emphasized the problems in ranking of academics and also selecting of master and university students in the universities as political aspects of science. For instance, a biology teacher explained her experiences in the university as the following excerpt;

> I took the research assistant exam in the department. The head of the department is from Elazığ. His department colleague's child is coming to the exam. I graduated from the same department, but his child taken to the that position. I think cultural differences are also effective. Hierarchy is effective. My professor was an assistant professor at that time, the professor's friend gave him reference. Let me tell you this: My professor faced conflict with other professor years ahead. Both was assistant professor; the other professor didn't give me his laboratory key for days because I was his student. The conflict between professors reflect on the students.
> (P7—M-BIO-MAG-PU-TEACH4) (Appendix D22)

As it seen in the quotation, the participant mentioned some hierarchy problems in the university she experienced. According to her, cultural differences play a great role in selecting students and researchers in the universities.

Table 23 shows the frequency of teachers and codes according to the factors of their branches, teaching experiences, educational levels and school types. It was found that physics teachers mentioned more diverse codes comparing to others (BIO = 11; CHEM = 7; PHY = 12; SCI = 22). It may because of the fact that one of the physic teachers is PhD student so he made more university-based factors compared to other. On the other hand, the ratio in teaching experiences was found similar except teaching experience from 11 to 15 that this participant had limited perception about the political power structure of science (TEACH1 =13; TEACH2 = 23; TEACH3 = 1; TEACH4 = 16). Besides, there was not found direct relationship between teachers' educational level and their perceptions about political power structure category of science comparing the number of teacher (UND = 32; MAS = 10; MAG = 11; PhDS = 4). On the other hand, it was found that teachers working in public schools mentioned more diverse codes comparing to teachers working in private ones (PRI = 4; PU = 48).

Table 23. The Number of the Teachers and the Frequency of the Codes from the Political Power Structures Category of the SI Aspects Science

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2 CHEM=2 PHY=2 SCI=6	BIO=11 CHEM=7 PHY=12 SCI=22
Teaching Experiences	0-5=3 6-10=5 11-15=1 16 and over=3	0-5=13 6-10= 23 11-15=1 16 and over=16
Educational Levels	UND=7 MAS=2 MAG=2 PhDS=1	UND=32 MAS=10 MAG=11 PhDS=4
School Types	PRI=2 PU=10	PRI=4 PU=48

4.2.1.2.6 Financial systems

To determine teachers' perceptions about financial systems of science, teachers were asked "Do you think there is a relationship between science and financial systems? If yes, what kinds of relationship exist?". When the answers of teachers were analyzed, it was found that teachers focused on three types of issues. These are in need of money for sources, economic concerns for doing science, and the effects of economy of governments on science. First of all, it was found that nine out of 12 participants though that science and money has direct relationships. They explained her ideas by making some connections to themes listed in the table 24. On the other hand, three teachers did not find any direct relationship between science and economy. For them, money may have potential to affect scientific studies for conducting fast or in more comfortable environment. However, it is not a fundamental need for science. For example, a biology teacher explained her ideas as the following excerpt;

> Actually, there is no relationship, but we are making connection because there's no such a thing as science when there's a lot of money. It is about research spirit. However, for those who try new studies will surely face with financial part. Those who are entrepreneurs may find themselves a resource, but it would be much better if the government says, “If you do scientific work, your money is ready”. Thus, a good scientist will find a way to overcome obstacles. He/she does not say “No money, so I don't work”. But maybe, the speed of her/his is slow. Motivation may fall from dealing with problems. However, for a person who has begun to study scientifically, I don't think those obstacles will stop her/him.
> (P2—H-BIO-MAG-PU-TEACH4) (Appendix D23)

As it seen in the quotation, teacher thought that conducting a scientific study is directly related to scientists’ willing. Even though money has potential to affects scientists’ motivation, scientists may overcome the problems based on money.

It was found that 66.6% of the participants mentioned the first theme which is they need money for sources. Most of the teachers thought that money is a fundamental need for conducting studies. According to them, scientists need to use laboratory equipment for data collection and analysis. Even, academics in social sciences also need money for equipment. They also mentioned scientists’ personal needs for money to continue their lives. For example,

> One of the most fundamental relationships is economic activities. Because there is a need for money for precious devices for the studies and even an analysis of work is something that takes long time with the computer. If devices are bad, it probably gives wrong results.
> (P8 –– M-CHEM-MAS-PU-TECH1) (Appendix D24)

Table 24. The Codes for Science Teachers' Perceptions about the Financial Systems Category of SI Aspects of Science (N=12)

Theme/ Codes	Explanation of the code	High N_H=4	%	Moderate N_M = 4	%	Low N_L=4	%	Total N_T	%
Theme	Need of money for sources (as an aim)	3	75	3	75	2	50	8	66.6
Related Codes	Money for equipment- laboratory expenses, money for personal needs	4		4		3		11	
Theme	Economic concerns for doing science	2	50	3	75	3	75	8	66.6
Related Codes	Economic concerns of governments, economic concerns of scientists, brain drain, commercialization and commodification of science, development of country, gaining Nobel prize	3		3		4		10	
Theme	The effects of economy on science (as a result)	2	50	1	25	3	75	6	50
Related Codes	Allocating money for science, financial budget for schools, accessibility of science, receiving incentive awards, depending on the development level of countries, scientific investments	2		1		5		8	
Total Theme Number		7		7		8			
Total Code Number		9		8		12			

As it seen in the quotation, teacher mentioned the significance of using lab equipment while doing science for reaching accurate results. The second theme is economic concerns for doing science that according to teachers, scientists may conduct studies considering their and governments' economic concerns. That means scientists may do science for gaining more money by exploring new things or receiving prizes. Teachers mentioned brain drain as an example of scientists' economic concerns. Besides, governments may also support conducting scientific studies for their scientific and economic development. Commercialization and commodification of science is an example for governments' economic concerns that governments may lead to misuse of science to reach their aims (gun making, drug making). The following quotation shows the perception of a teacher regarding the financial systems of science;

> Economic factors have a direct relationship with science. For example, a medicine invented, there are 100 people or 500 people in the world have that disease. This drug is not produced much because this disease is not very common. It was thought that there is no economic return. Or it may be very expensive to produce. In fact, consideration should be on necessity, but today manufacturers are looking for supply and demand It is also a valid evaluation, but it shouldn't be that much. I think it is mostly economically valued. (P6—M-CHEM-UND-PU-TECH3) (Appendix D25)

The participant made a connection between science and economy considering the economic concerns of companies or governments while doing science. According to him, this concern constructs the direct relationship between science and economy.

On the other hand, six out of 12 participants explained financial systems of science by considering the effects of governments' economy on science. In other words, they focused on the results of how science is affected by governments' developmental level. Most teachers claimed that there is a direct relationship between science and economy such that if the country is developed then, it will probably allocate more fund and budget to scientific studies. By this way, researchers may receive incentive awards and their accessibility of science may increase. For instance, a science teacher who have more than 20 years of teaching experiences explained her idea as the following quotation;

> There is a significant relationship between science and economy. The developed countries allocate more money to research. They provide all opportunities people to realize their dreams. Besides, if you do not have power in economy, you also cannot allocate enough source. (P11—L-SCI-UND-PU-TEACH4) (Appendix D26)

As it seen in the above excerpt, teacher made a positive parallel correlation between the development of science and country. Table 25 shows the frequency of codes considering teachers' branches, teaching experiences, educational levels, and school types. It was found that physics teachers mentioned more diverse codes comparing to other branches (BIO = 4; CHEM = 2; PHY = 7; SCI = 18) in terms of the number of teachers. On the other hand, the frequency of codes was found similar for other factors as it seen in the table 25.

Table 25. The number of Teachers and the Frequency of the Codes from the Political Power Structures Category of the SI Aspects of NOS

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2 CHEM=2 PHY=2 SCI=6	BIO=4 CHEM=2 PHY=7 SCI=18
Teaching Experiences	0-5=3 6-10=5 11-15=1 16 and over=3	0-5=8 6-10= 17 11-15=1 16 and over=6
Educational Levels	UND=7 MAS=2 MAG=2 PhDS=1	UND=20 MAS=5 MAG=4 PhDS=2
School Types	PRI=2 PU=10	PRI=5 PU=24

4.2.1.2.7 Social organizations and interactions

The final component of the social-institutional category of science is social organizations and interactions. Teachers were directed the question of "What do you think about the institutions scientists conduct their studies? And their relations?" It was found that almost each teacher gave at least one example that scientists do science. According to them, science can be done generally in universities, schools, research and development department of institutions, the institutions of TÜBİTAK, NASA, CERN, or science centers. It was seen in Table 26 that high level group teachers gave more diverse codes comparing the others, but the moderate group has the lowest one (H = 15; M = 10; L = 12). For example, a teacher in low level group explained the scientific institutions as the following quotation;

> TUBITAK, NASA, CERN, these are the popular places that come to my mind. Scientific studies are developing in such institutions or organizations. But now the scientist works at the university, which is also working at the laboratory, also factories. Therefore, I think that the concept of scientist is a broad concept. So, if a person wants to do science, everyplace can be laboratory for her/him. (P12 –L-SCI-MAS-PRI-TEACH1) (Appendix D27)

The participant explained scientific institutions by giving some examples from places scientists systematically work, and also everyplace they want to do science. On the other hand, seven out of 12 teachers also made some comments about the functions of these institutions. They generally thought that these institutions have some problems in their quality, interactions, information sharing, organizing training, being objective, reliable, and not affected by political ideologies. For example, a science teacher complained about the institution of TÜBİTAK in terms of the quality and the interaction among the other institutions.

> TÜBİTAK does not support universities, and universities do not support the studies of TÜBİTAK. Unfortunately, they do not support each other now… We participated some research project contests, but I can undoubtfully say that TÜBİTAK has lost its respect at many points.
> (P3—H-PHY-UND-PU-TEACH2) (Appendix D28)

Table 26. The Codes for the Teachers' Perceptions about the Social Organizations and Interactions of the SI Aspects of Science (N=12)

Themes/Codes	Explanation of the code	High N_H=4	%	Moderate N_M = 4	%	Low N_L=4	%	Total N_T	%
Theme	Institutions	4 100		4	100	4 100		12 100	
Related Codes	Schools, universities, TÜBİTAK, NASA, techno-parks, labs, R&D departments of companies, science centers	15		10		12		37	
Theme	Functions of institutions	3	75	2	50	2	50	7 58.3	
Related Codes	Insufficient knowledge sharing, low interaction among the institutions, the effects of political ideologies, need for increasing the number of institutions, lack of accuracy, objectivity	3		4		3		10	
Total Theme Number		7		6		6			
Total Code Number		18		14		15			

Table 27 shows the frequency of codes for the category of social organizations and interactions of SI aspects of science based on the factors of teachers' branches, teaching experiences, education levels and school types. It was found that physics teachers have the highest frequency compared to others (BIO = 9; CHEM = 7; PHY = 12; SCI = 23). It was interesting finding that when the teacher educational level increases, the frequency of codes also increases regarding the number of teachers (UND = 24; MAS = 12; MAG = 9; PhDS = 6). On the other hand, the frequencies of teachers' teaching experiences and school types were found similar to each other as is seen Table 27.

Table 27. The Number of the Teachers and the Frequency of the Codes from the Social Organizations and Interactions Category of the SI Aspects of Science

Factors	Number of the teachers	Frequency of the codes
Branches	BIO=2	BIO=9
	CHEM=2	CHEM=7
	PHY=2	PHY=12
	SCI=6	SCI=23
Teaching Experiences	0-5=3	0-5=13
	6-10=5	6-10=23
	11-15=1	11-15=4
	16 and over=3	16 and over=11
Educational Levels	UND=7	UND=24
	MAS=2	MAS=12
	MAG=2	MAG=9
	PhDS=1	PhDS=6
School Types	PRI=2	PRI=11
	PU=10	PU=40

Due of the fact that there is a limited number of participants for each group which are high, moderate and low, it was hard to determine the differences in their perceptions for each category separately. Hence, Table 28 shows the total differences among the groups of high, moderate, and low. The frequencies of codes were listed for the categories of RFN as the aims and values, professional activities, scientific ethos and social values, social-certification and dissemination, political power structures, financial systems, and social organizations and interactions. Table 28 shows that there is a consistency between quantitative and qualitative results. Such that teachers who got high scores from the NOS Questionnaire mentioned also more diverse codes such as for the categories of social certification and dissemination, political power structures, and social organizations and interactions in their interviews.

Table 28. The Total Codes for Science Teachers' Perceptions about AV and SI Aspects of Science (N=12)

Themes	High N_H=4 %	Moderate N_M = 4 %	Low N_L=4 %	Total N_T %
Aims and Values	14	17	11	42
Professional Activities	4	7	4	15
Scientific Ethos -Social Values	7	6	10	23
Social Certification and Dissemination	21	11	9	41
Political Power Structures	20	18	12	50
Financial Systems	9	8	12	29
Social Organizations and Interactions	18	14	15	47
Total Code Number	93	81	73	

On the other hand, Table 29 shows the effects of the factors of the teachers' branches, teaching experiences, educational levels, and school types on their total perceptions about the AV and SI categories of science. It was found that the frequency of codes shows diversities among different branches. Physics teachers have more nuanced perceptions than other branches. On the other hand, chemistry teachers have the lowest frequency than others in comparison to their numbers (BIO = 45; CHEM = 36; PHY = 60; SCI = 130). Besides, teaching experiences were not found effective in determining teachers' total perceptions about AV and SI categories of NOS (TEACH1 = 66; TEACH2 = 119; TEACH3 = 18; TEACH4 = 65). Even though a teacher who has a teaching experience between 10 to15 years has the lowest frequency, it is hard to generalize the result of it by looking his/her teaching experience due to being one person in that category. Additionally, the rates of the codes were found similar for the undergraduate, master student, and teachers who have Master' degree except the PhD student teacher. PhD student teacher has a remarkable difference from others in terms of the number of codes per teachers (UND = 22.8; MAS = 25; MAG = 22; PhDS = 30). Finally, even though the rates of codes for school types were found near each other, teacher who are working in private schools have higher frequency than others in comparison to number of teachers (PRI = 48; PU = 230).

Table 29. The Number of the Teachers and the Frequency of the Codes for the AV and SI Categories of Science (N=12)

Factors	Number of the teachers	Frequency of the codes	Number of codes per teachers
Branches	BIO=2 CHEM=2 PHY=2 SCI=6	BIO=45 CHEM=36 PHY=60 SCI=130	22.5 18 30 21.6
Teaching Experiences	0-5=3 6-10=6 11-15=1 16 and over=3	0-5=66 6-10=119 11-15=18 16 and over=65	22 23.8 18 21.6
Educational Levels	UND=7 MAS=2 MAG=2 PhDS=1	UND=160 MAS=50 MAG=44 PhDS=30	22.8 25 22 30
School Types	PRI=2 PU=10	PRI=48 PU=230	24 23

4.2.2 Science teachers' educational applications and teaching suggestions

It is significant that even though teachers' have higher level of NOS understanding, they should also be aware of how NOS can be taught in science lessons. Hence, the third main research question is "What are the teachers' perceptions about their educational applications and suggestions while teaching and learning the aims and values and the social-institutional aspects of NOS?" The third research question has three sub-research questions that the first one aims to reveal the teachers' perceptions about their educational application and suggestions while teaching NOS in science lessons. The following sections aim to answer the first-sub research question of the third research question.

4.2.2.1 Science teachers' educational applications and teaching suggestions of the aims and values of science in science lessons

Teachers were directed two fundamental questions to determine their ideas about teaching the aims and values of science in science lessons, and also their suggestions to teach this category of NOS better in science lessons. "Do you think you make connections to the aims and values of science in your science lessons? If yes, how do you do it?" are the questions directed to the teachers to determine their perception about teaching NOS in their science lessons. Table 30 presents the most common codes obtained from teachers' responses considering their NOS understanding level.

Firstly, 10 out of 12 teachers claimed that they teach the aims and values in their science lessons. On the other hand, two teachers in low level group claimed that due to the deficiencies in the texts books and the exam-oriented system they do not teach AV of science. When teachers were asked how they teach, they focused on different aspects of teaching NOS. Some of them mentioned the issues they paid attention while teaching AV; on the other hand, some of them mentioned their teaching approaches or ways. As it seen in Table 30, there are both same and different codes obtained from different groups. Five out of 13 teachers pointed out teaching tentativeness of science as a significant way to teaching AV category of NOS. According to them, students should know how scientific knowledge can change over time by the new scientific exploration to learn the aims and values of science. Three teachers also mentioned teaching scientific steps to students as a way of teaching AV category of NOS. That means students should know which steps that scientists follow while conducting study. These two codes are actually mainly related to "scientific knowledge" and "methods and methodological rules" categories of RFN. For example, one of the biology teachers expressed her idea as the following quotation;

> I pay attention a lot. Especially, I teach scientific method at first in the 9th grade. If I'm not teaching at ninth grade, I'm linking to scientific research later. I reference on the current scientific studies and mentioned that scientific knowledge can change over time.
> (P2—H-BIO-MAG-PU-TEACH4) (Appendix D29)

As it seen in the quotation, the participant mentioned making connections to scientific methods and tentativeness of scientific knowledge by the current studies to teach aims of science. Moreover, some teachers made RFN based connections such as teaching animal care, respecting the environment, teaching authority-based problems, and accuracy to students in science lessons. Even though these teachers mentioned the significance of teaching AV based issues in science lessons, they mentioned limited number of teaching approaches and methodologies they used. Watching documentaries, making real life connections, mentioning current studies are some of the techniques and activities that teachers used in their science lessons.

Table 30. The Codes for the Teachers' Perceptions about Their Educational Applications in Teaching the AV of Science in Science Lessons (N=12)

High N_H =4	Moderate N_M = 4	Low N_L =4
Teaching tentativeness of science (3)	Teaching tentativeness of science (2)	Teaching scientific steps
Teaching scientific steps (2)	Teaching accurate reporting	Student-centered activities
Teaching accurate reporting	Benefiting from scientific articles	Mentioning long term effects of some studies on nature
Mentioning current studies (2)	Making connection to real world	Teaching ethics
Mentioning the significance of science		Not teaching due to the deficiencies in text books
		Not teaching due to exam-oriented teaching approach

It was seen in Table 30 that teachers in the high-level group mentioned more codes comparing to others. For instance, one of the teachers explained her teaching approach as the following:

> In general, I prefer active participating method instead of traditional teaching. I expect students to do experiments by themselves. I try to watch them documentaries that attract their attention.
> (P6—M-CHEM-UND-PU-TECH3) (Appendix D30)

The participant emphasized using student-centered activities in teaching AV category of NOS. According to her, this increases students' attention to scientific topic.

Participants were asked their suggestions for teaching AV category of NOS by the question of "What can be added to science lessons to teach AV category of NOS?" Table 31 shows the codes and frequencies obtained from the responses of teachers. It was found that teachers generally focused on some teaching approaches without integrating AV of science in their lessons. Besides, they talked about meeting their needs or improving educational problems they faced.

Teachers in each group underlined the significance of student centered and practice-based education in science lessons. According to them, teachers should provide opportunities to students to explore science by themselves. According to them if students make experiments, think about the problems and try to solve these problems by using scientific methods, they will probably learn the aims and values of science. It was also interesting that teachers in each group mentioned the needs for physical equipment and environment for practice-based learning. The following excerpt presents teacher's suggestions for teaching AV aspects of science;

> Especially the application side is behind in teaching. We teach the theoretical information, there is no problem there. However, it is inadequate to ask only theoretical information to students. Obviously, activities and experiments need to be done too much. For example, we made a microscope.
> (P4 –H-SCI-UND-PRI-TEACH2) (Appendix D31)

It was seen in the quotation that teacher emphasized the significance of practice-based education in teaching science. Moreover, teachers in each group mentioned the integration of some issues for teaching AV of science. These are the topics of ethics, intellectual authority problems, and also the effects of culture, history and economy on science. By discussing about these topics enables students to notice the aims and values of science. On the other hand, one of the teachers in moderate group though that teaching the aims and values of science is not appropriate for middle secondary grade level students. There are also some general suggestions such as encouraging students to reading books, behaving students as scientists, discussing about technological developments that these were not focusing on the AV aspects of science. The following quotation shows the suggestions of a science teacher to integrate the aims and values of science in science lessons:

Table 31. The Codes for the Teachers' Perceptions about Their Teaching Suggestions in Teaching the AV of Science in Science Lessons (N=12)

High N_H =4	Moderate N_M = 4	Low N_L =4
curriculum based problems (3)	practice based education (4)	student centered teaching approach (4)
teaching scientific knowledge production process (3)	need for physical equipment and environment	organizing social learning environments (4)
practice based education (2)	teaching different branches of science	need for physical equipment and environment (2)
teaching values for satisfaction of his/her studies	adding selective courses about science,	discussing about technological developments
behaving students as scientists	not need to teach for middle secondary grade level students,	encouraging students to reading books
need for physical equipment and environment	no idea about development of curriculum	mentioning challenges of scientists
insufficient teachers		mentioning the effects of culture, history and economy

> The difficulties that scientists have faced in the past can be taught. Not only difficulties but also cultural and economic challenges can be taught. After that, harms caused by weapons which is outcome of science can be taught. (P10 – L--SCI-UND-PU-TECH2) (Appendix D32)

According to teacher, students should be informed about the concerns that scientists faced due to the cultural, historical or economic problems. Besides, talking about the misuse of technological developments such as gun making can be way to teach the aims and values of science.

4.2.2.2 Science teachers' educational applications and suggestions for teaching social-institutional aspects of science in science lessons

Same questions were directed teachers to determine their educational applications and teaching suggestion for social-institutional aspects of science. The results are presented by the codes and quotations separately for each aspect.

To determine their ideas about the implication of NOS in their lessons, teachers were asked these questions: "Do you think you make connections to the social- institutional aspects of science in your science lessons?" And, "if yes, how do you do it?" Table 32 shows the codes obtained from the responses of teachers for three groups, which are high, moderate and low.

It was interesting finding that six out of 12 teachers claimed that they do not teach social-institutional aspects of science in their science lessons. Some of them explained that those results were due to the curriculum-based problems, students' low-level achievement scores, or having no ideas about these institutions and their functions. One of the chemistry teachers explained her reasons as the following quotation;

> We have a very intensive curriculum. As I said, the students are not successful. However, I'm trying to teach them why they're learning chemistry when they ask questions like “why we are doing these activities?”. I am trying to explain what they're doing, what they should do, the benefits of chemistry, and where chemistry is in our life.
> (P8 -– M-CHEM-MAS-PU-TECH1) (Appendix D33)

According to the teacher, students’ academic success and curriculum-based problems limit teachers’ implications for teaching social-institutional aspects of NOS. However, teacher tries to mention the significance and the functions of science. Besides, mentioning the benefits of science is found as the most common code as it seen Table 29. According to teachers, students should know why science is done. They taught that if students are being aware of the benefits of science, they have more ideas about the social-institutional aspects of science. Moreover, limited number of teachers made connections to implications including some social-institutional aspects of science. These are sharing scientific knowledge, mentioning the effects of religion or other factors on science, introducing students to scientific institutions and their functions, and conducting studies or projects with students. For instance, a physics teacher mentioned how he teaches social-institutional aspects of science to their students as the following excerpt

> I introduce scientific institutions to my students. I start by explaining the aims of the scientific institutions and their serve to the society. Because when I'm talking about the CERN, then the question follows, “Teacher, do we have our own?” Then I mentioned scientific institutions we have. Students have gotten surprised. They ask then “Can we be scientists?” I answer yes to this question. When they listen to answer, you should see how their eyes be bright with desire. Hope!
> (P3—H-PHY-UND-PU-TEACH2) (Appendix D34)

As it seen in the quotation, teacher pointed out the significance of mentioning scientific institutions to students in science lessons. He thought that teaching about scientific institutions and their functions encourage students about scientific studies.

Table 32. The Codes for the Teachers' Perceptions about Their Educational Applications in Teaching the SI Aspects of Science in Science Lessons (N=12)

High N_H =4	Moderate N_M = 4	Low N_L =4
not taught SI of science	not taught SI of science (3)	not taught SI of science (2)
mentioning the benefits of science	mentioning the benefits of science (2)	talking about scientists
talking about scientists,	giving real life examples (2)	conducting project with students about science,
connecting science and society	mentioning scientific developments	mentioning scientific process
mentioning the effects of factors on science	sharing scientific news in the lessons,	the usage memorization technics,
introducing scientific institutions	encouraging students for research	

Teachers were also asked their suggestions for teaching SI in science lessons in a better way. They were asked the questions of "What can be added to science lessons to teach SI category of NOS?" Table 33 presents the codes obtained from the answers of teachers that the frequency of the codes shows diversities among the groups. It was found that high-level group has the most diverse codes than others and the frequency of codes decreases from high to low.

Most of the teachers suggested that teachers should have student-centered approach and enable students can conduct studies by active learning. Organizing trips to students, informing about scientists, inviting scientists to science lessons, using technology effectively, using different teaching methods such as drama, discussions can be ways to teach SI aspects of science in science lessons. For example, a teacher held the following view as a suggestion to teaching SI in science lessons;

> Social aspects and institutional aspects… I believe that not only we should teach scientifically, we can give examples such as it can be described as a drama, a theater or something. The positive or negative examples from the history can be told during the lesson. I think these may be more permanent. Or by videos on the Internet could be useful. I think it would be better if not only as a discourse but also be visually.
> (P7—M-BIO-MAG-PU-TEACH4) (Appendix D35)

This teacher thought that the usage of different teaching methods such as drama and using technology in science lessons by showing visuals, videos or movies could be effective ways to teaching SI in science lessons.

Table 33. The Codes for the Teachers' Perceptions about Their Teaching Suggestions in Teaching the SI Aspects of Science in Science Lessons (N=12)

Themes	High N_H =4	Moderate N_M = 4	Low N_L =4
About Teaching Approaches	organizing trips (4) accurate representation of scientists sharing literature inviting scientists to lessons usage of technology (2) mentioning scientific process by active learning (4)	encouraging students about science collaborative learning of science giving examples from history of science organizing trips by drama by movies using visuals	by drama constructive approach should not be taught in primary and middle science lessons, no idea about classroom activities
About Teacher Education Programs	adding a unit to curriculum behaving students as scientists need for laboratories	increasing science lesson hours need for materials need for lab lessons increasing the number of science fairs need for additional course developing effective lesson plans	developing teacher edu. programs, teaching si in teacher edu. programs

On the other hand, teachers also gave some suggestions to teach SI in effective ways. Increasing science hours in schools, meeting the needs for lab materials, increasing the number of scientific trips, developing lessons plans are some of them in schools that enable teachers to teach easier ways to these aspects. On the other hand, there were also some comments for developing teacher education programs in terms of having consistent instruction to learn how to teach SI aspects of science in science lessons. For example, a science teacher expressed her ideas as the following:

> I think that education should be given to teacher because every teacher does not have the same idea. For example, I have argued that activities should be done at the end of each unit, but another teacher said me that "who will deal with every month, it can be at the end of the semester". Or some teachers have biases such as "what were you waiting for those students, they are like girls". I think that students are already found their way for learning, but teachers should be educated.
> (P12 –L-SCI-MAS-PRI-TEACH1) (Appendix D36)

According to participant, having common ideas for teaching NOS in science lessons is important to integrate these topics into science lessons. So, teacher education programs play a great role in providing consistency among them.

It was also interesting finding that one teacher with more than 20 years of teaching experience in the low-level group has the idea that teaching the social-institutional aspects of science is not appropriate for middle secondary grade students. He explained her ideas as the following quotation;

> You can't tell this to primary school or middle school students. Your job is to develop imagination aspects of primary school or secondary school children. In other words, since the child who has reached high school age is beginning of becoming an individual, it is beneficial to start from the ninth grade.
> (P11—L-SCI-UND-PU-TEACH4) (Appendix D37)

According to him, starting to teach SI in science lessons from high school is more effective way considering students' cognitive structure.

In summary, teachers generally have the idea that they teach the aims and values of science, but it was seen that they generally focused on teaching the properties of scientific knowledge and scientific methods. In term of teaching social-institutional aspects of science, half of the teachers do not think they teach SI aspects of NOS in their science lessons. However, some of them mentioned participating project, student centered teaching approaches and some scientific activities including discussions, trips, using labs etc. Finally, the suggestions for teaching both aspects of science show similarities, which are generally constructive teaching-based activities. The next section presents teachers' perceptions about their pre-service and in-service teacher educations.

4.2.3 Science teachers' perceptions about teacher education programs

This section aims to answer the second sub-research question of the third main research question "What are teachers' perceptions about their pre-service and in-service teacher education programs considering the learning and teaching of the aims and values, and social-institutional aspects of NOS?" In order to answer of this research question, four interview questions conducted to 12 teachers to determine their ideas about pre-service and in-service teacher education programs in terms of teaching and learning AV and SI aspects of NOS. Teachers' perceptions about teaching AV and SI in pre-service and in-service teacher education are presented under each title separately. The next titles provide the results findings obtained responses of teachers.

4.2.3.1 Teachers' perceptions about the pre-service teacher education programs

This section includes the results of the questions about teachers' preservice teacher education programs considering teaching the aims and values and the social-institutional aspects of science. Each finding is presented as the following sub-titles with tables and quotations.

4.2.3.1.1 Teaching the aims and values in pre-service teacher education programs

In order to learn teachers' perceptions about teaching the aims and values in pre-service teacher education programs, teachers were asked, "Do you think the aims and values of science are taught teachers in your pre-service teacher education programs?" And, "if yes, how it is taught? If no, how can it be taught?" Table 34 presents the codes and themes obtained from the responses of participants for the above questions.

According to Table 34, nine out of 12 participants thought that the aims and values of science is not taught in pre-service teacher education programs. On the other hand, three of them thought that it is taught. When we look the answers of the teachers, teachers focused on different issues about pre-service teacher education programs. One of them is content of pre-service teacher education. Almost each teacher points out that there are some deficiencies in pre-service teacher education programs in terms of their content. Participants who think AV of science is not taught in pre-service teacher education mentioned some reasons for not learning AV aspects of science. According to them, pre-service teacher education programs have no vision to teach teachers the aims and values of science. Teachers mentioned that the content of education based on the curriculum of middle and secondary science lessons. They complained about the lack of NOS courses and emphasizes in pre-service teacher education. Finally, teachers focused on that teaching the aims and values of science in pre-service teacher education changes based on the universities. It was interesting that even one participant who thinks AV is taught in pre-service teacher education mentioned that AV is only mentioned in some pedagogy-based lessons. For instance, a science teacher expressed his ideas about teaching AV of science in universities by making connection to the content of pre-service teacher education as the following quotation:

Table 34. The Codes for the Teachers' Perceptions about Teaching the AV of Science in Pre-Service Teacher Education (N=12)

Themes	Yes (3 participants)	No (9 participants)
Teaching AV in Pre-Service Teacher Education	are taught (2) are taught in NOS lesson (1)	not taught, (6) not in-depth teaching (3)
Content of Pre-Service Teacher Education	not need for extra courses (1) only in some pedagogical based lessons (1)	no vision (1) curriculum based edu. (1) lack of NOS courses (3) changing based on the universities(2) need to emphasize in pre-service teacher edu (3) only theory-based teaching (1)
Teaching Approaches and Methods	by direct instruction (1)	not inquiry learning (1) traditional teaching methods (3) exam-oriented teaching (1)
Prospective Teachers		no concerns of teachers (1) depending on the teachers' interest (1)
Instructors		lack of teaching strategies (1) not being role modelling to students (1)
Suggestions	by selective courses (2) by role modeling (1) by student-based teaching approach (1) by using laboratories (1) by seminar (1) by mentioning real life examples (1)	by integrating different science courses (5) by using student-centered approach (4) by organizing trainings (2) by doing experiments (3) by organizing trainings (2) by doing experiments (3)
Total Codes	12	47

> We were not taught the aims of science. There could be examples from the history of science, but it is not just given to us as an information. The important points could be taught. Again, considering the values of science from the history of science, examples could be given from these events. Examples from wars could be given. There was already no a lesson of history of science. There was also no a lesson about philosophy of science. Maybe because of that I could not see any people can make connections between the situations as cause-effect relationships. Because we don't know. As I said, I also do not think that values are taught. There is no such a lesson in the universities. (P10—L-SCI-UND-PU-TECH2) (Appendix D38)

As it is seen in the quotation, teacher emphasized the need for the courses philosophy of science, and history of science for teaching AV of science in the universities. The second theme is about teaching approaches and methods in the universities that most teachers thought that instructors in the universities use traditional teaching methods and give exam-oriented lectures. For instance, the following excerpt focuses on teaching methods in pre-service teacher education as;

> What I remember is that the teacher was doing a presentation that is about what science was about or what science literacy is. Or students were dividing into groups and assigned them to make presentations. As I said before, it should be with more demonstration and practice. Students can go to laboratories if they are wanted to learn the aims of the science. We can observe from the instructors that they should give us some direction how can be taught aims of science in the lessons. Unfortunately, there was no such a thing even during our internships. I couldn't see it in the lessons obviously, maybe because of that it doesn't exist.
> (P5—M-SCI-UND-PU-TEACH2) (Appendix D39)

The participant complained about instructors' teaching methods as not being based on implementation in pre-service teacher education. According to her, teaching methods should be based on student-centered and instructors should guide teachers about how aims and values of science are taught in science lessons.

There are also some codes attributing to instructors and pre-service teachers. Some teachers thought that teachers generally have no concerns about teaching or learning of the aims and values of science. Besides, instructors' lack of teaching strategies and not being role modeling to teachers may lead to this result.

Teachers' suggestions for teaching and learning AV of science show similarities for teachers who said yes or no. Half of the teachers suggested to adding a new course or integrating AV of science in different science courses enable teachers to learn these issues. Then, instructors should use student-centered approach to provide teachers to gain experiences. Behaving prospective teachers as scientists organizing trips, doing experiments, and given examples are some other codes obtained from teachers' responses. For example, a physics teacher explained her ideas as the following excerpt;

> The aims of science can be taught by pre-service teachers by doing science. They may be asked to produce that information instead of finding and seeing the existing one again. It can be observed which processes go through. This process sometimes we do when we go through the events. If you enable teachers to experience these processes, they will probably understand the importance of it. Otherwise, by reading texts or books. There are many articles related to this. These are not so much permanent in learning, but experiences can do more.
> (P1-- H-PHY-PhD-PRI-TECH2) (Appendix D40)

In the above quotation, teacher pointed out the significance of integrating teachers into the knowledge production process as teaching the aims and values of science. Using texts, books and articles may also some ways to integrating these issues in pre-service teacher education.

All in all, teachers generally do not think they learned the AV of science in detailed in their pre-service teacher educations. The reasons for that can be attributed to content of the pre-service teacher education programs, deficiencies in teaching approaches and methods that instructors used, and teachers' interests to these topics for learning. On the other hand, teachers mainly suggested the development of programs by integrating the aims and values of science, and teaching strategies and methods in the universities. The following section presents teachers' perceptions about teaching social-institutional aspects of NOS in pre-service teacher education.

4.2.3.1.2 Teaching the social-institutional aspects of science in the pre-service teacher education programs

In order to determine science teachers' perceptions about teaching social-institutional aspects of science in pre-service teacher education programs, teachers were asked the questions of "Do you think social-institutional aspects of science are taught teachers in your pre-service teacher education programs? If yes how it is taught? If no, how can it be taught?" Table 35 provides the codes and themes from the responses of teachers who think social-institutional aspects of science are taught in pre-service teacher education or not.

As it seen in Table 35 themes divided into four rows considering teachers' issues focusing on the issues while explaining the reasons and suggestions. It was found that four out of 12 teachers though that teachers are mainly taught the SI aspects of science to some extent in pre-service teacher education. On the other hand, according to eight out of 12 of teachers, SI is not taught.

Majority of the teachers focused on diverse issues about teaching SI in pre-service teacher education. For example, teachers who think both SI is taught and not taught in pre-service teacher education explained the reasons by the limited number of lessons, differences among the universities and instructors, or motivation of learners. For example, a teacher expressed his idea about teaching SI aspects of science in pre-service teacher education as the following quotation;

> Not exactly. One or five percent is taught not more than ten percent. Of course, this varies from university to university, but very few are taught. So, I don't think that education was given at the university. For example, if someone found something, he doesn't know which institution he will apply to. Teachers thought that "If I want to do scientific researches, I have to go to the university.". I don't think that they have learned anything other than that. (P4 –H-SCI-UND-PRI-TEACH2) (Appendix D41)

Table 35. The Codes for the Teachers' Perceptions about Teaching SI Aspects of Science in Pre-Service Teacher Education (N=12)

Themes	Yes (4 participants)	No (8 participants)
Teaching SI aspects of science	are taught specifically (1) are taught to some extent (3)	Not taught (5) not taught in detail (3)
Teaching Approaches or Methods	need for emphases NOS pre-service teacher education (1)	not practice based teaching (3) not informing teachers about scientific institutions (1)
Other Factors	changing from universities changing according to instructors limited number of lessons (1)	no science-based aims (2) motivation of learners (1) changing from universities (1) limited number of lessons (2)
Suggestions	by student centered teaching approach (teaching by activities and experiments) (2) mentioning functionality of science institutions (2) teaching by talking with scientists (1)	by student centered teaching approach (teaching by activities and experiments) (4) mentioning functionality of science institutions (3) teaching by visiting scientific institutions (2) by in-service trainings (1) by reading science magazines (1)
Number of Total Codes	11	29

The teacher complained about the limited number of lessons and content-based problems. Additionally, half of the teachers mentioned deficiencies in teaching methods and approaches. According to them, the existing programs are not practice based and do not inform teachers about different scientific institutions and their functions. For example, a participant claimed as:

> I think it could be beneficial for us even there could be any scientific festival or exhibition, but it could not. I saw that every instructor has a study when I started my master's degree. They have their own lab and they work there. For me, university was like a high school. I was coming and leaving from class. We didn't know what the instructors were doing. When we see the name of our instructors in the book, we could be said that "Oh, did this teacher write this?". I don't think institutional aspects are taught either. I know TUBITAK for years, but even now, I do not exactly know what it does, how it does research. I do not have enough information about it. They are not taught anywhere, and perhaps that is the weakest point of us.
> (P8 –– M-CHEM-MAS-PU-TECH1) (Appendix42)

The participant mentioned that pre-service teacher education programs do not mentioned SI aspects of science. According to teacher, organizing professional activities such as fairs, seminars, trips may enhance teachers' perceptions about SI aspects of nature of science. Finally, Teacher made some suggestions to improve teaching SI in preservice science education. These suggestions show similarities for teaching AV of science that most of the teachers put emphasis the significance of student-centered teaching approach. Moreover, introducing scientific institutions to students, teaching SI in in-service teacher education, and enabling teachers talking with scientist are some of them.

It can be said that teachers have common ideas and suggestions about teaching AV and SI aspects of science in pre-service teacher education programs even though they think these aspects are taught or not taught in pre-service teacher education.

4.2.3.2 Teachers' perceptions about the in-service teacher education trainings

This section presents the responses of teachers of the questions considering in-service teacher trainings in terms of teaching the aims and values and the social-institutional aspects of science. Each finding is presented as the following sub-titles with tables and quotations in the following sections.

4.2.3.2.1 Teaching the aims and values of science in the in-service teacher trainings

In order to learn teachers' perceptions about teaching the aims and values in the in-service teacher education programs, teachers were asked "Do you think the aims and values of science are taught teachers in your pre-service teacher education programs?

If yes how it is taught? If no, how can it be taught." Table 36 provides the codes and themes obtained from the responses of teachers for the above question.

Table 36. The Codes for the Teachers' Perceptions about Teaching the AV of Science in the In-Service Teacher Trainings (N=12)

Themes	Yes (2 participants)	NO (10 participants)
Teaching AV in the in-service teacher trainings	Are taught in private in-service trainings of universities (1) Are taught in some extent (1)	not taught in in-service teacher training (10)
Teaching Approaches or Methods	not in-depth teaching (1)	only knowledge level training (2) NOS is assumed understood by teachers (1) lack of emphasis for NOS in PD (1) not taught in content (3)
Other Factors	changing from instructors (1)	based on learners' motivation (2) lack of technology (1)
Suggestions	by practice based edu. (2) teaching tentativeness of science (1) innovations in the curriculum (1) being aware of current studies (1) by discussions (1) increasing awareness of teachers (1)	by in-service teacher trainings (1) by distance education (1) by organizing camps (1) by NOS based PD programs (2) developing the content of the in-service trainings (2) by MEBBİS (1)
Number of Total Codes	11	28

It was found that 10 out 12 teachers think that AV of science was not taught in in-service teacher trainings while two of them think that it is taught in some extent. Besides, the themes show similarities with Tables 34 and 35 that teachers talked about teaching methods and content of the in-service trainings. According to them, teaching NOS is not taught as content in in-service teacher trainings. For instance, one of the teachers explained the content of in-service teacher training as the following quotation;

> It's definitely not taught. Because I wanted to apply for a science-related education but there wasn't even a single department. Courses can be opened by instructors at the university via MEBBİS and they can give lessons to teachers according to their majors. We have laboratories both in our universities and our schools so it can be done. We also have R & D units, science and art centers. If someone would examine in service training via MEBBIS, he/she can understand that my word is true.
> (P4 –H-SCI-UND-PRI-TEACH2) (Appendix D43)

In the above quotation, teacher complained about lack of NOS and science content in in-service teacher education. On the other hand, some teachers also mentioned the effects of learners' motivation and lack of technology on in-service teacher educations.

Additionally, it was also found that teachers' suggestions show similarities with other suggestions presenting table 34 and 35. However, teachers focused on more development of in-service trainings in terms of access, content and teaching methods such as distance education, the usage of MEBBIS, or suggesting NOS based PD programs.

4.2.3.2.2 Teaching the social-institutional aspects of science in the in-service teacher trainings

The question of "Do you think social-institutional aspects of science are taught teachers in your pre-service teacher education programs? If yes how it is taught? If no, how can it be taught?" are the final question to determine teachers' perceptions and suggestions for in-service teacher trainings. Table 37 presents the general theme and codes obtained from above questions.

It was interesting that the ratio was found similar for SI category of science that 10 out of 12 teachers do not believe SI is taught in the in-service teacher education programs. Teachers differently, mentioned the needs for conducting projects, for learning the functions of institutions, and professional activities.

Table 37. The Codes for the Teachers' Perceptions about Teaching the SI Aspects of Science in the In-Service Teacher Trainings (N=12)

Themes	Yes (2 participants)	No (10 participants)
Teaching SI in the in-service teacher trainings	are taught in in-service teacher training (2)	not taught in in-service teacher training (10)
Teaching Approaches or Methods		NOS is assumed understood by teachers (1) need long-term progression (1) not in content (1) need for practice-based learning (1)
Other Factors	changing from institutions (1) changing from instructors (1)	insufficient instructors (2) need for learning functions of institutions (1) based on learners' motivation (2) not in connection between institutions (1) changing from school types (1) need trainings for conducting projects (1) attendance problems in-service teacher trainings (1)
Suggestions	by in-service trainings (1) conducting R&D projects (1) organizing trips to science-art centers (1) by interdisciplinary relations (1)	by compulsory trainings (1) PD based on acquisition of content knowledge (1) raising awareness for issues related to NOS (1) presenting new developments in technology (1) by in-service teacher trainings (1) by MEBBIS (1) by meeting the needs of teachers (1) enabling social network (1) enabling sharing ideas (1)
Number of Total Codes	8	32

Similarly, participants' suggestions were similar to each other that they suggested the development of in-service teacher trainings by organizing trips, conducting projects, enabling social networks and sharing ideas.

All in all, the frequencies of codes and themes showed that most of the teachers do not think AV and SI aspects of science are taught in both pre-service teacher education and in-service teacher trainings. This result consistent with the quantitative data sources that Yes-No questions have the same frequency and percentages with the qualitative one. On the other hand, qualitative data source provided more detailed information about the results of the quantitative data sources. The responses of teachers showed that teachers think as teaching NOS can change from the universities and instructors. Besides, teaching approach and methods play a significant role in attracting teachers' attention and understanding different aspects of NOS. Same factors were found also significant for in-service teacher education programs that teachers have found deficiencies in terms of teaching and learning science, scientific concepts, developments about scientific studies, and also nature of science. Suggestions showed that teachers expect student-centered teaching approach, active and collaborative learning, developments in in-service teacher trainings, and accessing in-service teacher education programs easily.

4.2.4 Teachers' perception about their informal learning environment

The final sub-research question is "What are the perceptions of teachers on their informal learning environments?". In order to determine teachers' perceptions about their informal learning environments they were asked a question of "Do you consult each other as teachers for the issues you don't know? For example, you are directed a question about aims of science or social-institutional aspects of science. Which sources do you prefer first?" By these questions, teachers' ideas about their learning channels were aimed determined. Table 38 provides the lists of teachers' preferences for informal learning.

Table 38. Teachers' Preferences List for the Their Informal Learning Channels

	High	Moderate	Low
First source	social media (3) consulting colleagues (1)	social media (2) consulting colleagues (1)	consulting colleagues (3) social media (1)
Second source	consulting colleagues (1)	social media (1) consulting colleagues (1)	Social media (2) Consulting colleagues (1)
Other sources	by reviewing literature (2) using libraries (1) consulting experts in the universities (1)	consulting experts (1) consulting students (1)	always checking the knowledge (1) searching more reliable sources (1)
Not consulting	not consulting colleagues (1)	Not consult any source (1) no need to answer each question (1)	not consulting colleagues (1)

It was seen on Table 38, consulting teachers in the same fields, searching from social media and reviewing articles are the most common channels that teachers used. It was found that six out of 12 teachers use social media which are Google, Facebook, WhatsApp, and other online sources as the primary sources of learning scientific knowledge. Then, three of them consult their colleagues as secondary source of reaching issues they don't know. For example, a teacher expressed his ideas as the following quotation;

> I make research on Google as the first source. Because I know that it hasn't been taught to other friends. If there is a question about the lesson and I could not solve it, I would contact the teacher who expert about it is. Another example if I'm working on a project because of the fact that other teachers are not taught that issue and I do not have a book nearby, I look at the Google, internet.
> (P10—L-SCI-UND-PU-TECH2) (Appendix D44)

As it seen above quotation, teacher has bias towards asking questions to colleagues about the issues he does not know. Teacher thinks that they have same knowledge about the issues so because of the fact the access to online sources fast, he prefers to search by online sources. On the other hand, five out of 12 teachers consult their colleagues as the primary sources and, three of them uses social media as secondary sources of learning issues they wonder. The following excerpt presents a teacher's ideas about his learning channels;

> If they know about the topic, I consult to them. I ask to who has enough information about the topic or I think he is know something about it. If I think his knowledge is not enough, I back to search or ask more people the go into the research myself. But I usually see in other people that even if they do not know something, they are thinking that "I know so much, so no more can be known". They cannot provide no more information, or they tell wrong information with very confidence. Generally, these people are not curious. People think that they know a lot and, especially while their experience increases, their tendency to ask others is decreasing. If they are wrong, they probably have been making the same mistake for 15-20 years. They continue in this way and resist to change both when they come to in-service training. Currently, new graduates aged 25-30 or up to 30 are more likely to have in-service training and change their understanding.
> (P1-- H-PHY-PhD-PRI-TECH2) (Appendix D45)

The above quotation was good in terms of showing teachers' ideas about informal data sources, such as consulting colleagues, and also their observations about the effects of teachers' teaching experiences on their attitudes in-service teacher education programs. According to above teacher, teachers who have high teaching experiences show resistance to learning new information. Hence, teachers may pay attention to their colleagues when they ask questions considering colleagues attitudes toward new information.

As a summary, qualitative data sources provided a more detailed information about the answer of the research questions by presenting reasons with quotations and the tables including frequencies of codes and themes. It can be said that teachers generally have moderate level perception about AV and SI categories of NOS. Their educational applications to teach AV and SI categories of NOS should be developed. Hence, developing pre-service and in-service teacher education programs may help teachers to develop both their understanding about NOS, and also their professional and vocational skills. Additionally, it can be said that the quantitative and qualitative results are consistent in terms of interpreting data. The following section provides the discussion of the findings considering the studies in the literature.

CHAPTER 5

DISCUSSIONS AND CONCLUSIONS

This chapter mainly covers the summary of the results, discussion of the quantitative and qualitative results, some implications of teachers learning of NOS in pre-service and in-service teacher educations, and also their educational application in science lessons, finally limitation of the study and some recommendations for further studies.

5.1 Summary of the study

This study is based on Erduran and Dagher's (2014) framework of "Family Resemblance Approach (FRA)" which lately which renamed by Kaya and Erduran (2016b) as "Reconceptualized Family Resemblance Approach to Nature of Science" or RFN to show educational adaptations of FRA. This approach describes science as epistemic-cognitive and social-institutional systems (Erduran & Dagher, 2014). In this study, one of the epistemic-cognitive dimension which is the 'aims and values' and also the social-institutional aspects of science which includes the dimensions of 'professional activities', 'scientific ethos', 'social values', 'social certification and dissemination', 'political power structures', 'financial systems', and 'social institutions and interactions'. On the other hand, teacher education includes formal education of pre-service teacher education in the universities and also in-service teacher trainings, which are administrated by Ministry of National Education. Some of these training are compulsory while some of them are based on the teachers' voluntary participation. Moreover, teachers' informal learning has play key role in their professional and personal development. This study have several purposes which are investigating teachers' understanding and perceptions about the aims and values and the social-institutional aspects of science through NOS Questionnaire and in depth interview questions, determining the effects of teachers' branches, teaching experiences, educational levels, and school types on their perceptions about two aspects of science, presenting teachers educational applications and suggestions for teaching NOS in science lessons, determining teachers perceptions and suggestions about teaching and learning of NOS in their pre-service and in-service teacher education, and finally determining teachers' ideas about their informal learning. 220 teachers who are in science branches participated the quantitative part of the study by convenience sampling while 12 of them selected purposeful sampling for the qualitative one. The NOS Questionnaire includes 26 items and five Yes-No questions as a quantitative part of the study. On the other hand, interviews consist of 17 semi-structured questions aims to reach the purposes of the study. Descriptive and inferential data analyses were used to analyzed quantitative data. Thematic and content analysis were conducted for qualitative data. Quantitative data showed that there is no significant difference considering the teachers' branches, teaching experiences, educational levels, and school types. On the other hand, qualitative data provided broader and comprehensive results about teachers' perceptions two aspects of NOS and also each research question. All in all, this study also has some implications for teacher education, and school science. This study contributed to understand how NOS can be perceived by teachers, what teachers think about educational applications of NOS, and also their suggestions about pre-service and in-service teacher education programs. The following section discuss about the results of quantitative and qualitative findings considering the research questions by the help of literature.

5.2 Discussion of the results

The quantitative data analysis provided descriptive and inferential statistics about teachers' understanding about the AV and the SI aspects of nature of science, teachers' ideas about teaching the AV and the SI aspects of science in pre-service and in-service teacher education, and the effects of teachers' branches, teaching experiences, educational, levels, and school types on their perceptions. When the percentages of the mean scores about three dimensions of NOS Questionnaire were compared and contrast, it was found that teachers have higher mean score in educational application (EA) (87.8) than two others which are the aims and values of science (AV) (69.2) and social-institutional aspects of science (SI) (68.6). Thus, it can be said that teachers have more than moderate level understanding for both AV and SI aspects of science. When the items of the EA dimension of NOS Questionnaire were considering, it can be said that most of the teachers have common ideas about that students should be taught AV and SI categories of NOS, they may benefit from teaching these categories of NOS in science lessons, creating discussions about these issues in science lessons and enable students to works as collaborative way may increase their awareness about these aspects of science. It may because of the fact that since 2005, Turkey has adopted constructivism as a teaching approach; hence these terms or methods may become familiar most of them. Moreover, they also think that these issues should be taught in science lessons, which in most of the interviews, teachers mentioned the significance of teaching these aspects of NOS in science lessons.

Descriptive statistics also provided information about the frequency and percentages about teachers' ideas about teaching AV and SI in their pre-service and in-service teacher education programs. It was found that more than half of the participants think that they were not participate in-service training as voluntarily. The interviews provided more elaborated explanation for these results that most of the teachers mentioned the quality of the trainings, the properties of the trainers and trainees, the content of the training, duration of the training, and also teaching approaches and methods used in-service teacher trainings as a source of their motivation. It was also found that more than half of the participants do not think AV and SI aspects of science are taught in pre-service teacher trainings. On the other hand, the ratio increases for in-service trainings that more than 75% of the teachers do not think that AV and SI categories of NOS. The reason may be the difference in the content of trainings that teachers take science courses (biology, chemistry, physics, astronomy, mathematics, lab applications etc.), pedagogy courses (assessment, guidance, special education, teaching approaches and methods etc.), and selective courses (sociology, psychology, humanities, history, language courses etc.) some courses in their pre-service teacher education (YÖK, 2018). On the other hand, in-service teacher education programs mainly based on educational technology (Robotic Coding, Arduino, FATİH Project, EBA, PCK for technology etc.), teaching methods (STEM, Assessment, Special education, Classroom Management, Inquiry Learning, Argumentation, Intelligence Games, Creative Drama etc.), professional development (Student Coaching, Orientation, Guiding Adolescents, Leadership, Educational Psychology, Memory Technics, Emergency Education etc.), and finally content knowledge (Science Education, Astronomy, Developments in Biology, Ecological Literacy, Scientific Literacy, NOS etc.) (MEB Hizmet İçi Eğitim Planları, 2018). However, in-service teacher education programs are mainly depended on the Provincial and District National Education Directorates so access to these programs is changeable.

The inferential analysis indicated that teachers' understanding about AV, SI, and EA categories of NOS Questionnaire changes according to their branches but not their teaching experiences, educational levels, and school types. It was found that biology teachers have lower mean score than others in terms of EA and total NOS score. These results may be because of the fact that differences in biology teachers' educational applications than others. Such that the difference in total NOS scores due to the fact that biology teachers' low score in EA dimension of the Questionnaire because their AV and SI mean scores were similar to other branches. However, because of the fact that data were not distributed normally, and variances were not equal for different categories, Brown-Forsythe Test used. However, there are also some potential risks for Brown-Forsythe Test that it has less likely to determine the differences among the means compared to Levene's test (Hill, et all, 2006). However, when the mean scores of teachers considering their teaching experiences, educational levels, and school types, they were really similar to each other. Besides, the results show similarities with the qualitative data analysis, which provides the consistency of the findings. The results also showed that even there is no significant difference among the teachers who have different educational levels; the mean score of SI dimension of NOS Questionnaire also increases when the level of teacher increases. It may be because of the fact that having experiences about working mechanism of scientific knowledge such as attending conferences, reading and writing articles, discussing about different ideas approach etc.

On the other hand, qualitative data analysis provided a more comprehensive result about the research questions. The second main question was aimed to determine teachers' perceptions about the aims and values (AV) and the social-institutional (SI) aspects of NOS. It was found that most of the teacher perceived aims of science by serving the humanity and understanding the universe. Besides, majority of them made connection to ethics, and less of them also mentioned objectivity, universality and honesty as values of science. The codes obtained from the responses of teachers show coherence with Kaya, Erduran, Aksöz and Akgün's (2019) study that they work with 15 pre-service science teachers and investigate the effects of the 11- 3 hours intervention on their perceptions about each components of NOS. According to this study, intervention had positive effects on pre-service science teachers' perceptions. Even before the intervention most of the pre-service teacher emphasized serving to humanity, understanding the universe, and ethical issues by describing the aims and values of science, after the intervention they also generated new codes learning about the environment and the earth, and keeping up with modern developments and technology. Their codes also developed while explaining the values of science such as being free of bias and cultivating honest science.

In this study teachers' perceptions about the social-institutional aspects (SI) of science was investigated in depth for general and sub-categories of SI separately. Before asking for each dimension of SI, teachers were asked their ideas about SI of science. It was seen that most of the teachers made connection to using technology, doing science for society and dissemination of scientific knowledge as social aspects of science, and scientific institutions as the institutional aspects of science. Asking questions about each sub-category of science provided more detailed information about teachers' perceptions. They made probably connection with the words social and society, and institutions and science.

It was found that teachers' perceptions change for different sub-categories of SI. For example, most of the teachers perceived Professional Activities of science as following research steps, which is about scientific methods, and methodological rules of nature of science. They made limited connections to attending conferences, peer reviews, writing articles etc. For the Social Values and Scientific Ethos categories of SI, most of the teachers mentioned animal care, respect for the environment. However, less of them emphasized the significance of methodological issues such as accurate reporting, selecting data as representing the population etc. Moreover, for the category of Social Certification and Dissemination teachers have limited perceptions. Even some of the teachers mentioned some dissemination problems such as misuse of science, limited access to articles, or personal interest, less of them talked about verification, certification and testing issues as precondition of certification and dissemination of scientific studies. Also, they generally gave social media examples as dissemination channels of scientific studies. For Political Power Structures category of SI, teachers mentioned the effects of political ideologies, the relationship between finance and science, hierarchy problems in the universities, and also the effects of culture while explaining the political power structures of nature of science. For the Social Organizations and Interaction category of SI, teachers gave many examples to scientific institutions. However, most of them claimed that they have no idea about the functions of them or their interactions. Asking questions separately helped teachers to make connections easier.

It was seen that the total frequency of the codes and themes obtained from AV and SI aspects of science are parallel with the teachers' understanding level of NOS which was determined by NOS Questionnaire. That means teachers who are in high level group generated more codes comparing the moderate, and also moderate groups provided more codes compared to low. When all frequencies are calculated considering teachers' branches, it was found that physics teachers generated more codes than others. It may due to the differences among the disciplines. It was also found that teachers' branches affected their examples. For instance, chemistry teachers mentioned much more experiments than biology teachers. On the other hand, biology teachers generally gave health examples. Physics teachers focused on astronomy issues and science teachers gave examples considering their grade levels of students. Besides, teachers who had six to10 years of teaching experience mentioned more codes than others. It may be because those teachers have more experience than teachers who have zero to five years of teaching experience and also they remember more about their pre-service teacher education. Besides, it was found that as the teaching experience increased, there was a decrease in university-based examples. Teachers have difficulty in making connections to their pre-service teacher educations. Moreover, PhD student mentioned significantly higher number of codes. This result may be attributed to teacher's experiences in graduate level lessons. PhD lessons provides students readings and writing articles, attending conferences, attending groups works, making presentations, participating projects, making connections to scientific institutions, trying to find budgets for scientific studies, or having opportunity for observing the relationships between scientists. On the other hand, even though school types are not found as a significant factor, teachers who work in private schools mentioned some special personal development programs they participated in. All those may enable teachers to develop their perceptions about AV and SI aspects of science.

The third main research question was aimed to determine teachers' educational applications and suggestions in science lessons. It was found that most of the teachers mentioned teaching properties of scientific knowledge and scientific methods as teaching AV of science. On the other hand, half of the teachers claimed that they do not teach SI of science in their lessons. According to them, they teach SI by mentioning current developments about science, mentioning the benefits of science for society, and talking about scientists. These were really limited educational applications that do not provide students to higher levels understanding about NOS. On the other hand, teachers' suggestions were generally based on improving the conditions which lead to preventing teaching NOS such as, need for physical equipment, curriculum-based problems, adding selective course, need physical environment etc. There are also some suggestions in line with RFN based studies such as collaborative learning, active learning, adopting constructivist approach or organizing trips to scientific institutions. These studies emphasized that providing students to activities and environments which are similar to scientists may increase their attention to scientific studies such as working as team, making presentation, creating discussion environment, referencing scientific institutions etc. (Aksöz et al. 2017; Çilekrenkli, 2019; Erduran & Dagher, 2014; Kaya, Erduran, Akgün, & Aksöz, 2019;). It is also significant that the effectiveness of teaching NOS mainly depends on the teachers' high-level understanding (Harlen, 1990). Hence, increasing teachers' perceptions and understanding about NOS in teacher education play a great role in their educational applications in science lessons.

Determining teachers' perceptions about their pre-service and in-service trainings is also aimed in this study. When the results are considering it can be said that teachers generally thought that teacher education programs are insufficient in terms of quality, content, teaching methods, trainer and trainees. The results are in line with the study conducted by Gönen and Kocakoya (2006) that even though 75 out of 100 physics teachers think in-service training is necessary, 19% of the participant claimed that they have not participated any in-service teacher training. It was found that teachers are unwilling for participating in-service education programs. Similar results were also found by Arslan and Şahin (2013) that most of the teacher explain the reasons for participating in-service teacher education programs for personal development, involving in a social environment, taking certificates, and benefiting from trips. On the other hand, participants suggested the trainings should not be compulsory, trainees should be selected considering their competencies, trainings should be prepared considering the needs of trainees, also trainings should enable trainees to share their experiences

Finally, sub-research question was aimed to determine teachers' perceptions about their informal learning channels. It was found that teachers generally consult their colleagues as a first source for the issues they wondered. On the other hand, some of them prefer to search by themselves via online sources. The results are parallel with the literature that informal learning was seen as one of the most prominent features of teachers' learning due being accidentally, easy to access, not need to structured curriculum, place and time (Marsick & Watkins, 2001; Ünlühisarcıklı, 2018). Hence, teacher education programs should be organized to improve teachers' learning capacities in informal learning environments, enable them to explore their teaching ways, and working as collaborative ways. These are can be also helpful for teachers to reflect on their practice and learn from their colleagues in their classes. All in all, there are also some implications, recommendations, and limitations of this study.

5.3 Implications

The results of the quantitative and qualitative data showed that majority of the teachers have moderate levels of understanding considering the aims and values

(AV) and the social-institutional (SI) aspects of NOS. It was also found that teachers' branches, teaching experiences, educational levels, and school types do not have an effect on their understanding. The qualitative data specifically provided an explanation for the quantitative one that teacher education programs play a key role in development teachers' perceptions about NOS and their educational applications for teaching NOS. Majority of teachers thought that NOS cannot be taught in teacher education trainings. Hence, specifically NOS based courses or the courses mentioned these aspects of NOS such as philosophy of science, sociology of science, history of science, methods of science can be added to both pre-service and in-service teacher education programs. In this regard, RFN can be an effective approach in teaching epistemic-cognitive and social-institutional aspects of nature of science because it provides educational implications for each level of learners by presenting effective visuals and suggesting teaching methods for in school science and teacher education.

The responses of the teachers also showed that pre-service and in-service teacher education programs should be developed in terms of their quality, teaching approach and methods of instructors, and also the content of the educations. Most of the participants suggested that the student-centered teaching approach might enable them to integrate the process of scientific knowledge production. Besides, teacher education programs especially in-service teacher trainings may include more science-based content educations, which may be provided by workshops to teachers instead of direct instruction. All these factors can improve the quality of teacher education as well as the motivation of teachers to participation these trainings.

5.4 Limitations

There are also some limitations of this study. The first limitation is that this study only focused on two components of RFN, which are the aims and values, and the social-institutional aspects of science. Nature of science, on the other hand, was described as epistemic-cognitive systems by Erduran and Dagher (2014). That means all components of NOS provide a holistic structure about science. Hence, investigating teachers' understanding and perceptions about NOS in a holistic way could provide more detailed information about their understanding about NOS.

Second limitation can be selecting different number of participants for different factors such as branches, teaching experiences, or educational levels. Although the quantitative and qualitative results were consistent to each other, it cannot be claimed these results are valid for all teachers.

The third limitation can be related to the lenses of the researcher. Especially, qualitative data sources were including high level codes and themes. Even though similarity ratio was found high in the reliability study, the data has potential to affected bias of the researcher. It was nature of the qualitative based studies.

5.5 Recommendations

This study has significant contributions to science teacher education in terms of providing information about how teachers perceive some NOS components, which are the aims and values and the social-institutional aspects of science; their educational applications and suggestions for teaching these NOS components; their ideas about the pre-service and in-service teacher educations; and finally their ideas about their informal learning environments. Hence, there are some recommendations for the policy makers, teacher education, and future researchers.

5.5.1 Recommendations for the policy makers

The findings of this study present valuable information for the policy makers. Policy makers can take into consideration the teachers' perceptions about the NOS, and their suggestions for their educational applications while teaching the NOS. Besides, teacher education programs and the curriculum can be developed considering teachers perceptions and suggestions. The results showed that the content of the teacher education programs has a great effect on teachers' perceptions. Hence, the content of teacher trainings can be developed considering teachers' suggestions. For example, teachers mentioned some specific courses such as philosophy of science, nature of science, history of science etc. These courses can be integrated both school science and also teacher education programs by MEB and YÖK. It was found that there are some deficiencies in teacher trainings due to the instructors, teaching methods and approaches, duration, or places. Hence, the results of this study may enable policy makers to organize more qualified and effective teacher education programs in our country.

5.5.2 Recommendations for the teacher education

This study provides information for teachers' perceptions about their pre-service and in-service teacher trainings. Most of the teachers think that teacher education programs should be developed in terms of teaching methods and approaches. For example, teachers recommended in their interviews more learner oriented and practice-based activities in their trainings such as organizing workshops, trips, developing lesson plans, using technology effectively etc. Another recommendation can be the integration of the NOS itself in the teacher education programs. Different aspects of NOS can be taught teachers by explicit or implicit ways. For example, teachers can aware of the aims and values of science which scientists pay attention, institutions scientists work, the effects of sociological, political and economic factors on scientific studies, dissemination process of scientific knowledge etc. Hence, in order to increase teachers' awareness, instructors can also focus on these issues in their lessons and enable teachers to experience these processes by conducting a scientific study. Also, teachers can be expected to prepare lesson plans considering teaching these aspects of NOS in their science lessons. Final recommendation can be the development in physiological environment in science education where the number science-based materials, laboratories, lab lessons can be developed.

5.5.3 Recommendations for the future studies

For the future research, increasing the number of participants with equal size diversity, conducting studies about all aspects of RFN can be beneficial for getting more representative results about the population. On the other hand, interview questions, which about pre-service and in-service teacher education can be adapted for NOS Questionnaire. By this way, qualitative data can also be used to explain the results of the quantitative data in terms of teacher education programs. Besides, further studies can be conducted with workshops and empirical based studies to determine the effectiveness of teaching RFN in pre-service and in-service teacher education programs. Empirical based studies may be focusing on determining the effects of teaching NOS in explicit or implicit ways in the pre-service or in-service teacher education programs and determining the changes in teachers' perceptions, implications or attitudes towards science.

APPENDIX A

APPROVAL OF BOĞAZİÇİ UNIVERSITY-INAREK/SBB ETHICS SUB-COMMITTEE

T.C.
BOĞAZİÇİ ÜNİVERSİTESİ
İnsan Araştırmaları Kurumsal Değerlendirme Alt Kurulu

Sayı: 2017/74

7 Aralık 2017

Büşra Aksöz
Eğitim Bilimleri

Sayın Araştırmacı,

"Fen Branşındaki Öğretmenlerin Bilimin Doğasına İlişkin Anlayışları: Bilimin Amaç ve Değerleri ile Bilimin Sosyal-Kurumsal Yönleri" başlıklı projeniz ile ilgili olarak yaptığınız SBB-EAK 2017/76 sayılı başvuru İNAREK/SBB Etik Alt Kurulu tarafından 7 Aralık 2017 tarihli toplantıda incelenmiş ve uygun bulunmuştur.

Doç. Dr. Gül Sosay

Doç. Dr. Mehmet Yiğit Gürdal

Doç. Dr. Ebru Kaya

Yrd. Doç. Dr. Bengü Börkan

Yrd. Doç. Dr. İnci Ayhan

APPENDIX B

INFORMED CONSENT FORM

KATILIMCI BİLGİ VE ONAM FORMU

Araştırmayı destekleyen kurum: Boğaziçi Üniversitesi
Araştırmanın adı: Fen Branşındaki Öğretmenlerin Bilimin Doğasına İlişkin Anlayışları: Bilimin Amaç ve Değerleri ile Bilimin Sosyal-Kurumsal Yönleri
Proje Yürütücüleri: Prof. Dr. Zeynep Kızıltepe, Doç. Dr. Ebru Kaya
Adresi: Boğaziçi Üniversitesi, Kuzey Kampüs, EF Binası, Eğitim Bilimleri Bölümü Bebek/İstanbul 34342
Adresi: Boğaziçi Üniversitesi, Kuzey Kampüs, ETA-B Binası, Matematik ve Fen Bilimleri Bölümü Bebek/ İstanbul 34342
Araştırmacının adı: Büşra Aksöz
E-mail adresi: busra.aksoz@boun.edu.tr
Telefonu: 05310112960

Sayın Öğretmen,

Bu anket, Boğaziçi Üniversitesi, Eğitim Bilimleri Bölümü, Yetişkin Eğitimi programında yüksek lisans öğrencisi olan Büşra Aksöz'ün yüksek lisans tezi kapsamında uygulanmaktadır. Büşra Aksöz'ün ‘‘Fen Branşlarındaki Öğretmenlerin Bilimin Doğasına İlişkin Anlayışları: Bilimin Amaç ve Değerleri ile Bilimin Sosyal ve Kurumsal Yönleri" başlıklı tezi Boğaziçi Üniversitesi, Eğitim Bilimleri Bölümü öğretim üyesi Prof. Dr. Zeynep Kızıltepe ve Boğaziçi Üniversitesi, Matematik ve Fen Bilimleri Eğitimi Bölümü öğretim üyesi Doç. Dr. Ebru Kaya tarafından yürütülmektedir. Bu tez kapsamında fen branşlarında (fizik, kimya, biyoloji ve fen bilimleri) görev yapan öğretmenlerin bilimin doğasına ilişkin algılarını ‘‘Yeniden Kavramsallaştırılmış Aile Benzerliği Yaklaşımı’’ çerçevesinde değerlendirmek hedeflenmektedir. Bu bağlamda, fen branşlarındaki öğretmenlerin bilimin amaç ve değerleri ile bilimin sosyal ve kurumsal yönlerine ilişkin algıları belirlenecek ve öğretmenlerin almış oldukları lisans ve hizmet içi eğitimlerin etkisi değerlendirilecektir.

Bu araştırmaya katılmayı kabul ettiğiniz takdirde, sizden 29 maddeden oluşan ve yaklaşık 10 dk sürecek olan bu anketi tamamlamanız beklenmektedir. Anketin ilk kısmında görev yaptığınız okul türü, hizmet yılınız, branşınız, eğitim durumunuz ve e-mail adresiniz sorulmaktadır. E-mail adresinizin istenme nedeni, çalışmaya katılan öğretmenlerin bazıları ile çalışmanın diğer adımında görüşmelerin yapılacak olması ve görüşme yapılacak öğretmenlere bu e-mail adresleri aracılığıyla ulaşılacak olmasıdır.

Bu araştırma bilimsel bir amaçla yapılmaktadır ve katılımcı bilgilerinin gizliliği esas tutulmaktadır. Bu nedenle anketler aracılığıyla toplanan veriler araştırma süresi boyunca bilgisayarda güvenliği korunarak muhafaza edilecek ve araştırma sona erdiğinde silinecektir. Bu araştırmaya katılmanız tamamen sizin isteğinize bağlıdır. Katıldığınız takdirde, çalışmanın herhangi bir bölümünde bir sebep göstermeden çalışmadan ayrılma hakkına sahipsiniz. Araştırma projesi hakkında herhangi bir şey sormak istediğiniz takdirde lütfen tez yürütücüleri Prof. Dr. Zeynep Kızıltepe (e-mail adresi: zeynep.kiziltepe@boun.edu.tr), Doç. Dr. Ebru Kaya (e-mail adresi: ebru.kaya@boun.tr) ve yüksek lisans öğrencisi Büşra Aksöz (e-mail adresi: busra.aksoz@boun.edu.tr) ile temasa geçiniz. Eğer bu araştırmaya katılmayı kabul ediyorsanız, lütfen aşağıda bulunan onay kutucuğunu işaretleyiniz.

Ben, bana verilen metni okudum ve katılmam istenen bu çalışmanın amacını ve içeriğini göz önünde bulundurarak, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın katılmayı kabul ediyorum.

( ) Evet

( ) Hayır

Katılımcının Adı Soyadı:...
İmzası:..
Adresi (varsa Telefon No, Faks No):...
....
Tarih (gün/ay/yıl):...../......./.............

Araştırmacının Adı-Soyadı:...
İmzası:..
Tarih (gün/ay/yıl):...../......./........

APPENDIX C

NATURE OF SCIENCE (NOS) QUESTIONNAIRE (ENGLISH)

PART 1: DEMOGRAPHIC INFORMATION

Gender: ……………………..   e-mail adress: ……………………..

School Type:
- o Public School
- o Private Okul

Branches:
- o Physics Teacher
- o Chemistry Teacher
- o Biology Teacher
- o Science Teacher

Education Level:
- o Undergraduate Level
- o Master Student
- o Master Graduate
- o PhD Student
- o PhD Graduate

Serving Year:
- o 0 to 5 years of teaching experience
- o 6 to 10 years of teaching experience
- o 11 to 15 years of teaching experience
- o 16 and above years of teaching experience

PART 2: NATURE OF SCIENCE QUESTIONNAIRE

In this questionnaire, there are 26 statements about the aims and values and the social-institutional aspects of the nature of science. Please read the following statements and then select the alternative that best describes your position on the statement. The alternatives are ‘‘Totally Disagree’’, ‘Disagree’, ‘‘Neither Agree nor Disagree’’, ‘Agree’ and ‘‘Totally Agree’’.

	Totally disagree	**Disagree**	**Neither Disagree nor Agree**	**Agree**	Totally Agree
1. Science lessons should include financial (economical) aspects of science.					
2. Epistemic, cognitive and cultural values of science cannot be distinctly distinguished from each other.					

3. Science takes place in institutions such as universities and research centers.					
4. Science is a social system.					
5. Politics do not influence science.					
6. Scientists should respect the environment.					
7. Scientists don’t have to share their research with society.					
8. The diversity of scientists solving a problem means less biased results					
9. Educating students about scientific aims and values improves scientific literacy.					
10. Students should be encouraged to collaborate with their peers in science lessons because scientists collaborate with other scientists when doing research.					
11. Scientists need money to do research.					
12. The gender of scientists influences how they do science.					
13. Intellectual honesty in science does not have to be taught in lessons.					
14. Scientists should change their minds when they realize that their ideas are not supported by evidence.					
15. Policies of governments affect the growth of scientific knowledge.					
16. Some scientists earn more money than others, causing tension between scientists.					
17. Scientific facts are not affected by bias and individual subjective prejudice of scientists.					
18. Race and ethnicity of scientists have nothing to do with science.					
19. Teaching epistemic, cognitive, social and cultural values should be the core components of the science curriculum.					
20. Scientists write papers in academic journals.					

21. There is no relationship between scientific facts and values.					
22. Scientists participate in conferences to share their research with other scientists.					
23. Internalizing scientific aims and values enables students to gain and understand scientific knowledge and issues.					
24. Students should understand that scientists have social values such as honesty.					
25. There are hierarchies among science teams and these can change.					
26. Scientists socially interact with other scientists while doing research.					

PART 3: YES– NO QUESTIONS

1. Did you participate voluntarily in any in-service training except for compulsory in-service training?
   - o Yes
   - o No

2. Do you think that science teachers are taught the aims and values of science in undergraduate science education programs?
   - o Yes
   - o No

3. Do you think teachers are taught the aims and values of science in in-service trainings?
   - o Yes
   - o No

4. Do you think that teachers are taught social-institutional aspects of science in undergraduate science education programs?
   - o Yes
   - o No

5. Do you think that teachers are taught the social and institutional aspects of science in in-service training?
   - o Yes
   - o No

APPENDIX D

NATURE OF SCIENCE (NOS) QUESTIONNAIRE (TURKISH)

BÖLÜM 1: DEMOGRAFİK BİLGİLER

Cinsiyet: ……………………..	E-mail Adresi: ……………………..
Okul Türü: o Devlet Okulu o Özel Okul	Branş: o Fizik Öğretmeni o Kimya Öğretmeni o Biyoloji Öğretmeni o Fen Bilimleri Öğretmeni
Eğitim Durumu: o Lisans Mezunu o Yüksek Lisans Öğrencisi o Yüksek Lisans Mezunu o Doktora Öğrencisi o Doktora Mezunu	Hizmet Yılı: o 0 – 5 o 6 – 10 o 11 – 15 o 16 ve üzeri

BÖLÜM 2: BİLİMİN DOĞASI ANKETİ

Bu ankette bilimin amaç ve değerleri ile sosyal ve kurumsal yönlerine ilişkin 26 madde bulunmaktadır. Lütfen bu maddeleri dikkatlice okuyun ve maddelere ilişkin fikrinizi en iyi tanımlayan seçeneği seçin. Anketteki seçenekler “Kesinlikle Katılmıyorum”, “Katılmıyorum”, “Kararsızım”, “Katılıyorum” ve “Kesinlikle Katılıyorum” şeklindedir.

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Fen dersleri bilimin finansal (ekonomik) yönünü içermelidir.					
2. Bilimin epistemik (bilgisel), bilişsel ve sosyal yönleri birbirinden çok belirgin bir şekilde ayrılamaz.					
3. Bilim, üniversiteler ve araştırma merkezleri gibi kurumlarda gerçekleşir.					

4. Bilim sosyal bir sistemdir.					
5. Politika bilimi etkilemez.					
6. Bilim insanları çevreye saygı göstermelidir.					
7. Bilim insanları araştırmalarını toplumla paylaşmak zorunda değillerdir.					
8. Bir problemin farklı bilim insanları tarafından çözülmesi, sonuçların daha az önyargılı olduğu anlamına gelir.					
9. Öğrencileri bilimin amaç ve değerleri hakkında eğitmek bilimsel okuryazarlığı geliştirir.					
10. Bilim insanları araştırma yaparken diğer bilim insanlarıyla iş birliği yaptıkları için öğrenciler de fen derslerinde akranlarıyla iş birliği yapmaları için teşvik edilmelidir.					
11. Bilim insanları araştırma yapmak için paraya ihtiyaç duyarlar.					
12. Bilim insanlarının cinsiyetleri onların bilimi nasıl yaptıklarını etkiler.					
13. Bilimdeki entelektüel dürüstlük kavramının derslerde öğrencilere öğretilmesi zorunlu değildir.					
14. Bilim insanları düşüncelerinin kanıtlarla desteklenmediğini fark ettiklerinde fikirlerini değiştirmelidir.					
15. Hükümetlerin politikaları bilimsel bilginin gelişimini etkiler.					
16. Bazı bilim insanlarının diğerlerinden daha fazla para kazanması bilim insanları arasında gerginliğe yol açar.					
17. Bilimsel gerçekler, bilim insanlarının önyargılarından ve öznel düşüncelerinden etkilenmez.					
18. Bilim insanlarının ırklarının ve etnik kökenlerinin, bilimle hiçbir ilgisi yoktur.					
19. Epistemik, bilişsel, sosyal ve kültürel değerleri öğretmek fen müfredatının temel bileşenleri olmalıdır.					
20. Bilim insanları akademik dergilerde makaleler yazarlar.					

21. Bilimsel gerçekler ve değerler arasında hiçbir ilişki yoktur.					
22. Bilim insanları, araştırmalarını diğer bilim insanlarıyla paylaşmak için konferanslara katılırlar.					
23. Bilimsel amaç ve değerlerin içselleştirilmesi öğrencilerin bilimsel bilgi ve konuları anlamalarına yardımcı olur.					
24. Öğrenciler bilim insanlarının dürüstlük gibi sosyal değerlere sahip olmaları gerektiğini anlamalıdır.					
25. Bilim ekipleri arasında birtakım hiyerarşiler vardır ve bu hiyerarşiler değişebilir.					
26. Bilim insanları araştırma yaparken diğer bilim insanlarıyla sosyal olarak etkileşimde bulunurlar.					

BÖLÜM 3: EVET – HAYIR SORULARI

1. Zorunlu hizmet içi eğitimler dışında gönüllü olarak katıldığınız hizmet içi eğitimlere katılıyor musunuz?
   - o Evet
   - o Hayır

2. Öğretmenlere lisans fen eğitim programlarında bilimin amaç ve değerlerinin öğretildiğini düşünüyor musunuz?
   - o Evet
   - o Hayır

3. Öğretmenlere hizmet içi eğitimlerinde bilimin amaç ve değerlerinin öğretildiğini düşünüyor musunuz?
   - o Evet
   - o Hayır

4. Öğretmenlere lisans fen eğitim programlarında bilimin sosyal ve kurumsal yönlerinin öğretildiğini düşünüyor musunuz?
   - o Evet
   - o Hayır

5. Öğretmenlere hizmet içi eğitimlerde bilimin sosyal ve bilimin kurumsal yönlerinin öğretildiğini düşünüyor musunuz?
   - o Evet
   - o Hayır

APPENDIX E

SEMI-STRUCTURED INTERVIEW QUESTIONS (ENGLISH)

Teacher Interview Form

This interview is planned to be used in the thesis study of Büşra AKSÖZ, a graduate student in the Adult Education Program of the Department of Educational Sciences at Boğaziçi University. Audio recordings of the interviews will be taken with the permission of the participant in order to contribute to the validity of the analysis. The record will not be used, listened to or shared by anyone other than the researcher. The names of the participants will be kept confidential while transcribing the interviews.

Thank you for your participation and cooperation.

Introduction

Can you introduce yourself shortly about your branch, training activities etc.

1. The Aims and Values and the Social-Institutional Aspects of Science

1. What comes to your mind when I say the aims and values of science? Could you give some examples?
2. What comes to your mind when I say social-institutional aspects of science? Could you give some examples?
3. What kinds of professional activities do scientists do? Could you give some examples?
4. Do you think there are some social values and scientific ethos that scientists pay attention? If there are what do these values consist of?
5. What do you think how scientists share scientific knowledge they generated? or Could they share?
6. Do you think there is a relationship between scientists' race, nationality, gender, beliefs, cultural values or their hierarchical dynamics (which our approach called it political power structures) between science? If yes, what kinds of relationship, can you explain?
7. Do you think there is a relationship between science and financial systems? If yes, what kinds of relationship exists?
8. What do you think about the institutions where in scientists conduct their studies?

2. Teaching the Aims and Values and the Social-Institutional Aspects of Science in Science Lessons

9. Do you think you make connections to the aims and values of science in your science lessons? If yes, how do you do it?
10. What can be added to science lessons to teach the aims and values category of NOS?
11. Do you think you make connections to the social- institutional aspects of science in your science lessons? If yes, how do you do it?
12. What can be added to science lessons to teach the social- institutional aspects category of NOS?

3. Teacher education

Pre-service Teacher education
13. Do you think the aims and values of science are taught teachers in your pre-service teacher education programs? If yes how it is taught? If no, how can it be taught?
14. Do you think social-institutional aspects of science are taught teachers in your pre-service teacher education programs? If yes how it is taught? If no, how can it be taught?

In-service teacher Education
15. Do you think aims and values of science are taught teachers in your pre-service teacher education programs? If yes how it is taught? If no, how can it be taught.
16. Do you think social-institutional aspects of science are taught teachers in your pre-service teacher education programs? If yes how it is taught? If no, how can it be taught.

Teachers' Informal Learning
17. Do you consult each other as teachers for the issues you don't know? For example, you are directed a question about aims of science or social-institutional aspects of science. Which sources do you prefer first?

APPENDIX F

SEMI-STRUCTURED INTERVIEW QUESTIONS (TURKISH)

Öğretmen Görüşme Formu

Bu görüşme Boğaziçi Üniversitesi Eğitim Bilimleri Bölümü, Yetişkin Eğitimi Programı'nda Yüksek Lisans öğrencisi Büşra AKSÖZ' ün tez çalışmasında kullanılmak üzere planlanmıştır. Görüşme sonrasında yapılacak olan analizin geçerliliğine katkısı açısından, katılımcının izni ile görüşmelerin ses kaydı alınacaktır. Alınan kayıt araştırmacı dışında kimse tarafından kullanılmayacak, dinlenilmeyecek ve üçüncü kişilerle paylaşılmayacaktır. Görüşmelerin transkripsiyonu yapılırken katılımcıların isimleri gizli tutulacaktır.

Katılımınız ve iş birliğiniz için teşekkürler.

Giriş

Kendinizi biraz tanıtabilir misiniz? Hizmet yılınız, branşınız, sürdürdüğünüz eğitim faaliyetleriniz…

1. Bilimin Amaç ve Değerleri ile Bilimin Sosyal ve Kurumsal Yönleri

1. Bilimin amaçları ve değerleri deyince aklınıza neler geliyor? Örnek verebilir misiniz?
2. Bilimin sosyal ve kurumsal yönleri deyince aklınıza neler geliyor? Örnek verebilir misiniz?
3. Bilim insanları ne çeşit bilimsel etkinliklerde bulunabilirler? Örnekler verebilir misiniz?
4. Bilim insanlarının bilim yaparken dikkat ettikleri değerler sistemi var mıdır? Varsa bu sistem neleri içerir?
5. Sizce bilim insanları ürettikleri bilgileri nasıl paylaşıyorlar? ya da paylaşabiliyorlar mı?
6. Bilim insanları bilimsel çalışmalarını hangi kurum ve kuruluşlarda gerçekleştirirler?
7. Ekonomik faktörlerin bilimle ilişkisi, var mıdır? Varsa nasıl bir ilişki söz konusudur?
8. Politik güç yapıların (bilim insanlarının cinsiyetlerinin, ırklarının, inançlarının, kültürel değerlerinin ya da birbirleri arasındaki hiyerarşilerin...) bilimle bir ilişkisi var mıdır? Varsa nasıl bir ilişki söz konusudur?

2. Bilimin Amaç ve Değerleri ile Sosyal ve Kurumsal Yönlerinin Fen Derslerinde Öğretilmesi

9. Siz derslerinizde bilimin amaçlarına değerlerine değindiğinizi düşünüyor musunuz? Evet ise nasıl değiniyorsunuz?
10. Bilimin amaç ve değerlerini öğretmek için fen derslerine neler eklenebilir?

11. Siz derslerinizde bilimin sosyal ve kurumsal yönlerine değindiğinizi düşünüyor musunuz? Evet ise nasıl değiniyorsunuz?
12. Bilimin sosyal ve kurumsal yönlerini öğretmek için fen derslerine neler eklenebilir? Örnek verebilir misiniz?

3. Öğretmen Eğitimi

Lisans Fen Eğitim Programları
13. Öğretmenlere lisans fen eğitim programlarında bilimin amaç ve değerlerinin öğretildiğini düşünüyor musunuz? Evet ise nasıl öğretiliyor? Hayır ise nasıl öğretilebilir?
14. Öğretmenlere lisans fen eğitim programlarında bilimin sosyal ve kurumsal yönlerinin öğretildiğini düşünüyor musunuz? Evet ise nasıl öğretiliyor? Hayır ise nasıl öğretilebilir?

Hizmet İçi Eğitim Programları
15. Öğretmenlere hizmet içi eğitimlerinde bilimin amaç ve değerlerinin öğretildiğini düşünüyor musunuz? Evet ise nasıl öğretiliyor? Hayır ise nasıl öğretilebilir?
16. Öğretmenlere hizmet içi eğitimlerde bilimin sosyal ve bilimin kurumsal yönlerinin öğretildiğini düşünüyor musunuz? Evet ise nasıl öğretiliyor? Hayır ise nasıl öğretilebilir?

Öğretmenlerin Örgün Olmayan Ortamlarda Öğrenmesi
17. Bilmediğiniz konular olduğunda öğretmenler olarak birbirinize danışıyor musunuz? Örneğin, size bilimin amaç ve değerlerine ya da bilimin sosyal ve kurumsal yönlerine yönelik sorular yöneltildiğinde ilk hangi kaynaklara başvurursunuz?

APPENDIX G

QUOTATIONS IN THE ORIGINAL TURKISH

1. Bilimin amaçları deyince aklıma direk benim sağlık üzerinde geliyor aslında, sağlıkla ilgili yapılan çalışmalar geliyor. İnsanların tedavi edilmesi, hastalıklar… Niyeyse bu bana daha çok bilimmiş gibi geliyor aslında hani kimya fizik biyoloji tabi ki hepsi önemli şeyler ama sağlık üzerine yapılan çalışmaları daha değerli görüyorum.

2. Bilimin amacı aslında doğru bilgiye ulaşmak. Yani kulaktan dolma değil de daha çok bilimsele, verilere dayalı olması gerekiyor. Sadece bu da yeterli değil. Bu doğruların insanlara anlatılması da çok önemli. Yani bilim okur yazarlığı dediğimiz olay da buradan geçiyor. Kişi bilim yaptığı zaman daha gerçekçi düşünüyor, her görüp duyduğu bilgiye inanmıyor, sorguluyor ve araştırıyor. Böylece gerçekdışı olaylara göre yaşamını şekillendirmiyor.

3. Bilimin etik değerleri vardır yani bilim tamam çalışmalar yapar, bir şeyler bulur ama onları insanların faydasına kullanmak zorundadır. Yani sırf kendi çıkarları için başkalarına zarar vermek şeklinde olmamalıdır. Sırf kendi çıkarları için başkalarına zarar vermek şeklinde olursa bu bilime aykırı düşer.

4. Bilimin bir etiği olmalı mı olmamalı mı emin değilim. Çünkü olursa bizi nereye götürür, insanlar için iyi mi olur? …Silah yapımını engellersek, yasaklarsak yani yarın bir gün bir göktaşı çarpımında ya da ne bileyim akıllı bir (çok çok düşük olsa da bin de bir ihtimal olsa da) uygarlığın dünyayı işgali sırasında o silahlara ihtiyacımız olacak ve sıfırdan üretmek çok zor olacak. Bilimin kuralları olmalı ama değişmeli. Etik kuralları olmalı ama değişmeli. Okuduğum kadarıyla, çok hızlı, önümüzdeki 100 sene, 200 sene içerisinde çok hızlı bir yapay evrimsel süreç bizi bekliyor.

5. Bilimin değerleri bir kere dürüstlük olması gerekiyor. Dürüstlük ve güvenilirlik ön planda olması gerekiyor. …eg.. Çünkü arada farklı düşünce ya da dil, din, ırk ayrımı yapılmaksızın, hani bir bilgi için. Ve bunu halka doğru anlatabilmek için tarafsız olması gerektiğini düşünüyorum. Muhakkak etkileniyor mu? Tabi ki etkilenmek zorunda çünkü biz de insani varlığız, yalnız bunları yaparken yani bilimsele bir bilgiye ulaşmaya çalışırken ya da bilimsel bir faaliyet gerçekleştirirken, kişisel gömleğimizi biraz daha aza indirip, kapıda bırakıp içeri girmemiz gerektiğini düşünüyorum.

6. Bilimin değerleri… Toplum/insan açısından değerlendirebiliriz. Tarafsız olması olabilir. İnsanlara zarar vermemek ya da doğanın ya da insanların sürekliliğini sağlayacak şekilde çalışma yürütmek olabilir.

7. Bilimin topluma yayılmasıdır bence. Biz aslında hayatımızı veya bir toplum hayatını bilime göre yönlendirirse bence daha rahat ve mutlu bir toplum olur. Ben bunu anlıyorum. Yani bilimin toplumun içine yerleşmesi gerekiyor.

8. Bilimsel çalışmalar yaparak bir şeyler icat edersin. İnsanları bir araya getirirsin, kaynaştırırsın. Budur yani mesela bir uçak, uçağa binersin gidersin bu bilimin sosyal yönü olur yani. Toplumları bir araya getirir.

9. "Bilimin sosyal yönü deyince yani toplumun ihtiyaçlarını gözetmesi geliyor aklıma. Daha sonra bu seminerler, konferanslar geliyor aklıma. Kongreler geliyor. İnsanlar yaptıkları şeyleri orda birbirine aktarmış oluyor bu hem sosyal öğrenmeyi sağlıyor."

10. Yani şöyle düşündüğüm şey doğruysa bilim belli kurullara bırakılmamalı, belli kurulların altında olmamalı. Tabi ki denetimi, yönetimi, ya da doğruluğu muhakkak belli komisyonlar tarafından yapılması gerek ancak bilim halk tarafından da yapılabileceği, ki buna örnek olarak TÜBİTAK 4007 projeleri ön planda şu anda. Halk için bilim şenlikleri yapılmakta. Yani halkın da katılabileceği birçok çalışmanın yapılması gerektiğini düşünüyorum. Sosyal anlamda da sadece denetim mekanizması olabileceğini düşünüyorum, çünkü eğer bir kuruma bırakıldığında Keplerin ya da Galileo'in yaşamış olduğu problemler hepimizin başına gelecektir.

11. İlk önce sorunu ortaya koyması lazım. Bilimsel basamakları takip etmesi lazım. ..Sonra onun çözümüne yönelik çözümler üretmesi lazım. .. En sonunda ya bilimsel bilgiyi üretecek ya da o bilimsel bilgiyi kullanarak yeni bir ürün üretecek. Eğer var olan bilimsel yöntemlerle çözülemiyorsa yeni yöntemler seçmesi lazım.

12. Bir konferans düzenlenebilir. Konferanslar sanki hep farklı şehirlerden farklı ülkelerden katılmamız gerekiyormuşuz gibi düşünüyoruz ama hani bir üniversite bile yıl sonunda her öğretmenin ya da her bölümün çalıştığı, düzenlenebilir. Biz mesela ne yapıyoruz. TÜBİTAK bilim fuarlarını yapıyoruz. Her üniversitede mesela atıyorum kimya bölümü kendi içinde her öğretmenin yaptığı çalışması sunsa, sergilese çocukların da ilgisini çekecektir eminim ki.

13. Başta etiğe uyduklarını düşünmek istiyorum, buna dikkat ederek çalıştıklarını düşünmek istiyorum ama okuduğumuz haberler, gördüğümüz şeyler biraz daha bu noktada biraz sıkıntı çektiğimizi gösteriyor. Atıyorum bir haber çıkıyor. Makalesini yazmış, gayet güzel akademisyen ama makale çalıntı. Bunları duymak istemiyoruz, yani o makale tamamen kendisine ait olsun istiyoruz. Etik değerlere başta dikkat edecek.

14. Toplumsal birtakım sorunlara çözüm getirecek çalışmalar olursa tabi ki hani kendi yaptıkları çalışmaların bir faydası olacak açısından hani bir duygusal doyum da sağlayabilir. Ama bir birikim olmadan yeni bir çalışma yapmak da kolay olmayacağı için herkesin kendi çalışma alanında, kendi bilgi birikimiyle ilgili her çalışma mutlaka bilim dünyasına bir faydası olacaktır yayın olarak. Belki bugün çok önü açık bir şekilde kullanıma geçmeyecek, insanlığa faydası olmayacak ama belki birkaç adım sonrası yeni çalışmalarla olumlu olacaktır. Ya bir soruna çözüm getirmesi tabi. Çevre içi sorunları çözecek çalışmalar.

15. Bilimsel değerler deyince aklıma bilimsel araştırma basamaklarına uymak geliyor. Yani çalışmanın daha evvelden yapılmamış olması, yapıldıysa da onu kanıtlamaya yönelik olmalı. Data toplanırken sadece çevrelerindeki 1-2 kişiyle değil tüm halkı yansıtmalı sonuçlar. Yine bilim insanı bulduğu sonuçları doğru yazmalı, sonuçları çarpıtmamalı.

16. Çalışmanın içeriği ve sonucuna bağlı olarak yaptığı çalışma zarar verecek nitelikteyse engeller çıkar ama onun dışında son derece faydalıysa çıkacağını sanmıyorum ama hani şöyle söylerler. "Kansere çare bulundu, ilaçlar bulundu ama onlar çıkartılmıyor, çok ileri teknoloji var var ama çıkartılmıyor." Bu tarz şeyler şehir efsanesidir umarım diye düşünüyorum. Sonuçlarına bakarak hani insanlar parayı düşünerek farklı davranabilir, insanlar yaptığı çalışmanın sonuçlarını düşünerek farklı davranabilir, daha fazlasını isteyerek farklı davranabilir, bu tarz engeller çıkabilir karşılarına.

17. Mutlaka yayın yaparak paylaşmış olurlar. Açıkçası yayın yapan kurumların etik olarak değerlendirmelerini bilmiyorum…. Herkes çalışmasını mutlaka yayın yapıyor ama bu geniş kitlelere ulaşabilecek, saygın literatür dediğimiz o dergilerde bilimsel makaleler olarak yayınlanmasındaki sıkıntıyı açıkçası bilmiyorum.

18. Şu anda birçok ulusal ve uluslararası bilimsel dergiler var. Bunların her şeyi inceleyen hakemleri de bulunuyor. Sosyal medyanın güvenirliği kanıtlanmadığı için çok cazip gelmiyor. Ulusal basın olabilir bilinen bir bilginin kanıtlanması durumunda.

19. Cinsiyetle de ilişkili algılar var, şu anda bile dilimize geçen… Bilim adamı diyoruz farkındaysanız. Sürekli sanki bilim üreten kişinin erkek olduğunu düşünüyoruz… Bu ciddi bir ayrım sebebi bence. Çok iyi teknoloji, tıpla ilgili bir gelişme oluyor ama içinde atıyorum domuz ya da domuzla ilgili bir şey olduğu zaman biz Türkler ne yapıyoruz. "Aaa biz bunu kullanamayız, günah, ölecekse de ölsün" gibi bir şeyler oluyor. Hani muhakkak inanç da etkiliyordur bence ve olumsuz etkiliyordur.

20. Onların çok fazla etken olduğunu düşünmüyorum. Bilimin dili tektir ne cinsiyete bakar ne ırka bakar ne de profesördür, yardımcı doçenttir ona bakar yani. Bilim ondan anlayabiliyorsan, onun peşinden gidebiliyorsan sana bir şeyler sunar yani. Bilim insanı bilim yapmak isterse ona hiçbir şey engel olamaz.

21. Devletlerin politikaları neyse bilimsel çalışmalara desteği de o şekilde oluyor. Yani bilimsel çalışmadan ne kadar iyi anlıyorlarsa devletler de yine aynı şekilde bilim insanları gibi ne kadar tarafsızlarsa, ya da işte ne kadar bilimsel çalışmaları önemsiyorlarsa o şekilde destekliyorlar. Ama politik kaygıları varsa, politik kaygıları neticesinde bu bilimsel çalışma bana daha çok uyuyor, bu bilimsel çalışma bana hiç uymuyor diyebilirler. Ya da işte devletlerin biraz önce dediğim gibi ekonomik kaygıları varsa, ekonomik kaygılardan ötürü bazı sektörlere yatırım yapmayabilirler. Daha çok inşaata yapmaları gibi... Ondan sonra eğer politik bir kaygısı varsa örneğin ülkemizde ben bunu gözlemliyorum. Evrimin anlatılmasında çok büyük sıkıntılar var.

22. Bölümdeyken araştırma görevlisi sınavına girdim. Bölüm başkanı Elazığlı. Kendi bölüm arkadaşının çocuğu geliyor. Ben aynı yerden mezunum ama onun çocuğu alınabiliyor. Kültürel farklılıklar da etkili bence yani. Hiyerarşiler etkili. Benim hocam o zamanlar yardımcı doçentti, profesörün arkadaşı tanıdık oldu yani hiyerarşiler kesinlikle etkili. Şunu da anlatayım. Benim hocam onun hocası ile yıllar öncesinden sürtüşme yaşamış. İkisi de yardımcı doçent, ben onun öğrencisi olduğum için laboratuvar anahtarını bana günlerce vermedi. Hocaların kendi aralarındaki etkileşimler öğrencilere yansıyor.

23. Aslında yok ama maalesef bir ilişkilendiriyoruz. Çünkü illa çok para olunca bilim olacak diye bir şey yok o bir araştırma ruhuyla ilgili. Ama yeni çalışmalar deneyenler için mutlaka bir maddi kısmı olacak. Bunu girişimci olanlar belki kendilerine kaynak olarak bulabilirler ama devletin aslında “sen hadi bilimsel çalışmayı yap, sana para hazır” demesi çok daha hoş olur. Yani iyi bir bilim adamı engelleri aşacak bir yol bulur. Para yok o yüzden çalışmam demez. Ama belki hızı yavaş olur. Sorunlarla uğraşmaktan motivasyonu düşebilir. Ama bilimsel çalışmaya başlamış bir kişi için o engellerin duracağını sanmıyorum.

24. En temel ilişkilerden biri ekonomik faaliyetler. Çünkü çalışmalar için çok ciddi cihazlara ihtiyaç var ve yaptığınız çalışmaların bir analizini bile yapmak çok ciddi anlamda bilgisayarla zamanımızı alan bir şey ki. Bu cihazlar kötü ise muhakkak yanlış sonuçlar veriyor.

25. Ekonomik faktörlerin bilimle ilişkisi doğrudan var. Mesela atıyorum bir ilaç yapıldı, üretimi atıyorum yani dünyada o hastalıkla ilgili 100 kişi veya 500 kişi var. Bu ilaç çok üretilmiyor o hastalık çok yaygın olmadığı için, ekonomik getirisinin olmadığı düşünülüyor. Ya da tersi çok pahalı oluyor. Aslında normal olan, yani gerekli mi değil mi ona bakmak lazım ama günümüzde hep arz talebe bakıyorlar. Bir nevi o da geçerli ama yani ekonomiden yana o kadar olmaması lazım. Gereğinden fazla ekonomik olarak değer verildiğini düşünüyorum ben.

26. Ekonomik faktörlerin bilimle çok önemli bir ilişki vardır. Ekonomisi gelişmiş ülkeler araştırmaya geliştirmeye daha çok kaynak ayırıyor. İnsanların yapabilecekleri şeyleri hayallerini gerçekleştirmesi için gerekli bütün dokümanları onun önüne koyuyor. Zaten ekonomik gücün yoksa bu işlere pek fazla kaynak ayıramıyorsun.

27. Şöyle TÜBİTAK'ta, NASA'da, CERN'de bunlar benim aklıma gelen büyük yerler. Bu gibi kurum ve kuruluşlarda geliştiriyorlar çalışmalarını. Ama şimdi bilim insanı üniversitede yani aynı zamanda laboratuvarda da çalışıyorlar. Fabrikalarda olabilir. Dolayısıyla bilim insanı kavramı biraz geniş bir kavram yani bilim yapmak isteyen herkese laboratuvar ortamı bulunduğu yerdir diye düşünüyorum.

28. TÜBİTAK kurumu üniversiteleri desteklemiyor, üniversiteler TÜBİTAK'ın yaptığı çalışmaları olumlu bulmuyor. Şu an birbirini destekleyici çalışmalar maalesef gerçekleşmiyor. Bu araştırma proje yarışmaları... onlara katıldık ama birçok noktada TÜBİTAK'ın karizmasını kaybettiğini gönül rahatlığıyla söyleyebilirim.

29. Çok ağırlık veriyorum. Özellikle 9. sınıflarda bilimsel yöntemde çok duruyorum. Dokuzda girmiyorsam bir şekilde konuyu bilimsel çalışmaya bağlıyorum. Hem bilimsel çalışma hem de herhangi bir konuda şu son çalışma şunu söylüyor, bu değişebilir, bugün böyle, dün böyleydi diye belirtiyorum.

30. Genelde düz anlatım yerine öğrencileri aktif olarak katmayı. Belgesel olsun, deney olsun bu tarz şeyleri öğrencilerin kendisinin yapmasını istiyorum. Onların ilgisini çekecek konularda belgeseller izletiyorum.

31. Özellikle uygulama çok arka planda kalıyor. Biz o teorik bilgi dediğimiz bilgiyi veriyoruz, orada hiç sıkıntı yok. Sadece başkasının bulduğu o teorik bilgiyi çocuklara sormak bilimsel bilgi için yetersiz oluyor… Kesinlikle etkinlik ve deneylerin çok fazla yapılması lazım. Örneğin biz mikroskop yapmıştık.

32. Geçmişte bilim adamlarının karşılaştıkları zorluklar ortaya konulabilir. O anki tarihi, kültürel ve ekonomik zorluklar ortaya konulabilir. Ondan sonra, bilimsel yolla üretilen yani teknolojiyle üretilen silahların vermiş olduğu zararlar ortaya konulabilir.

33. Müfredat olarak çok yoğun bir müfredatımız var. Dediğim gibi başarı seviyesi çok yüksek öğrenciler değil. Ancak, onlara neden kimya öğrendiklerini genellikle etkinlik sırasında bunları yapıyoruz diye sorduklarında anlatıyorum. Onlara ne yaptıklarını ne yapmaları gerektiğini, kimyanın faydalarını ve hayatımızdaki yerini öğretiyorum.

34. Bilimsel kurumların tanıtımını mutlaka yapıyorum öğrencilerime. Bilimsel kurumların amaçlarını, topluma hizmet durumlarını hepsini anlatarak işe başlıyorum. Çünkü ben çocuğa CERN'den bahsediyorum. Hocam Türkiye'de de var mı sorusu geliyor, işte orda diyorum ki artık arkadaşlar Türkiye'de olanlar da bunlar… Çocuklar şaşırıyor. Hocam biz de bilim insanı olabilir miyiz? Evet çocuğum siz de olabilirsiniz deyince o gözlerindeki pırıltıyı görmelisiniz. Umut!

35. Sosyal yönlerini ve kurumsal yönlerini… Ben şuna inanıyorum sadece biz bilimsel olarak değil de bir örnek verebiliriz, bir tiyatro filan olabilir bir drama şeklinde bunlar anlatılabilir. Geçmişte yaşanan olumlu veya olumsuz örneklerden ders esnasında iken canlı anlatılabilir. Bunlar daha kalıcı olur diye düşünüyorum. Veya internet üzerinden böyle videolar varsa filmler. Sadece söylem olarak değil de görsel olarak da ön planda olursa daha iyi olur diye düşünüyorum.

36. Sadece bence öğretmen eğitimi verilmeli her öğretmen aynı bakmıyor olaya. Mesela ben bilimsel araştırmaların her ünitenin sonunda olması gerektiğini savundum ama aynı zümrede bir hoca "kim uğraşacak dönem sonu yapsınlar" dedi. Ya da "işte ne bekliyordun ki onlar zaten kız gibi" önyargılar oluyor öğretmenlerde. Bence önce öğretmen eğitimi verilsin öğrenci zaten bir yolunu buluyor yani.

37. Bunu ilkokul çocuklarına ya da ortaokul çocuklarına anlatamazsın. İlkokul ya da ortaokul çocuklarına anlatacağın şeyin hayal kurma yönlerini geliştirmek. Yani lise çağına gelmiş çocuk artık yavaş yavaş birey olma özelliğine yöneldiği için ondan itibaren başlamak özellikle lise dokuzuncu sınıflardan başlamakta fayda var.

38. Bilimin amaçları bize öğretilmedi. Bilim tarihinden örnekler verilebilirdi ama bu sadece bir bilgi olarak söylenip geçilmezdi. Önemli noktalar öğretilebilirdi. Yine bilim tarihinden bilimin değerleri düşünülerek olaylar üzerinden örnekler verilebilirdi, savaşlardan üzerinden örnekler verilebilirdi.

Bilim tarihi diye bir ders yoktu zaten biz de. Bilim felsefesi diye de bir ders yoktu. Belki bu nedenle, çoğu insanların neden sonuç ilişkilerini, olayları birbirine bağladıklarını tarihsel süreç içerisinde görmedim. Çünkü bilmiyoruz. Dediğim gibi değerlerinin de öğretildiğini düşünmüyorum... Üniversitelerde böyle bir ders yok bilimin değerleri ile alakalı.

39. İşte benim hatırladığım şey hoca slayt yapıyordu işte bilim şudur fen okurluğu yazarlığı budur şeklinde oradan okuyor ya da öğrencileri gruplara ayırıp bizlere sunum yaptırıyordu. Az önce söylediğim gibi daha çok gösterilerek uygulatarak. Daha çok laboratuvara gidilebilir hani bilimin amaçlarını öğreteceksen eğer. Eğer çocuğa öğretmek istiyorsak çocuklara şu şekilde anlatın gibi hoca bunu yaparken biz gözlemleyebilmeliyiz. Gittiğimiz stajlarda bile böyle bir şey yoktu maalesef. Derslerde çok net göremedim açıkçası çok teori de kalıyor her şey o yüzden herhalde yok.

40. Bilimin amaçları öğretmen adaylarına bilim yaptırılarak öğretilebilir. Sen bize tekrardan bunu bir bul, gör gibi değil de o bilgiyi üretmeleri istenebilir. Hangi süreçlerden geçtiği gözlemlenebilir. Eğer öğretmenlerin bu süreci yaşamalarını sağlarsanız, bunun önemini anlayacaklardır. Başka türlü doğrudan metinlerle, metinlerle ya da kitapları okutmakla… Bununla alakalı da birçok makale var, çok fazla. Çok kalıcılığı olmayan şeyler ama yaşamak daha fazla şey yapabilir.

41. Yani tam olarak değil. Yüzde 1-5 bilemedin %10 öğretiliyor fazlası değil. Tabi bu üniversiteden üniversiteye değişiyor ama çok az bir kısım öğretiliyor. Yani üniversitede o eğitimin verildiğini düşünmüyorum. Örneğin bir şey mi buldu biri, nereye başvuracak hangi kuruma başvuracak bunu bilmiyor yani. "Bilimsel çalışmalar yapmak istiyorsam üniversiteye gelmek zorundayım". Onun dışında bir şey öğrendiklerini sanmıyorum.

42. Üniversitede yapılan bir şenliğin, bir fuarın bile bence faydası olabilirdi bizlere ama olmadı. Ben yüksek lisansa başladıktan sonra gördüm ki her öğretmenin bir çalışması var. Kendine özel laboratuvarı var ve orada çalışıyor. Üniversitedeyken lise gibiydi yani. Derse girip çıkıyordum. Öğretmenlerin ne yaptığından haberimiz olmuyordu. Kitapta ismini görünce "Aaa bunu bu hoca mı yazmış?" derdik. Kurumsal yönlerin de öğretildiğini düşünmüyorum. Ben yıllardır TÜBİTAK'ı biliyorum ama şu an bile tam olarak ne iş yapıyor, nasıl araştırmalar yapıyor çok net bir bilgim yok. Onun dışında hiçbir yerde öğretilmiyor bunlar ve belki de en zayıf olduğumuz nokta temelde budur.

43. Kesinlikle öğretilmiyor bu net kesin bir şey. Çünkü ben baktım başvurmak istiyordum bilimle alakalı bir eğitime ancak hiç yoktu tek bir tane bile yoktu. Üniversitedeki hocalarımız tarafından MEBBİS üzerinden dersler açılıp

öğretmenlere branşlarına göre bunun eğitimini verebilirler. Üniversitelerimizde laboratuvarlarımız var, okullarımıza laboratuvarlarımız var yani rahatlıkla. AR-GE birimlerimiz var, bilim sanat merkezlerimiz var. MEBBİS üzerinde bizim hizmet içi eğitimlere bakan rahatlıkla benim dediğimi ispat olarak görebilir.

44. İlk kaynak olarak Google a başvuruyorum. Çünkü diğer arkadaşlara da öğretilmediğini biliyorum. Dersle alakalı bir soru gelirse, çözemezsem matematik varsa işin içinde matematik öğretmenine başvururum. Ya da bir proje üzerinde çalışıyorsan. Onlara da bir şey öğretilmediği için ulaşabileceğim yakınlarda bir kitap olmadığı için Google a başvuruyorum, internete başvuruyorum.

45. Genelde bilimsel tercihim danışmak olur biliyorlarsa. Bulabildiğim, bildiğini düşündüğüm kişiye danışmak olur. Eksik olduğunu düşünüyorsam araştırmaya yönelebilirim veya daha fazla kişiye sorup ondan sonra araştırma yöntemine girebilirim. Ama diğer insanlarda genelde gözlediğim dediğim şey şu oluyor. Eksik biliyorlarsa bile sanki bilinirliğin sadece bu kadar olduğu ve ben de bu kadar biliyorum, daha fazlası bilinemez yani… başka bir şey yok mesajı veriyorlar. Ya da yanlış anlattıklarını gördüm kendilerinden çok emin bir şekilde. Genelde bu kişiler çok merak etmiyorlar. İnsanlar özellikle tecrübeleri arttıkça çok bildiklerini düşünüyor başkalarına soru sorma eğilimi azalıyor. Yanlışları varsa da zaten büyük ihtimal 20 yıldır 15 yıldır aynı yanlışı yapıyorlar. Bu şekilde devam ediyor ve hizmet içi eğitim veya değişim kısmına geldiği zaman da direnç gösteriyorlar. Şu anda 25- 30 yaş arası yeni mezunlar veya 30 yaşına kadar. Biraz daha hizmet içi eğitimlere ve bu anlayışlarını değiştirmeye yatkınlar.

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