Available online at ijci.wcci-international.org

International Journal of Curriculum and Instruction 13(3) (2021) 2923-2956

IJCI
International Journal of Curriculum and Instruction

Examining the changes in pre-service science teachers' views on science, technology and society: The impact of socio-scientific issues*

Hatice Güngör Seyhan[b], Murat Okur[c]

[b]*Assoc.Prof.Dr., Sivas Cumhuriyet University, Faculty of Education, Department of Chemistry Education, Sivas, Turkey*
[c]*Assist.Prof.Dr., Sivas Cumhuriyet University, Faculty of Education, Department of Basic Education, Sivas, Turkey*

Abstract

In this study, applications based on socioscientific subject-oriented science, technology, society and environmental education were carried out. The aim of the study is to determine the views of pre-service science teachers, who are engaged with the applications, about science, technology and society and to determine whether these views are sufficient. 83 pre-service science teachers participated in the study. In order to evaluate the pre-service teachers' views on science, technology and society, the "Views on Science, Technology and Society Questionnaire (VOSTS)" was used, which was developed by Aikenhead, Ryan and Fleming (1989). According to the VOSTS pre-test results, it was observed that there was diversity in the views of the pre-service teachers in subjects such as the definitions of science and technology, the impact of society on science, and the classification of scientific knowledge. It is among the findings that pre-service teachers have many misconceptions about these issues. The unsatisfactory views of the pre-service teachers, who produced solutions to problem situations consisting of socioscientific issues and finalized their suggestions, of the pre-service teachers about science, technology and society, were replaced by more realistic and acceptable views after the applications.

Keywords: Pre-service science teachers, science, technology and society, views on science, technology and society

1. Introduction

1.1. Introduce the problem

The fact that developed countries in the field of science and technology are also economically advanced has further increased the interest in science education and the goal of countries to make a more effective science education has gained importance. It is

*This study was presented as an oral presentation at the "2nd International Congress of Pedagogical Research" on May 15-16.

[b]Corresponding author: Assoc.Prof.Dr. Hatice Güngör Seyhan, +90-5337793896, *hgunsey@gmail.com*

a necessity to raise individuals who will meet the needs of the age, and the studies of developing new education programs that can meet the needs of the age, understand and apply science and technology, which is its reflection in practice, have gained speed instead of more teacher-centred and rote-learning based teaching programs (Şeker, 2007). Program development studies affect the improvement of the quality of education positively (Erden, 1998). It is seen as an important problem to improve science teaching in schools, to make students love science, and to train teachers who are qualified in this field. In order to solve these problems, efforts to improve science education have been continuing for many years (Akgün, 2001, p.12).

"Science, Technology and Society" education, which developed in some western countries in the 70's and 80's and became a science education trend (Aikenhead, 2003; Yager, 1996), has gained more importance in science education in the last 30 years, and has affected the science curricula of many countries with more emphasis on the impact of scientific and technological developments on the "Environment" (Yalaki, 2014). The most important aim of science, technology, society and environmental education is to develop an opinion on the nature and history of science, the relationship between science and society and the relationship between science and technology in individuals. In this context, the main goals of science, technology and society include (i) making free decisions in the field of science and technology, (ii) using scientific problem-solving skills in daily life and (iii) communicating with others about extraordinary situations in out-of-school environments (Taşkın, Çobanoğlu, Apaydın, Çobanoğlu, Yılmaz & Şahin, 2008). In our country, fundamental reforms have been made in education programs since 2004 and education programs have changed according to the needs at various times. In this context, it is aimed to raise each person as individuals with scientific and/or science literacy in the Turkish Education System. In parallel with these developments, science, technology, society and environmental education were included in science teaching programs prepared in Turkey in 2005 and 2013 (MoNE, 2005; 2013). Yalaki (2014) mentions the results of many researchers who examined science teaching programs prepared in Turkey in 2005 and 2013 in terms of science, technology, society and environmental education. Unlike the 2005 program, despite the addition of new dimensions in the fields of learning scientific process skills, science-technology-society-environment and attitudes-values in the 2013 program, it is a major deficiency of the 2013 program that these dimensions are not associated with the gains (Eskicumalı, Demirtaş, Erdoğan & Arslan, 2014). Again, socioscientific issues, one of these sub-dimensions, were included in the new program and these topics were integrated into the book. However, effective teaching in the classroom is insufficient because it is not reflected in the skills appropriate to the outcomes (Yılmaz Tüzün, 2014). Some gains on the basis of science, technology, society and environmental gains, classes and learning areas, which are determined in the program, have been given too much and some gains very little (Avcı & Önal, 2013). It is also emphasized that although pre-service teachers generally grasp the interaction between science-technology-society and the environment, they do not sufficiently understand the basic science theories in the background of technological developments that the pre-service teachers’ science literacy, knowledge of current phenomena, concepts and principles cannot go beyond superficiality (Özdemir, 2010; Yalaki, 2014). All these results reveal that pre-service teachers and students have deficiencies in science, technology, society and environment that require high-level thinking skills, and new curricula do not eliminate these deficiencies.

Socioscientific issues, which are scientific situations that affect the society they will enter into discussion, also include decision making regarding the solution of these situations, moral reasoning and evaluation of ethical concerns (Zeidler & Nichols, 2009). According to Sadler and Zeidler (2005b), socioscientific situations are defined as the selection of scenarios containing scientific ethical and moral situations that will attract students' attention throughout the academic process and the students' discussion on them. According to Yapıcıoğlu (2016), one of the methods used in learning environment where socioscientific situations are used is problem scenarios (Dolan, Nichols & Zeidler, 2009; Evren & Kaptan, 2014; Sadler, 2004; Topçu, 2015). The structuring of problem scenarios is through life-related case studies such as newspaper reports, photographs, scientific articles, simulations, experimental or laboratory results. The next stage after the structuring of the scenarios is the presentation of questions and solution proposals for problem solving (Açıkgöz, 2003). Socioscientific situation-based learning environments encourage the exploration of knowledge. It supports the making of logical discussions, the development of scientific process skills and analytical thinking skills (Polyiem, Nuangchalerm & Wongchantra, 2011). According to Zeidler, Walker, Ackett, and Simmons (2002), socioscientific situation-based learning environments can be defined as a broader approach than STSE education that brings together the dimensions of science, technology and society.

The basic idea adopted by the science-technology-society and environment approach (Yager, 1996), which is based on allowing students to recognize the real-life problems they have, collect data for the solution of problems, think about alternative solutions, follow the basic order in their decisions, is to connect individuals who are caught between school and society with the real world. Students who have a view of science, technology, society and the environment aim to be a strong country in the world, think creatively and critically in the society, use the knowledge they learn to solve the problems they encounter, make decisions in the face of a problem related to science in the society, participate in a scientific discussion and express their ideas and they are science literate individuals who read and interpret a scientific study, understand the impact of science, technology and society on each other, and have the necessary and sufficient knowledge in their place and time (Çepni, Bacanak & Küçük, 2003). As a common component of these characteristics; while the relationship between science and technology, science and technology, the impact of science and technology on society, the impact of technology and science on society, and the social structure of technology and scientific knowledge, the characteristics of scientists and the dimensions of the natural structure of scientific knowledge are the opinions that students should have; society's expectations are in this direction as well (Kahyaoğlu, 2004).

Among the science, technology, society and environment (STSE) learning areas included in the Science Curriculum, (a) socio-scientific issues can be defined as issues that concern society and science, take the source of science, are controversial and lead to controversy and conflict in society (Sadler, 2004; Sadler & Zeidler, 2005; Topçu, 2015). Many issues such as cloning, stem cell, genome projects, global warming, alternative fuels and vaccines that occur as a result of the interaction of science and society today can be given as examples of socio-scientific issues (Sadler, 2004; Topçu, 2015). In recent years, educators who aim to achieve the goals of modern science education have focused on socio-scientific issues (Türkmen, Pekmez & Sağlam, 2017). Science, Technology, Society and Environment (STSE) is an understanding of (b) the nature of science that stands out as the most important link of the concept of scientific literacy in science education. It is defined as the values and beliefs inherent in science or scientific knowledge as a way of knowing (Abd-el-Khalick, Bell & Lederman, 1998). It is stated that the nature of science and the values and acceptances in the nature of scientific knowledge are expressed. One of the other STSE learning areas covering the understanding of the interaction of science and technology and their contribution to each other is (c) the relationship between science and technology, and another is the understanding of the social contribution of science, which includes (d) understanding the contribution of scientific knowledge to social development and solving social problems (MoNE, 2013)

1.2. The importance of the research

One of the dimensions of science literacy in the Turkish Education System is that the individual has sufficient knowledge about the nature of science and scientific knowledge. When the program reform movements in various countries are examined, it is predicted that all individuals in the society will be educated as science literate (Zan Yörük, 2008). In this context, the Turkish Education System in each individual that scientific literacy is intended to train individuals are given a high place in the "Science-Technology-Society and Environment" education (STSE) in science teaching program developed in Turkey in 2005 and 2013 (MoNE, 2005; 2013). However, many literature results examining these curricula show that socioscientific issues are included in the curriculum under the literacy dimension of STS and environment education, and that these subjects are integrated into the book but not reflected with appropriate skills, so that effective teaching cannot be provided in the classroom (Avcı & Önal, 2013; Eskicumalı et al., 2014; Özdemir, 2010; Yalaki, 2014; Yılmaz Tüzün, 2014). The use of STSE education at all grade levels in science education is of great importance because of the exact overlap between the scientific literacy aimed by this education and the concept of scientific literacy specified within the scope of the Program for International Student Assessment (PISA). A learning approach that includes the gains of science, technology, society and environment aims to raise science and technology literate individuals who are educated and able to make the right decisions in the subjects that concern society in these areas by teaching the technology and social content to which scientific information is related (Kılıç, 2006). This learning approach is considered as an approach responsible for problem-centred issues arising from natural or industrial processes or local, national, international problems. Problems that need to be investigated in this approach are chosen by students with an interdisciplinary perspective from the problems that enable them to examine the concepts, processes and effects of science and technology. In addition, with this approach, students are active participants in the learning process with their ability to solve scientific and technological problems and to make decisions (Demirçalı, 2007). Raising individuals who are able to establish the interaction between science and technology and the environment well, who are aware of the positive and negative effects of science and technology on the environment, and who can see the positive and negative aspects of developments in science and technology reveals the importance of gaining environmental awareness. It is accepted as an absolute necessity to achieve this goal, to make pre-service teachers gain the nature of science and scientific knowledge more clearly in their faculties, and to reveal the understanding of "science, technology and society" in science education. However, there are studies showing that STS course is appropriate in terms of content and that experimental studies are needed in order to improve students' views on science, technology and society (Ayar, 2007; Ayvacı & Özbek, 2015; Bacanak, 2002; Çelik, 2003; Turgut, 2005; Yalaki, 2014; Zan Yörük, 2008).

In addition, socioscientific issue-based environments that emerged in the 2000s also include conceptualizations of moral dimension, individual experiences, and the nature of science (Zeidler et al., 2005). In other words, it can be said that this approach offers a more comprehensive framework for educating students as science literate individuals. Science literacy involves not only understanding scientific information, but also decision-making on socioscientific issues (Sadler & Zeidler, 2005b). According to Yapıcıoğlu (2016), the situations that socioscientific subject-based learning environments focus on are listed as follows according to many researchers: how science is based on situations and events, the superior qualities of living creatures, the effects of physical-social environment and scientific decisions on individuals, the effects of moral principles on scientific decisions (Driver, Newton & Osborne, 2000; Sadler, 2004; Zeidler et al., 2005; Kara, 2012). Based on all these, problem situations consisting of socioscientific issues were integrated into STSE education in our study. The pre-service teachers dealt with problem situations consisting of socioscientific issues such as genes, disease and health, the expanding universe, climate, weather and humans, the changing world, atomic and subatomic particles, energy and society.

1.3. Purpose of the research

In present study, an educational environment based on “Science, Technology, Society and Environment” education was created within the scope of the “Science, Technology and Society” course with 83 pre-service science teachers studying in the last year of the university. The “Science, Technology and Society” course was first applied in Faculties of Education in the 2001-2002 academic years. The determined aim of this course is defined as “the characteristics of individuals with advanced science literacy and the role of science teaching and science teacher in achieving these characteristics, the relationship between science, technology and society”. Some learning areas and key concepts of socioscientific issues determined by "Hawkhill Institution", which is one of the programs that will help to develop science literacy in science, technology and social education content, are limited as follows (Bacanak, 2002): Biosphere and universe (global warming, acid rain, ozone depletion, etc.); the changing world (the formation of the earth, how maps are drawn, the formation of continents, glaciers and mountains, and the way humanity shows them (mapping), etc.); illness and health (a historical overview of disease-related problems, known and common diseases, etc.); radiation (obtaining energy from radiation, where radiation is used in nature, Chernobyl, etc.); genes (Mendel and his laboratory, his experiments in Czechoslovakia, Watson and Crick DNA model, chromosome, replication, etc.); nuclear power (history of nuclear research and studies of nuclear research centres, the origin of radiation, Chernobyl, fission / fusion, hydrogen bomb, Nagasaki, radioactive waste, etc.); energy and society (past and future of energy, limitations in meeting the needs of near and far future societies, agricultural revolution, industrial revolution, nuclear energy, acid rain, greenhouse effect, ozone depletion problem, renewable energy sources, etc.). It is aimed to determine the views of the pre-service teachers who are engaged with the applications carried out within the scope of the STS course, about "science, technology and society" and it was examined also the effects of applications on these views.

2. Method

In the study, “pre-test-post-test research design for a single group” was used. In this research design, all applications and studies are carried out with a single group. The measurements of the subjects related to the dependent variable are obtained by using the same subjects and the same measurement tools as the pre-test before the application and the post-test after the application (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz & Demirel, 2011). In this study, in which the effects of the applications carried out within the scope of the Science-Technology-Society course on the change in the views of pre-service teachers about "science, technology and society" are examined, the experimental process includes a teaching process consisting of two hours each week, for a total of 15 weeks. The research design used in the study is similar to the method of many studies examining the "science, technology and society" views of individuals (Ayvacı & Özbek, 2015; Göz, 2019; İnce, 2017; Kahyaoğlu, 2004; Zan Yörük, 2008).

2.1. Study group

The universe of the research is composed of pre-service teachers studying at the Department of Science Education who will become science teachers in the near future. The sample is composed of 83 students studying in Faculty of Education, Department of Science Education in 4th grade in the fall semester of the 2018-2019 academic years.

2.2. Data Collection Tools

2.2.1. Views on Science, Technology and Society Questionnaire (VOSTS)

In the study, a questionnaire developed by Aikenhead, Ryan and Fleming (1989), consisting of 114 multiple-choice items and originally named VOSTS, was used. The questionnaire consists of 9 categories: science and technology, the impact of society on science/technology, the future category, the impact of science/technology on society, the impact of school science on society, the characteristics of scientists, the social structure of scientific knowledge, the social structure of technology, and the nature of scientific knowledge. 14 items suitable for the purpose of the research were used, with a reliability of 0.74 (Split Half), content validity of which was made with the opinion of 3 experts. These selected items contain statements belonging to the five subscales (science and technology, influence of society on science/technology, influence of science/technology on society, social construction of scientific knowledge, and nature of scientific knowledge) of the nature of science and applied as pre- and post-tests to pre-service teachers before and after the applications.

2.3. Data Analysis

The views of pre-service science teachers on science, technology and society were examined item by item. In the study, descriptive analysis was applied for the responses of the pre-service teachers given to the VOSTS items. The questionnaire consists of a basic judgment statement and a number of different alternatives associated with this statement of judgment. Pre-service teachers' views on science, technology and society were classified using Rubba, Harkness and Bradford (1996) categories according to “Realistic”, “Acceptable” and “Unsatisfactory” perspectives. When the literature is examined, it is seen that the answers given to the VOSTS questionnaire are categorized according to this classification. (Arı, 2010; Ayvacı & Özbek, 2015; Bayram, 2017; Doğan et al., 2011; Göz, 2019; Guilherme, Faria & Boaventura, 2016; İnce, 2017; Kılınç, 2010;

Zorlu, & Baykara, 2015). In this classification, "Unsatisfactory" classification refers to inappropriate traditional (positivist) perspective; "Acceptable" classification refers to reasonable, appropriate options; "Realistic" (post positivist) classification, on the other hand, expresses the contemporary perspective (Doğan et al., 2011)

2.4. Application Process

STSE education applications started with the emergence of a problem situation that can be investigated by pre-service teachers, attracts attention and has the opportunity to apply in the lives of individuals. The selected problem situations are related to the socio-scientific issues determined within the learning areas that the researchers put into practice within the scope of the related course within the framework of STSE education. Afterwards, they were given the opportunity to conduct research on scientific and technological issues related to the selected problem situation. They used a wide variety of sources to access information. For example, the media, internet, libraries, experts in the field, universities and private or public organizations have become sources for accessing the desired information. Under the guidance of the researchers, the students were engaged in the process of conducting a scientific research, collecting data, organizing and discussing and interpreting the collected data and information, developing hypotheses and solution proposals, and reaching a conclusion. At this stage, if possible, students contacted experts and consulted their hypotheses or conclusions. Then, according to the conclusion reached, it was planned that the students would make a decision and, if appropriate, initiate an action as responsible members of the society. In addition, students who witnessed how science and technology affect society, make a decision according to the acquired information and apply it, so that they learn to take responsibility in science and technology-related issues in society. After the researches, pre-service teachers were asked to present their possible solution suggestions for their own problem situation with their reasons and explanations. This whole process, which involved the pre-service teachers' implementation of the most probable solution suggestions by deciding on an action, resulted in a period of 15 weeks. In the last phase of the STSE education, pre-service teachers presented their presentations summarizing the whole process and the project products they created to their classmates and researchers. Examples of problem situations and solution suggestions posed by pre-service regarding the lived society in during their STSE applications are as follows:

Sample 1

Project proposed by group 15

Problem Situation: Global warming, which is defined as the temperature increase detected in the earth and in the lower layers of the atmosphere as a result of the strengthening of the natural greenhouse effect, is an environmental problem that has been discussed all over the world in recent years and solutions are sought on the international platform. Global warming is seen as the biggest effect of the greenhouse effect on the world. One of the factors that cause the greenhouse effect is excessive and wrong farming. Is it possible to minimize the environmental damage of greenhouse gases?

Solution Proposal: Fertilizer production with food residues at home instead of chemical fertilizers used in agriculture

Sample 2

Project proposed by group 10

Problem Situation: The world is facing more and more energy needs day by day. Fossil fuels constitute the biggest energy resources used at the moment. So, unfortunately, non-renewable energy resources are used extensively. It is possible to solve the energy need, which has become the biggest problem of the world, without harming the environment with renewable energy sources and clean energy sources. How can renewable energy sources be used in daily life in a way that facilitates our lives and helps the energy cycle?

Solution Proposal 1: Producing vegetables and fruits by making greenhouses with geothermal energy

Solution Proposal 2: To produce biogas and organic fertilizers by the accumulation and processing of biomass (animal waste).

3. Findings

In the VOSTS questionnaire, when the views of the pre-service teachers regarding each item are classified according to the "realistic", "acceptable" and "unsatisfactory" view, the results are shown collectively in Table 1.

Table 1. Classification of pre-service teachers' responses to the VOSTS questionnaire (pre- and post- test)*

Subscales of Items	**Items**	**VOSTS**					
		Pre-Test (%)			**Post-Test (%)**		
		U	**A**	**R**	**U**	**A**	**R**
Science and Technology	Define science (Item1)	2.4	60.1	37.3	-	44.6	55.4
	Define technology (Item 2)	37.3	42.1	20.4	39.7	30.1	30.1
	The relationship between science and technology (Item 3)	34.8	14.4	50.6	30.1	9.6	60.2
Influence of society on	Define relationship between government and science (Item 4)	21.6	28.9	49.4	22.8	25.3	62.7

science / technology	Define Ethics (Item 5)	32.4	20.4	46.9	33.7	9.6	56.6
	Define educational institutions (Item 6)	-	31.3	68.6	-	20.4	79.5
	Public influence on scientists (Item 7)	57.8	15.6	26.4	37.3	32.4	30.1
Influence of science / technology on society	Define contribution of social decisions (Item 8)	19.2	39.7	40.9	15.6	38.5	45.7
	Define characteristic features of scientists (Item 9)	21.6	50.5	27.7	14.4	51.8	33.7
	The effect of gender on science and technology (Item 10)	42.1	32.4	25.3	26.4	34.8	38.6
Social construction of scientific knowledge	The effect of national influence on science and technology (Item 11)	-	49.4	50.5	3.6	45.8	50.6
Nature of scientific knowledge	Changeability of scientific knowledge (Item 12)	-	15.6	84.3	-	6.0	93.9
	Classifying scientific knowledge (Item 13)	84.2	-	15.7	83.1	-	16.8
	Ability to make logical explanations in justifications (Item 14)	31.2	-	62.6	37.3	-	68.6

*In the Table 1, the "Realistic" views is symbolized by "(R)", "Acceptable" views by "(A)" and "Unsatisfactory" views by "(U)" and the percentages for each item are given.

In the tables below, *only* the answers given by the pre-service teachers to the VOSTS items addressed to them are included and the results are presented as percentages.

The first item of the questionnaire used within the scope of the study refers to the "*definition of science*". Table 2 shows how diverse the responses of pre-service science teachers to the definition of science differ.

Table 2. Percentage distributions of responses to Item 1

Science is difficult to define; because science is complex and concerned with many issues. But the science is essentially:			
Your position, basically :**		**Pre-test (%)**	**Post-test (%)**
C[R]	It is searching for the unknowns about our world and the universe, discovering new things and how they work.	37.3	55.4
F[A]	It is finding and using the knowledge necessary to make this world a better place for life.	27.7	25.3
B[A]	It is information such as principles, laws, and theories that explain the world we live in.	15.6	13.3
D[A]	It is doing experiments to solve the problems of the environment we live in.	9.6	3.6

A[A]	These are fields such as biology, physics and chemistry.	3.6	2.4
G[A]	It is the gathering of people who have ideas and techniques to discover new information.	3.6	-
E[U]	It is to invent or design something.	2.4	-

**The views that the pre-service teachers did not choose for each item are not shown in the Tables.
(R): Realistic views; (A): Acceptable views; (U): Unsatisfactory views.

According to Table 2, while the rate of pre-service teachers who chose the definition of science presented with a "realistic" view before STSE applications was 37.3%, the rate of pre-service teachers who adopted "acceptable" views was 60.1%. After the applications, the pre-service teachers who adopted the "realistic" views showed an increase of 18.1%.

In the second item of the VOSTS questionnaire, pre-service teachers' views on the "*definition of technology*" were examined (Table 3).

Table 3. Percentage distributions of responses to Item 2

Technology is difficult to describe because it does so many things. But the technology is essentially:			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
B[U]	It is the application of science.	22.9	34.9
C[A]	They are new methods for daily use, tools, machines, computers or practical appliances.	21.7	14.4
G[R]	They are the ideas and techniques necessary to design or manufacture things, organize workers, businessmen and women, consumers, and improve society.	14.4	22.9
D[A]	It is robots, electronic devices, computers, communication systems or automation.	14.4	12.0
A[U]	It is very similar to science.	14.4	4.8
E[R]	It's the technique of doing things or the way to solve everyday problems.	6.0	7.2
F[A]	It's about inventing, designing and testing things.	6.0	3.6

According to Table 3, the rate of the pre-service teachers with "unsatisfactory" views is 37.3%. While the rate of those who adopt the "acceptable" views is 42.1%, the rate of pre-service teachers who have "realistic" views is 20.4%. After the applications within the scope of STSE applications, it was observed that the "realistic" and "acceptable" views of the pre-service teachers for the definition of technology were similar and remained almost stable in their "unsatisfactory" views (39.7%).

In the third item of the VOSTS questionnaire, the pre-service teachers' views on *the relationship between science and technology* were examined (Table 4).

Table 4. Percentage distributions of responses to Item 3

Science and technology are closely related.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
B^R^	Science and technology are closely related; because scientific research guides technological developments and technological developments accelerate scientific research.	50.6	60.2
A^U^	Although it is difficult to see how technology helps science, science and technology are closely related because science is the basis of technological advances.	21.6	21.6
C^A^	Science and technology are closely related because, despite their differences, it is difficult to say that they are separate because they are tightly linked.	14.4	9.6
D^U^	Although it is difficult to see how technology helps science, science and technology are closely related because technology is the basis of all scientific advances.	13.2	8.4

According to Table 4, it was observed that 50.6% of the pre-service teachers adopted "realistic" views before the applications and this rate increased to 60.2% after the applications. The pre-service teachers have adopted 34.8% "unsatisfactory" and 14.4% "acceptable" views for the relationship between science and technology.

The fourth item of the questionnaire is based on the views taken on *the reasons for the financial support that governments will give to scientists* (Table 5).

Table 5. Percentage distributions of responses to Item 4

Governments are required to provide financial support to scientists to search and find what is curious in nature and the universe.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
D^R^	Money needs to be spent on scientific research because scientists can make a better place to live by understanding our world better.	49.4	62.7
C^A^	Often it is impossible to say whether research is beneficial, but still it is necessary to spend money on scientific research because it is an investment risk that we have to take.	24.1	18.1
A^U^	All countries should spend money on scientific research so that they do not lag behind other countries and depend on them.	13.2	12.0

B[U]	Money must be spent on scientific research in order to satisfy the instinct that awakens the scientific curiosity of man.	6	4.8
E[A]	Money should only be spent on scientific research if it is directly related to our health, our environment, or agriculture.	4.8	2.4
H[U]	I don't know enough about this subject to make a choice.	2.4	-

According to Table 5, while 49.7% of pre-service teachers adopt "realistic" views before the applications, the rates of those who adopt "unsatisfactory" (21.6%) and "acceptable" (28.9%) views are almost close to each other. After the applications, the "realistic" views of the pre-service teachers increased by 13.3%.

The results of the fifth item analysis, in which the views about "*the effects of the culture, religious or moral views on scientists and scientific researches in the place where scientific studies*" were carried out, it was observed that there was no consensus among pre-service science teachers (Table 6).

Table 6. Percentage distributions of responses to Item 5

Some societies have specific views on nature and man. Scientists and scientific research are influenced by the religious or moral views of the culture where the study is conducted.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
B[R]	Religious or moral views influence scientific research because scientists may unwittingly choose research that supports the perspective of their cultures***	31.3	27.7
D[R]	Religious or moral views influence scientific research; because everyone reacts differently to their own culture. These individual differences affect the type of research being conducted***	15.6	28.9
F[U]	Religious or moral views do not influence scientific research because research continues despite debates between scientists and certain religious or cultural groups*	15.6	22.9
C[A]	Religious or moral views influence scientific research because many scientists do not conduct research that does not fit their beliefs and upbringing**	12	3.6
G[U]	Religious or moral views do not affect scientific research, because scientists will investigate issues that are important to science and scientists, without taking cultural and moral views into account*	7.2	6
E[A]	Religious or moral views do not affect scientific research, because scientists	6	3.6

	will investigate issues that are important to science and scientists, without taking cultural and moral views into account**		
A[A]	Religious or moral views influence scientific research because some societies want research done for their own benefit**	2.4	2.4
I[U]	I don't know enough about this subject to make a choice*	4.8	2.4
J[U]	None of these choices fits my basic viewpoint*	4.8	2.4

The highest rate of pre-service teachers' view given to this item before the applications was that "religious or moral views affect scientific research because scientists unwittingly choose studies that support the point of view of their cultures" (31.3%), and this rate has decreased by 3.6% after the applications. The second highest number of views given to this item was that "religious or moral views affect scientific research; because everyone reacts differently to their own culture and these individual differences affect the type of research conducted" and this rate has increased by 13.3% after the applications. 20.4% of the pre-service teachers adopted "acceptable" views and the rate of those who preferred the views dropped to 9.6% after the applications. While 32.4% of the pre-service teachers preferred the views in the "unsatisfactory" category before the applications, they preferred these views at a similar rate after the applications (33.7%).

The results of the pre-service teachers' answers for the sixth item of the questionnaire, "*the effect of educational institutions on the development of science and technology*" are given in Table 7.

Table 7. Percentage distributions of responses to Item 6

The success of science and technology depends on how much the public supports scientists, engineers, and technicians. This support depends on students who learn how to use science and technology in the country, that is, individuals who will form the future society.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
C[R]	Yes, the more students learn about science and technology, the more knowledgeable they will be, they will form better ideas, and the better they will contribute to how technology and science can be used.	48.2	51.8
D[R]	Yes, the more students learn about science and technology, the better the society will grasp the importance of science and technology, the better they will understand the opinions of experts, and the more they will provide the necessary support for science and technology.	20.4	27.7
A[A]	Yes, the more students learn about science and technology, the more the country will develop. Students are our future.	25.3	12

B[A]	Yes, the more students learn about science and technology, the more scientists, engineers and technicians will be among them, and the country will prosper.	6	8.4

According to Table 7, the majority of the pre-service teachers (68.6%) preferred “realistic” views. While 31.3% preferred "acceptable" views before the applications, the rate of those who preferred "realistic" views after the applications increased (79.5%).

The answers for the 7th item of the VOSTS questionnaire about *the effect of the public on scientists* are given in the Table 8.

Table 8. Percentage distributions of responses to Item 7

Some societies raise more scientists than other societies. This situation stems from the way families raise their children at school and society.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
C[U]	The upbringing style is a very important factor because some teachers and schools offer better science lessons than others or encourage students to learn more.	54.2	37.3
D[R]	Upbringing style is the most important factor, because family, schools and society provide children with scientific skills, encouragement and opportunity to become scientists.	21.6	21.6
B[A]	Upbringing style is a very important factor because some families encourage their children to ask questions and be curious. Families teach all the values we will carry throughout our lives.	10.8	14.4
E[A]	It is difficult to say anything. The upbringing certainly has an impact, but the person himself is also important. The upbringing style and the individual are equally effective.	4.8	12.0
A[A]	Upbringing is a very important factor because some societies place more emphasis on science than others.	-	6
F[R]	Often, intelligence, talent, and interest in science affect who will become a scientist. However, the breeding style also has an effect.	4.8	8.4
G[U]	Often, intelligence, talent, and interest in science are effective because people are born with these traits.	2.4	-
H[U]	I don’t understand.	1.2	-

When the answers for the 7th item are examined, 57.6% of the pre-service teachers were "unsatisfactory" before the applications; 15.6% preferred "acceptable", and 26.4% preferred "realistic" views. After the applications, it was observed that the pre-service teachers preferred the views in all three categories at similar rates.

The responses of pre-service teachers for the 8th item defining *the contribution of social decisions* were given in the Table 9.

Table 9. Percentage distributions of responses to Item 8

Scientists and engineers are the people who have to decide whether nuclear reactors can be built or where they should be built, because it is the scientists and engineers who know the facts best.			
		%	%
Your position, basically:		**Pre-**	**Post-**
D[R]	Decisions need to be made equally. The opinions of scientists and engineers, other experts and the informed society must all be taken into account in decisions affecting society.	40.9	45.7
C[A]	Scientists and engineers need to make decisions because they have the education and knowledge that enable them to better understand the subject, but the public should be involved in this process, either informed or consulted.	37.3	25.3
B[U]	Scientists and engineers need to make decisions because they are knowledgeable and can make better decisions financially and personally than government bureaucrats or private companies interested in this business.	10.8	12
A[A]	Scientists and engineers need to make decisions because they have education and knowledge that enable them to better understand the subject.	2.4	13.2
E[U]	The government has to decide because this issue is fundamentally political. Scientists and engineers should make recommendations.	3.6	-
F[U]	Society has to make a decision because that decision will affect everyone, scientists and engineers must make recommendations.	-	3.6
I[U]	I don't know enough about this subject to make a choice.	2.4	-
H[U]	I don't understand*	1.2	-
J[U]	None of these choices fits my basic viewpoint*	1.2	-

When the responses of pre-service teachers for the 8th item were examined, 40.9% of the pre-service teachers preferred "realistic" views before the applications and this rate increased to 45.7% after the applications. After the applications, 38.5% of the pre-service teachers preferred the views in the "acceptable" and 15.6% "unsatisfactory" category.

In the Table 10 were given the item in which *the views about the characteristics of scientists.*

Table 10. Percentage distributions of responses to Item 9

Scientists can best solve any everyday problem. Because scientists are more knowledgeable than other people.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
D[A]	Scientists are not better than other people at solving any everyday problems, because scientists are like everyone else in everyday life. Experience and common sense solve everyday problems.	45.7	48.2
A[R]	Scientists are better at solving any practical problems than other people. Their logical problem-solving thoughts or specialized knowledge give them an advantage when solving problems.	27.7	33.7
B[U]	Scientists are not better at solving any everyday problem than other people, because science classes give everyone enough problem-solving skills and practical problem-solving knowledge.	12	7.2
C[A]	Scientists are not better at solving any everyday problems than other people, because generally scientists' training is not helpful in solving everyday problems.	4.8	3.6
E[U]	Scientists are probably worse than other people at solving any everyday problems because they work out of everyday life in a complex world.	3.6	7.2
F[U]	I don't understand.	3.6	-
H[U]	None of these choices fits my basic viewpoint.	2.4	-

In another item were presented, pre-service teachers preferred "acceptable" views before (50.7%) and after (51.8%) the applications. While the rate of those who prefer "realistic" views were 27.7% before the applications, it increased by 10% after the applications.

The views of the pre-service teachers were presented for *the effect of gender on the science process and product* in the Table 11.

Table 11. Percentage distributions of responses to Item 10

There are more women engaged in science today than before. This makes a difference in scientific discoveries. Scientific discoveries made by women will be different from those made by men.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
G[R]	There is no difference between the discoveries made by male and female scientists because any difference between their discoveries is due to the	25.3	38.6

	individual difference between them. These kinds of differences are not about being a woman or a man.		
H^A	Women will make quite different inventions because, by their nature and upbringing, women have different values, perspectives, perspectives, or traits.	18	20.4
E^A	There is no difference between the discoveries made by male and female scientists, because research objectives are determined by the demands and desires of people outside of scientists as well as scientists.	14.4	10.8
D^U	There is no difference between the discoveries made by male and female scientists, because males and females are the same in terms of the subjects they want to explore in science.	22.9	9.6
B^U	There is no difference between the discoveries made by male and female scientists because male and female scientists receive the same education.	7.2	7.2
F^U	There is no difference between the discoveries made by male and female scientists, because no matter what they make, everyone is equal.	8.4	6
A_U	There is no difference between the discoveries made by male and female scientists, because any good scientist will definitely make the same discovery as other good scientists.	3.6	3.6
C^A	There is no difference between the discoveries made by male and female scientists, because in general, men and women are equally intelligent.	-	3.6

When the views of the pre-service teachers were examined in the Table 11, 42.1% of the pre-service teachers preferred "unsatisfactory", 32.4% "acceptable" and 25.3% "realistic" views before the applications. After the applications, it was observed that the pre-service teachers who preferred “realistic” (38.6%) and “acceptable” (34.8%) views remained similar. The number of those who preferred the views in the "unsatisfactory" category decreased to 26.4%.

The answers given by the pre-service teachers for the item describing *the national impact on scientific knowledge and techniques* were presented in the Table 12.

Table 12. Percentage distributions of responses to Item 11

Scientists trained in different countries view a scientific problem from different angles. This means that a country's education and cultural system can affect the results the scientist achieves.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
B^A	The educational and cultural system of a country affects the results	25.3	42.2

	achieved by scientists, because each country has different systems for science education. The way scientists are taught to solve problems affects the results scientists will achieve.		
A^R^	The educational and cultural system of a country affects the results achieved by scientists; because education and culture affect all fields, including the way of thinking about a scientific problem.	31.3	34.9
D^R^	This depends on the situation. The way a country educates its scientists affects the way some scientists think. But other scientists can also look at problems in a personal way, based on their personal opinions.	19.2	15.7
CA	A country's educational and cultural system affects the results achieved by scientists; because the country's administration and industry only support projects that fit their needs. This affects what the scientist will investigate.	24.1	3.6
F^U^	A country's educational and cultural system does not affect the results achieved by scientists; because scientists all over the world use the same scientific method that leads to similar results.	-	3.6

When the answers for the item 11 were examined, 50.5% of the pre-service teachers preferred "realistic" and 49.4% "acceptable" views before the applications. After the applications, there was no change in the ratio of pre-service teachers in these two categories.

The views of the pre-service teachers about *the uncertainty of scientific knowledge* were presented in the Table 13.

Table 13. Percentage distributions of responses to Item 12

Even if the researches made by scientists are done correctly, the findings reached at the end of the research may change over time.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
A^R^	Scientific knowledge changes; because scientists refute the theories or discoveries of scientists before them. Scientists do this by using new techniques and improved tools, finding previously overlooked factors, or uncovering errors in the initial research.	48.2	61.4
B^R^	Scientific knowledge changes; because old knowledge is reinterpreted in the light of new discoveries. Scientific facts may change.	36.1	32.5
C^A^	Scientific knowledge seems to change; because the interpretation or application of old facts may change. Experiments done properly lead to	10.8	6

	fixed facts.		
D[A]	Scientific knowledge seems to change; because new information is added on old information; old information actually does not change.	4.8	-

When the views of the pre-service teachers were examined, 83.1% of the pre-service teacher's preferred "realistic" views before the applications and this rate increased by 10.8% after the applications. We can say that most of the pre-service teachers agree on the changeability of scientific knowledge.

The views of the pre-service teachers on *the classification of scientific knowledge* were presented in the Table 14.

Table 14. Percentage distributions of responses to Item 13

Scientific ideas develop from hypotheses to theories, and the result is scientific law if they are strong enough.			
Your position, basically:		**Pre-test (%)**	**Post-test (%)**
A[U]	Hypothesis can turn into theory, theory into law; because if the hypothesis is tested with experiments and its accuracy is proven, it becomes a theory. Theories become laws if they are tested and proven to be correct by different people over a long period of time.	18.1	30.1
B[U]	Hypothesis can turn into theory, theory into law; Because the hypothesis is tested with experiments, if there is supporting evidence, it becomes a theory. After a theory has been tested many times and found to be correct, this is enough for the theory to become a law.	10.8	25.3
D[U]	Theories can't become laws because they both are different types of ideas. Theories are based on scientific ideas which are less than 100% certain, and so theories can't be proven true. Laws, however, are based on facts only and are 100% sure.	34.9	22.9
E[R]	Theories cannot be laws; because these are different kinds of thoughts. Theories are based on scientific considerations that are not fully certain and their accuracy cannot be proven. However, laws are based only on facts and are 100% precise.	15.7	16.8
C[U]	Hypothesis can turn into theory, theory into law; because for the development of scientific thought, it is a logical way for the hypothesis to be transformed into theory, and theory into law.	14.4	4.8
H[U]	None of these choices fits my basic viewpoint.	3.6	-

F^U	I don't understand.	2.4	-

When the views of the pre-service teachers on the classification of scientific knowledge were examined, 84.2% of the pre-service teachers gave answers in the "unsatisfactory" category for the concepts of "hypothesis-theory-law" before the applications. The views of the pre-service teachers about these concepts with the relationship between them did not change after the applications (83.1%).

In the last item of the VOSTS questionnaire, the views of the pre-service teachers about *their ability to provide reasonable rationale* were examined (Table 15).

Table 15. Percentage distributions of responses to Item 14

If scientists find that people who work with asbestos are twice as likely to develop lung cancer as the average person, that should mean that asbestos causes lung cancer.			
		%	%
Your position, basically: (Please read from A to J, and then choose one.)		**Pre-**	**Post-**
B^R	The facts may not mean that asbestos causes lung cancer; Because more research is needed to find out whether asbestos or another substance causes lung cancer.	33.7	38.5
C^R	The facts may not mean that asbestos causes lung cancer; because asbestos can act indirectly or with other things.	28.9	30.1
A^U	The facts clearly prove that asbestos causes lung cancer. If asbestos workers are more likely to get lung cancer, then the cause of the cancer is asbestos.	7.2	15.7
G^U	I don't have enough information to make a choice*	4.8	10.8
D^U	The facts may not mean that asbestos causes lung cancer; Because if asbestos had cancer, all asbestos workers would have gotten lung cancer.	8.4	7.2
F^U	I don't understand.	8.4	3.6
E^U	Asbestos cannot be the cause of lung cancer because many people who do not work with asbestos also develop lung cancer.	2.4	-

When the answers given to this item were examined, 62.6% of the pre-service teachers gave "realistic" and 31.2% "unsatisfactory" views before the applications, while this rate remained almost the same after the applications.

4. Discussion

In the study, the effect of the "Science, Technology, Society and Environment" education carried out by the pre-service science teachers within the scope of the Science, Technology and Society course on their views on science, technology and society were investigated. For the 14 items that the pre-service teachers participated in the study gave their views on the VOSTS questionnaire, "Interdependence of science and technology", "Define relationship between government and science", "Define Ethics", "Define educational institutions", "Define changeability of scientific knowledge" and "Define logical explanations in justifications" issues were observed to have a "realistic" point of view. It is one of the satisfactory findings of the study that the pre-service teachers preserved these views after the applications. The item with the highest rate among all items before and after the applications in the study, with a post-positivist point of view, belongs to the item from which the views on the subject of "Define changeability of scientific knowledge" were taken. However, pre-service teachers had an "unsatisfactory" point of view on "Public influence on scientists", "Gender effect on the science and technology" and "Define classification level of scientific knowledge". It was determined that they did not change their views on the nature of the classification level (Hypotheses, theories and laws) after the STSE applications.

The items in the "science and technology" sub-dimension of the VOSTS questionnaire consist of the definitions of science and technology and the judgments and justifications regarding their relationship with each other. When the responses of the pre-service teachers regarding the definition of "science" are examined, it is noteworthy that there is a variety in the pre-service teachers' answers before the STSE applications. The results obtained before the applications are similar to the findings obtained in the literature (Aikenhead & Ryan, 1992; Ayvacı & Özbek, 2015; Botton & Brown, 1998; Bradford, Rubba & Harkness, 1995; Göz, 2019; Kahyaoğlu, 2004; Zan Yörük, 2008).

After the applications carried out within the scope of the STS course, the number of those who marked the option representing the "realistic" view in the definition of "science" increased. When the options classified according to the "acceptable" perspective of the pre-service teachers after the STSE applications were examined, it was observed that they chose to define as "the effort to improve the world we live in and what has been done in this process" and that they have misconceptions about the concepts, facts and events that they consider equated with the definition of science: ability to use knowledge, theory-law-principle, experiment, match with physics, chemistry, biology. The presence of similar findings in many studies examined in the literature as well as these misconceptions about the definition of "science" among pre-service teachers draw attention (Ayvacı & Özbek, 2015; Balkı et al., 2003; Demir & Akarsu, 2013; Göz, 2019; İnce, 2017; Kahyaoğlu, 2004; Kılınç, 2010; Turgut et al., 2017; Ürek, 2012). In the second item of the VOSTS questionnaire, the views of the pre-service teachers about the definition of "technology" were examined. Before the applications within the scope of the STS course, technology was seen as the "application of science" or was "likened to science" from an "unsatisfactory" point of view. After the applications, the pre-service teachers were asked the reasons for selecting this option, and the pre-service teachers stated that technology was always defined as "the application of science" throughout their education life or in books. The high rate of those who defined technology as an "acceptable" view before the applications shows that there is a misconception that pre-service teachers confuse the concepts of science and technology with each other.

It was observed that there were similar misconceptions encountered in the studies conducted by Erişti and Kurt (2011), Göz (2019), Herdem et al. (2014), Kahyaoğlu (2004), Solomonidou and Tassios (2006) and Zan Yörük (2008). Pre-service teachers consider technology similar to robot, electronic device, computer tool or equipment. There was an increase in the number of people who preferred the view defining technology according to the "realistic" perspective after the applications, but the fact that those who preferred the views presented according to the other two categories were also intense after the applications showed that the misconceptions about this concept still continue. In the research of Botton and Brown (1998) with graduate students, they examined the answers given to the items in which the views about the definition of science and technology of the VOSTS questionnaire were presented and it was emphasized that there was a problem in learning the concepts of science and technology. In the study, it was stated that the participants explained technology as the application of science, even though they were graduate students. This study shows that the difficulty in learning science and technology concepts in the field of STSE continues in higher education levels. Çelik (2003) stated in his study that some pre-service teachers confused the concepts of science and technology. Çınar and Çepni (2012) stated in her study that pre-service teachers think that technology is an application of science and they are dependent on science. It is noteworthy that pre-service teachers, who were observed to have misconceptions in the definition of science and technology, preferred "realistic" views for the relationship between science and technology before and after the applications. The majority of pre-service teachers think that science and technology are closely related. According to them, scientific research leads to practical applications in technology and technological developments increase the ability to conduct scientific research. This finding is similar to the findings obtained in the studies of Kahyaoğlu (2004) and Göz (2019). When the answers given to the 4th item, which includes the views of the sub-dimension of the impact of society on science/technology, half of the pre-service teachers preferred the "realistic" view that "money should be spent for scientific researches because scientists can make the world a better place for understanding and living". This view was also preferred with the highest rate in the post-test. With this result, it is revealed that pre-service teachers defend the view that scientific research should be supported, their views on the relationship between science and government are sufficient and they have an idea about which sources and with whom scientific studies are funded. The importance of STSE applications is emerging in terms of increasing the projects aimed at solving a problem situation that primarily concerns the society in which the pre-service teachers, who will be active in the process, are their participants or executives and to raise their awareness of what is the main force behind the realization of these projects. Similar results were observed in the studies of İnce (2017), Kahyaoğlu (2004), Ayvacı & Özbek

(2015) and Zan Yörük (2008). In the relationship of governments with science, whether the studies by scientists are beneficial or not, it is acceptable in the sense that there is an investment risk that needs to be funded for scientific research. It also highlights that financial support should be used directly in scientific research related to health, environment or agriculture. From this point of view, it would be a realistic perspective for scientists to make our world a better place to live in using financial support for scientific research (Aikenhead & Ryan, 1992). Another view examined in the sub-dimension of the impact of society on science technology is on the social and cultural element of the nature of science. Pre-service teachers showed that they had a “realistic” perspective by using their preferences for the view that “religious or moral views affect scientific research” before the applications (Aikenhead & Ryan, 1992). Contemporary views claim that the actions of scientists are largely influenced by their previous values, experiences, and beliefs. An increase has been observed in pre-service teachers who have this view after STSE applications. This finding is similar to the findings of researchers such as Ayvacı & Özbek (2015), Chan and Tanner (2008), Haidar (1999) and Kahyaoğlu (2004). When the answers of the pre-service teachers to the subject of “treasure educational institutions”, which are examined in the sub-dimension of the effect of society on science/technology, are examined, the pre-service teachers will be able to support the success of science and technology to the public's support to scientists, engineers and technicians, and to students who learn how to use science and technology, namely the future. They preferred the view that it depends on the individuals who will form the society. A similar finding was observed in the studies of Göz (2019) and Kahyaoğlu (2004). The number of pre-service teachers who preferred these views representing the “realistic” perspective increased after the STSE applications. Pre-service teachers are aware that the support of society to science and technology for this item can be through educational institutions or their efforts to contribute (Aikenhead & Ryan, 1992). In some societies, about the issue of training more scientists than other societies, half of the pre-service teachers presented opinions in the “unsatisfactory” category before the implementation. Approximately one-fourth of the pre-service teachers prefer “realistic” views, as it will increase the support of the whole society to become scientists, and will give well-educated citizens the opportunity to make informed decisions on scientific and technological issues (Kahyaoğlu, 2004). One of the expressions evaluated according to the “acceptable” point of view for the sub-dimension of “the impact of society on science and technology” is that "the training style and the individual's efforts to raise him/herself are equally effective”. The following views can be given as examples of the views reflecting this statement (Göz, 2019): -Some societies give more importance to science than other societies, -Some families encourage their children to ask questions and teach them all the values they will carry throughout their life (Zengin, 2018). However, the fact that the family, school and society give children the courage and opportunity to gain scientific skills and become scientists, as well as the way of growing up to become a scientist, the interest in intelligence, talent and science gives a realistic view on the effect of society on science-technology in determining who will be a scientist (Aikenhead & Ryan, 1992). After the individual efforts of the teacher candidates during the applications within the scope of the STS course, a decrease was observed in their “unsatisfactory” views, but it was observed that the rate of views in all categories was similar after the applications. Similar findings were observed in the studies of Göz (2019), İnce (2017) and Kemaneci (2013). For the subject of “define contribution of social decisions”, which is examined within the scope of the sub-dimension of the effect of science/technology on society, before the applications pre-service teachers preferred “realistic” view that the views of scientists and engineers, other experts and the informed society should all be taken into account in decisions affecting society and “acceptable” view that the public should only be informed that engineers should make decisions. An increase has been observed in those who prefer realistic views about the necessity of involving the public in social decision making after the STSE applications. This result is similar to the findings of the studies of Çelikdemir (2006), Göz (2019), İnce (2017), Kahyaoğlu (2004), Kılınç (2010) and Zan Yörük (2008). Pre-service teachers anticipate that developing countries should raise individuals who are decision-makers at the expected level, especially when dealing with other related issues such as science and environment.

The number of pre-service teachers who prefer the “acceptable” view, who think that the education of scientists is not aimed at solving daily problems and that they can solve everyday problems with experience and common sense, since scientists are like everyone else, increased slightly after the applications. The number of “realistic” pre-service teachers who think that scientists are better able to solve logical problems with their specialized knowledge than other people have also increased slightly after the STSE. However, pre-service teachers with an acceptable point of view remained at a higher rate. As there is no consensus among pre-service teachers that scientists can best solve any practical daily problem, pre-service teachers justify their life in a limited social environment such as families of scientists and/or friends of other scientists or laboratory environments where they only carry out scientific research they have shown. For these reasons, pre-service teachers think that scientists who always think about science and scientific research in their daily lives are insufficient in solving their daily problems. When the opinions of the pre-service teachers about the effect of gender on the developments in science and technology were examined, the majority of the pre-service teachers stated that there was no difference in the discoveries made by male and female scientists before and after the practices. Similar results were observed in the study of Çelik (2003), Dikmentepe & Yakar (2016), Göz (2019), İnce (2017), Kahyaoğlu (2004), Ürek (2012) and Zan Yörük (2004), However, when these views were analysed in detail, they suggested that if only one-fourth of the pre-service teachers had a difference in scientific discoveries before the applications, the reason for this was individual differences. Although the pre-service teachers with this “realistic” view increased after the STSE applications, it is striking that there is no consensus among the pre-service teachers in their views. The fact that the majority of the teacher candidates participating in the study (62%) are female students suggests that this result may occur.

In the item in which views about the effect of different countries’ scientific perspectives on the scientific knowledge and technique developed in them are presented, the pre-service teachers agreed on the views that reflect the “realistic” and “acceptable” perspective. This points to an agreement based on the view that a country's education system and/or culture influence the conclusions scientists reach, and that countries make a difference in scientific research. Scientists trained in different countries may approach a scientific problem from different angles. In this context, it is accepted as "realistic" in that education and culture will affect all areas of life, including scientific problems, and that this situation can sometimes change, and that scientists can look at problems in personal ways by emphasizing their own personal views. However, considering that each country has its own science education system, it is an acceptable view that scientists will reach a conclusion through that system to solve the problem, and that the countries' own administration and industry have science that fits their needs, which can affect what scientists will study (Aikenhead & Ryan, 1992). The finding for this item is also similar to the findings obtained in the studies of Dikmentepe and Yakar (2016), Doğan Bora (2005), Göz (2019), İnce (2017), Kahyaoğlu (2004) and Zan Yörük (2008). The statement "Even if the researches made by scientists are done correctly, the findings reached at the end of the research may change over time" was used in order to determine the views of the pre-service teachers about the changeability factor of the nature of science. Most of the participants, before and after the applications, showed the belief that scientific knowledge can change in the future if the research is done correctly. The fact that the history of science was also mentioned at the beginning of the applications within the scope of STSE applications, gave the pre-service teachers the opportunity to observe that scientific knowledge changed depending on the conditions of the period in the historical process. Uncertainty of scientific knowledge is one of the main features of science that makes it different from other forms of knowledge and prevents it from being dogmatic. In a study investigating the effect of the historical approach on students' views on the nature of science, it was concluded that the atomic topic had an effect on students' thinking about the changeability element of the nature of science (Özcan & Turgut, 2014). It is thought that practices involving socioscientific issues such as global warming (Khishfe & Lederman, 2006) or topics prone to argumentation (Sadler, Chambers, & Zeidler, 2004) enable students to adopt a more realistic view about the changeability element of the nature of science. In the studies conducted and in the current study, it is revealed that students mostly have the view that scientific knowledge is changeable (Çelikdemir, 2006; Göz, 2019; İnce, 2017; Kahyaoğlu, 2004, Kaya et al., 2017; Khishfe & Abd-El-Khalick, 2003; Khishfe & Lederman, 2006; Kılınç, 2010. Relationships between hypothesis-theory-law were asked to see if pre-service science teachers considered hypotheses, theories, and laws as a hierarchical relationship or as different kinds of ideas and statements. Before and after the applications, pre-service teachers think that a scientific theory will turn into a law if it is supported with sufficient evidence. This situation is similar to previous studies in the literature (Altun Yalçın et al., 2010; Ayvacı & Özbek, 2015; Doğan Bora, 2005; Liu & Lederman, 2007; Mıhladız & Doğan, 2012; Turgut, 2005).

As the reason for the misconception that there is a hierarchical relationship between hypothesis-theory-law, it is seen that scientific concepts are not emphasized much in many written sources and textbooks, and a concept such as theory that can lead to major misconceptions as a result of students' inability to fully construct it is seen to be correctly or incompletely defined (Apaydın & Sürmeli, 2006). Pre-service teachers think that the concept of law is the most reliable type of knowledge in terms of proof and certainty among the types of scientific knowledge. Although concepts such as hypothesis, theory and law are frequently mentioned in textbooks, it is seen that there is wrong and incomplete information on this subject from primary school to university (Yenice et al., 2015). However, while explaining the myths about the nature of science in his research, McComas (1998) stated that the misconception that hypotheses form theories and theories form laws is a common scientific myth. In this context, it can be thought that it is effective to focus on the types of scientific knowledge in the "science and history of science" unit in the classroom discussion environment, and to explain the different and similar points one by one by giving examples of the concepts of hypothesis, theory and law. Tatar, Karakuyu and Tüysüz (2011) mentions that in daily use, the law is considered to be at the top of the hierarchical structure because it is the last resort to rely on when making decisions, and this usage will place the law in a higher position than the theory and hypothesis, which does not have as much use in daily life. One of the reasons for this situation can be shown in the written sources as the fact that hypotheses become theories if they have wide validity as a result of following a certain scientific method, and that theories become universal laws as a result of their proof. In the final item of the VOSTS questionnaire, opinions were received on whether it is necessary to find cause and effect to elaborate on what else influences a study outside of the context of the subject being investigated in order to provide a rationale for it. Most of the pre-service teachers preferred the view that the facts before and after the applications do not mean that asbestos causes cancer. This means that most of the pre-service science teachers are aware of cause-effect relationships related to scientific and technological issues. These results show that students take into account the elements about the nature of science, since students are asked to research a research thoroughly and interpret it within the limits of the scientific framework (Göz, 2019). Similar findings are similar to those observed by Ayvacı and Özbek (2015) and Kahyaoğlu (2004).

5. Conclusions

In this study, in which the effects of STSE applications carried out within the scope of STS course on the views of pre-service teachers about science, technology and society were examined, a development in favour of the "realistic" perspective was observed in the views of pre-service teachers in "science and technology, influence of society on science / technology, define contribution of social decisions, gender effect on the process and product of science, define national influence on scientific knowledge and technique, define changeability of scientific knowledge and define logical reasonable justification" dimensions of the nature of science after the applications. In a study examining the effect of STS course on pre-service teachers' views on science, technology and society, it was found that there was a difference in the social and cultural values of the nature of science (Sandoval & Morrison, 2003). It has been determined that there is generally a positive relationship between science and technology, technology is seen as a product of science, but some pre-service teachers use the concept of technology instead of the concept of science. It has been seen in the statements of pre-service teachers that technology has positive and negative effects on society and the environment, especially technology facilitates the life of society, but harms public health and the environment (İnce, 2017). In the relations that the pre-service teachers established with the sub-fields of the STSE learning field, it was found that experiment and observation were emphasized in the associations related to the nature of science, that most students could not establish relationships and lack of knowledge about socio-scientific issues, and that science courses would be effective in the formation of positive consciousness in science and career awareness. Çelik (2003) stated in his study that some pre-service teachers confuse the concepts of science and technology.

The science, technology and society lesson in which STSE applications is included is quite different from other science lessons in terms of teaching. In the STS course, students exhibit behaviours such as detecting daily science-related events, producing solutions, suggesting and making decisions in an active learning process. In addition to the problems related to the environment and society they live in, teacher candidates also deal with problems that concern all countries of the world such as global warming, nuclear power, disease and health. In this process, it is expected that it will be sufficient for pre-service teachers to reach the resources that will provide information about the problems they have posed. Science education given with the STSE perspective requires students to be active in the education and training process and to be encouraged to research and solve problems. Such an understanding of education allows students to apply to various sources to obtain information, to conduct research in the light of the information they have obtained and in cooperation with other students, to interpret the research results they have obtained, to discuss among themselves, and most importantly, as a result of all these experiences, they come to a decision about the subject they research and requires them to take action to implement it. According to Solomon and Aikenhead (1994), it is a frequently used and recommended process in STSE education to start teaching with a subject that concerns the society and is related to science and technology. For example, it is an ideal situation for individuals who will be engaged in this training to start with recognizing a problem situation that primarily concerns their community. When they encounter a problem that concerns society, students need to learn the technology related to this problem and the science behind this technology in order to understand this problem and produce solutions. Therefore, the first task of the students in STSE education is to research the technological and scientific aspects of the subject they will examine and then, if possible, to conduct a scientific research in the light of this information and collect data.

The STSE education, which was put into practice and gained importance in the 70s, has been effective in determining science literacy and high-level thinking skills as targets in today's science curriculum. Teachers and students who can actively use comprehensive skills such as scientific research skills, knowledge of the nature of science, recognizing the society and environment in which they live, and designing and implementing projects on socioscientific issues included in STSE education should be involved in the process. Although STSE education and various related achievements were included in the Science Curriculum, which was started to be used in 2005 and later updated in 2013, the fact that STSE education was not sufficiently included in classroom activities necessitates the use of STSE education more actively. In order to reach the goals of today's science curricula, large-scale in-service training programs should be planned and STSE education should be given more space in teacher training institutions.

References

Abd-El-Khalick, F., Bell, R.L., & Lederman, N.G., (1998). The nature of science and instructional practice: Making the unnatural natural. *Science Education, 82*(4), 417-436. **https://doi.org/10.1002/(SICI)1098-237X(199807)82:4<417::AID-SCE1>3.0.CO;2-E.**

Açıkgöz, K.Ü., (2003). *Active learning*. Eğitim Dünyası Publications: Izmir.

Aikenhead, G.S., & Ryan, A.G. (1992). The development of a new instrument: Views on Science–Technology-Society (VOSTS). *Science Education, 76*(5), 477–491. **https://doi.org/10.1002/sce.3730760503**

Aikenhead, G.S., (2003). STS education: A rose by any other name. A chapter in: *A vision for science education: Responding to the work of Peter J. Fensham*. Edited by Roger Cross, Routledge Press.

Aikenhead, G.S., Ryan, A., & Fleming, R., (1989). *Views on science-technology-society* (form CDN.mc.5). Saskatoon, Canada: Department of Curriculum Studies, University of Saskatchewan.

Akgün, Ş., (2001). Science teaching, p.12, Giresun: Zirve Offset.

Altun-Yalçın, S., Kahraman, S., Açışlı, S., & Yılmaz, Z.A., (2010). Investigating the views of the pre-service science teachers about the nature of science. *Erzincan University Journal of Science and Technology, 3*(2), 181-197.

Apaydın, Z., & Sürmeli, H., (2006). University students' attitudes towards the theory of evolution. Ö. Genç, (Ed.), In Evolution, *Science and Education* (1st ed.). Istanbul: Nazım Library.

Arı, Ü., (2010). *Investigation of the pre-service science teachers' and pre-service classroom teachers' views on nature of science*. Master of Science, Fırat University, Elazığ.

Avcı, D., & Önal, N., (2013). Investigation of the distribution of science-technology-society-environment acquisitions in science and technology curriculum (6-8th grade). *Mehmet Akif Ersoy University Journal of Education Faculty, 1*(25), 225-240.

Ayar, M.C., (2007). *The effect of STS class on the views of the pre-service science teachers about the nature of science*. Master of Science, Marmara University, Institute of Educational Sciences, Istanbul.

Ayvacı, H.Ş., & Özbek, D., (2015). The effect of science technology society course on pre-service science teachers' perceptions of nature of science. *HAYEF: Journal of Education, 12*(1), 131-152.

Bacanak, A., (2002). *A study about the evaluation of the science student teachers' scientific literacy and application of science-technology-society course*. Master of Science, Karadeniz Technical University, Institute of Science, Trabzon.

Balkı, N., Çoban, A.K., & Aktaş, M., (2003). The ideas of the students of the primary school about science and scientists. *Journal of Uludağ University Faculty of Education, 16*(1), 11-17.

Botton, C., & Brown, C., (1998). The reliability of some VOSTS items when used with pre-service secondary science teachers in England. *Journal of Research in Science Teaching, 35*(1), 53–71. **https://doi.org/10.1002/(SICI)1098-2736(199801)35:1<53::AID-TEA4>3.0.CO;2-M**.

Bradford, C.S., Rubba, P.A., & Harkness, W.L., (1995). Views about Science-Technology-Society interactions held by college students in general education physics and STS course. *Science Education, 79*, 355–373. **https://doi.org/10.1002/sce.3730790402**.

Büyüköztürk, Ş., Kılıç-Çakmak, E., Akgün, Ö.E., Karadeniz, Ş., & Demirel, F., (2011). *Scientific research methods*. Ankara: Pegem Publishing.

Chan, J., & Tanner, K., (2008). *Understanding middle school students" views of the nature of science: Perspectives from a seventh grade classroom*. NARST Annual International Conference 2008, Abstracts Book.

Çelik, S., (2003). *The perspective teachers' views of the nature of science and influence of "science, technology and society" course on these views*. Master of Science, Atatürk University, Institute of Social Sciences, Erzurum.

Çepni, S., Bacanak, A., & Küçük, M., (2003). Changing values in the goals of science education: science-technology-society. *Journal of Values Education, 1*(4), 7-29.

Çınar, S., & Çepni, S., (2012). An approach in the science and technology curriculum: Science, Technology, Society (STS) approach. *Journal of Kazım Karabekir Education Faculty, 0*(24).

Demir, N., & Akarsu, B., (2013). Middle school students' perceptions of the nature of science. *Journal of European Education, 3*(1), 8-15.

Demirçalı, S., (2007). *Developing and implementing supplementary activities based on STS approach in secondary 8. Grade science lesson in the unit of genetics*. Master of Science, Gazi University, Ankara.

Dikmentepe, E., & Yakar, Z., (2016). Pre-service science teachers' views on science technology society. *International Journal of Higher Education, 5*(2), 183-195. **https://doi.org/10.5430/ijhe.v5n2p183**.

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

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

Dolan, T.J., Nichols, B.H., & Zeidler, D.L., (2009). Using socioscientific issues in primary classrooms. *Journal of Elementary Science Education, 21*(3), 1-12.

Erden, M., (1998). *Program evaluation in education*. Ankara: Anı Publishing

Erişti, S.D., & Kurt, A.A., (2011). Elementary school students' perceptions of technology in their pictorial representations. *Turkish Online Journal of Qualitative Inquiry, 2*(1), 24- 37.

Eskicumalı, A., Demirtaş, Z., Gür Erdoğan, D., & Arslan, S., (2014). The comparison of the science and technology curriculum and renewed science curriculum. *International Journal of Human Sciences, 11*(1), 1077-1094. **doi: 10.14687/ijhs.v11i1.2664**.

Evren, A., & Kaptan, F., (2014). *Socioscientific situation-based teaching and its importance in science education*. VI. International Congress of Educational Research (ICER). Hacettepe University, Ankara, 5-8 Juny, 2014.

Göz, H., (2019). *Opinions of gifted students about science, technology and society*. Master of Science. Recep Tayyip Erdoğan University, Institute of Science, Rize.

Guilherme E., Faria, C., & Boaventura, D., (2016). Exploring marine ecosystems with elementary school Portuguese children: Inquiry-based project activities focused on "real-life" contexts. *Education, 44*(6), 715–726. **https://doi.org/10.1080/03004279.2015.1007884**

Haidar, A., (1999). Emirates pre-service and in-service science teachers' views about the nature of science. *International Journal of Science Education, 21*(8), 807-822. **https://doi.org/10.1080/095006999290309**.

Herdem, K., Aygün, H.A., & Çinici, A., (2014). Investigating of 8th grade students' perceptions of technology through their cartoons. *Amasya Education Journal, 3*(2), 232-258.

İnce, M.C., (2017). *The effect of informal learning environment upon students' understanding of science-technology-society-environment*. Master of Science. Yıldız Technical University, Institute of Science, Istanbul.

Kahyaoğlu, E., (2004). *Investigation of the pre-service science teacher's views on science technology and society issues*. Master of Science, Middle East Technical University, Ankara.

Kara, Y., (2012). Pre-service teachers' perceptions on the instruction of socioscientific issues in the curriculum. *European Journal of Teacher Education, 35*(1), 11-129.

Kaya, E., Erduran, S., Akgün, S., & Aksöz, B., (2017). Nature of science in teacher education: A holistic approach. Necatibey Faculty of Education, *Electronic Journal of Science and Mathematics Education, 11*(2), 464-501. **https://doi.org/10.17522/balikesirnef.373423**

Kemaneci, G., (2012). *Searching for the image of scientists from the point of view of gifted students*. Master of Science, Gazi University, Ankara.

Khishfe, R., & Lederman, N., (2003). *The development of students' conceptions of nature of science*. Paper presented at the Annual Meeting of the American Educational Research Association (AERA), Chicago, IL.

Khishfe, R., & Lederman, N., (2006). Teaching nature of science within a controversial topic: Integrated versus non-integrated. *Journal of Research in Science Teaching, 43*(4), 395-418. **https://doi.org/10.1002/tea.20137.**

Kılınç, E., (2010). *Analysing the knowledge structures of secondary school students about the nature of science via the concept map*. Master of Science, Gazi University, Ankara.

Liu, S.Y., & Lederman, N.G., (2002). Taiwanese students' views of nature of science. *School Science and Mathematics, 102*(3), 114-122. **https://doi.org/10.1111/j.1949-8594.2002.tb17905.x.**

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

Mıhladız, G., & Doğan, A., (2012). Comparison between science teachers' and pre-service teachers' content knowledge about the nature of science. *E-International Journal of Educational Research, 3*(1), 78-96.

Ministry of National Education, MoNE, (2005). *Primary education science and technology course (6.7. and 8. grades) curriculum*, Ankara.

Ministry of National Education, MoNE, (2013). *Primary education institutions (primary and secondary schools) science course (3rd, 4th, 5th, 6th, 7th and 8th grades) curriculum*, Ministry of National Education, Board of Education and Discipline, Ankara.

Önen Öztürk, F., & Bayram, H., (2017). The effect of nature of science teaching based on two different approaches on the elimination of prospective science teachers' misconceptions. *Marmara University Atatürk Education Faculty Journal of Educational Sciences, 45*(45), 115-136. **DOI: 10.15285/maruaebd.308619**.

Özcan, I., & Turgut, H., (2014). Assessing pre-service science teachers' nature of science understanding: A study of scale development. *Sakarya University Journal of Education,* 4(2), 38-56.

Özdemir, O., (2010). Situation of the pre-service science and technology teachers' scientific literacy. *Journal of Turkish Science Education, 7*(3), 42-56.

Polyiem, T., Nuangchalerm, P., & Wongchantra, P., (2011). Learning achievement science process skills, and moral reasoning of ninth grade students learned by 7E learning cycle and socioscientific issue-based learning. *Australian Journal of Basic and Applied Sciences, 5*(10), 257-564.

Rubba, P.A., & Harkness, W.J., (1996). A new scoring procedure for the views on science-technology-society instrument. *International Journal of Science Education, 18*(4), 387-400. **https://doi.org/10.1080/0950069960180401**.

Sadler, T.D., & Zeidler, D.L., (2004). The morality of socioscientific issues: Construal and resolution of genetic engineering dilemmas. *Science education, 88*(1), 4-27. **https://doi.org/10.1002/sce.10101.**

Sadler, T.D., (2004). Informal reasoning regarding socioscientific issues: A critical review of research. *Journal of Research in Science Teaching, 41*(5), 513-536. **https://doi.org/10.1002/tea.20009.**

Sadler, T.D., Chambers, F.W., & Zeidler, D.L., (2004). Student conceptualizations of the nature of science in response to a socioscientific issue. *International Journal of Science Education, 26*(4), 387-409. **https://doi.org/10.1080/0950069032000119456**.

Sadler, T.D., & Zeidler, D.L., (2005b). The significance of content knowledge for informal reasoning regarding socioscientific issues: Applying genetics knowledge to genetic engineering issues. *Science Education, 89*(1), 71–93.

Sandoval, W.A., & Morrison, K., (2003). High school students' ideas about theories and theory change after a biological inquiry unit. *Journal of Research in Science Teaching, 40*(4), 369 – 392. **https://doi.org/10.1002/tea.10081**.

Solomon J., & Aikenhead, G., (ed.) (1994). *STS education: International perspectives on reform*. Teachers College Press, New York.

Solomonidou, C., & Tassios, A., (2007). A phenomenographic study of Greek Primary School Students representations concerning technology in daily life. *International Journal of Technology and Design Education, 17*(2), 113-133. **https://doi.org/10.1007/s10798-006-0007-9.**

Şeker, S., (2007). *The evaluation of the new primary curriculum 6th class science and technology lesson curriculum in the light of teacher's opinions*. Master of Science, Karadeniz Technical University, Trabzon.

Tairab, H.H., (2001). How do pre-service and in-service science teachers view the nature of science and technology? *Research in Science and Technological Education, 19(*2), 235-250. **https://doi.org/10.1080/02635140120087759**.

Taşkın, Ö., Çobanoğlu, E.O., Apaydın, Z., Çobanoğlu, H., Yılmaz, B., & Şahin, B., (2008). Undergraduate students' perception of theory concept. *Boğaziçi University Journal of Education, 25*(2), 35-51.

Tatar, E., Karakuyu, Y., & Tüysüz, C., (2011). Pre-service primary school teachers' misunderstandings about nature of science. *Buca Faculty of Education Journal, 29*, 153-161.

Topçu, M.S., (2015). *Socioscientific issues and teaching*. Ankara: Pegem Academy.

Turgut, H., Öztürk, N., & Eş, H., (2017). Gifted students' perception of science and scientists. *Abant İzzet Baysal University Journal of Faculty of Education, 17*(1), 423-440. **https://doi.org/10.17240/aibuefd.2017.17.28551-304646**.

Turgut, H., (2005). *The effect of constructivist design application on prospective science teachers' scientific literacy competence improvement at the dimensions of "nature of science" and "science-technology-society interaction"*. PhD Thesis, Yıldız Technical University, Istanbul.

Türkmen, H., Pekmez, E., & Sağlam, M., (2017). Pre-service science teachers' thoughts about socio-scientific issues. *Ege Journal of Education, 18*(2), 448-475. **https://doi.org/10.12984/egeefd.295597.**

Ürek, H., (2012). *Comparison of intellectually gifted and non-gifted students? Perceptions and attitudes toward science*. Master of Science. Balıkesir University, Institute of Science, Balıkesir.

Yager, R.E., (1996). *History of science/technology/society as reform in the United States*. State University of New York Press, Albany.

Yalaki, Y., (2014). How is science, technology, society, environment (STSE) education in Turkey? *Cito Education: Theory and Practice*, 26, 27-36.

Yapıcıoğlu, A.E., (2016). A mixed method study on the efficiency of socioscientific issue based approach implementations in science teacher education. PhD Thesis, Hacettepe University, Institute of Educational Sciences, Ankara.

Yenice, N., Özden, B., & Balcı, C., (2015). Examination of pre-service science and elementary school teachers' views about nature of science. *Erzincan University Journal of Education Faculty, 17*(1), 237–281. **https://doi.org/10.17556/jef.52022**.

Yılmaz-Tüzün, Ö., (2014). Evaluation of the renewed and updated Science Curriculum in the context of Student Monitoring System (SMS). *Cito Education: Theory and Practice, 24*, 26-50.

Yörük, N.Z., (2008). *Effects of science, technology, society and environment (STSE) approach teaching chemistry with using the 5E learning model*. PhD Thesis. Hacettepe University, Ankara.

Zeidler, D.L., Walker, K.A., Ackett, W.A., & Simmons, M.L., (2002). Tangled up in views: Beliefs in the nature of science and responses to socioscientific dilemmas. *Science Education, 86*(3), 343-367.

Zeidler, D.L., & Nichols, B.H., (2009). Socioscientific issues: Theory and practice. *Journal of Elementary Science Education, 21*(2), 49-58.

Zengin, Ö., (2018). *Childhood experiences of scientists and their scientific career processes. Master of Science*. Recep Tayyip Erdoğan University, Institute of Science, Rize.

Zorlu, Y., & Baykara, O., (2015). Is the technology application of science? The views of pre-service science and technology teachers. *Journal of Kazım Karabekir Education Faculty, 29*, 123-144.