Preservice Science Teachers' Views on Science-Technology-Society

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Abstract

The aim of this study is to investigate the views of pre-service science teachers on Science-Technology-Society (STS). In the research, a descriptive research method was used and data were collected using the Views on Science-Technology-Society (VOSTS) Questionnaire. In general, the results of this study revealed that pre-service science teachers have developed positive views about some STS components such as meaning of science and technology. The results have also revealed that pre-service science teachers think that there is influence of not only science/technology on society but also of society on science/technology. According to many pre-service science teachers, scientific knowledge may change, and their views about the fact that theories are not laws, shows a positive development about the nature of scientific knowledge through the science teacher education program.

Keywords: Nature of Science, Pre-service Science Teachers, Science-Technology-Society, Teacher Education Program, Views on Science-Technology-Society

1. Introduction

With the introduction of the products developed with scientific and technological progress in our daily lives, the importance of scientific and technological literacy has increased. Nowadays, students use technology in all aspects of life. With the increasing importance of science and technology in modern society and their significant effects perceived by society, the "Science-Technology-Society" approach emerged in the 1980s. The STS approach, which presents science as a thinking way to the learner and leads him to get conceptual comprehension, has been introduced in science programs (Wilson & Livingston, 1996; Yager, 2005). Science education, with this approach, aims to provide the students with the recognition of complex relationships between concepts, principles, theories, scientific processes and science-technology-society. In other words, it enables students to get understand the conception about the nature of science (Bradford, Harkness & Rubba, 1996; Abl-El Khalick, Bell & Lederman, 1997; Bell, Blair, Crawford & Lederman, 2003; Schwartz, Lederman & Crawford, 2004; Mansour, 2009; Mansour, 2010; McComas, 2005).

In education where the STS approach is used, the students are at the center. One of the major targets of the STS approach is to improve the students' creative skills (Yager, Mackinnu & Yager, 2005). In these classes, especially in science and technology, science subjects including current issues and requirements for the society are dealt with. The students notice their problems in these subjects and find solutions to these problems by using their pre-existing knowledge and experiences. Problems or questions also provide the ideas which haven't been considered before. Many major philosophers, scientists and researchers state that their inspirations are mostly related to non-scientific thoughts and ideas (Penick, 1996). For this reason, it is needed to ask open-ended and thought-provoking questions, because answers to these kinds of questions will come up as creative solutions. The students decide themselves which sources they will use to answer the questions posed by them. They not only collect information but also analyses, synthesize and evaluate the information. In these processes, their higher order thinking skills improve (Lutz, 1996). Creativeness is concerned with asking questions with a purpose, suggesting potential explanations, testing the ideas, visualizing, combining objects and ideas in new ways, presenting alternative and rare suggestions, imagining or designing, combining, separating, and assembling tools and machines (Yager et al., 2005). This process takes place in science lectures where the STS approach is implemented and enables the students to use/perceive science like a scientist (Yager & Akcay, 2008).

Developing future youths as scientifically and technologically literate citizens who have necessary and sufficient scientific and technological knowledge, and who can use scientific knowledge and technology in their daily lives, as well as keep up with scientific and technological developments, is up to the teachers. Teachers, by associating their lessons with the nature of science will help the students to develop as scientifically and technologically literate individuals (Abd-El Khalick, Bell & Lederman, 1997). Therefore, perceptions of the teachers on the nature of science will influence the learning and teaching process (Schwartz, Lederman & Crawford, 2004). The more modern perceptions about the nature of science the teachers have, the easier it will be for the students to understand science concepts correctly (Morgil, Temel, Seyhan & Alşan, 2009). For this reason, the perceptions of pre-service teachers about the nature of science and also their views about STS should be improved.

Having a significant influence on developing scientifically literate persons, the STS approach was introduced in the new science curriculum of primary schools in Turkey in 2005 across the whole country after a pilot scheme in 2004, and began to be introduced gradually in all the classes of primary schools (MEB, 2005). With the new curriculum, the name "science" was changed to "science and technology". The aim of this new curriculum is to promote the development of scientifically and technologically literate citizens, who are capable of: (a) utilizing their knowledge of science and technology in solving everyday problems and making decisions; (b) critically analyzing the newly generated scientific knowledge and its role in human society; (c) comprehending the tentative characteristics of scientific knowledge; (d) identifying the strengths and the limitations of science and technology for advancing human goodness; (e) analyzing the interactions among between science, technology, and society; and (f) making meaningful connections of science and technology to other human endeavors (TMNE, 2005, p. 12–13)

With the new curriculum, it has been accepted that science lessons involve not only teaching scientific inferences and theories, but also emphasizes students' comprehension of the nature of science and technology, interactions of these with one another, society and the environment, and their using knowledge, perceptions and skills to engage with the problems related to science and technology. In addition, new targets such as possessing scientific values like the students' improving their knowledge, experience and interest in occupations based on science and technology, learning to learn, being keen on learning, questioning, caring for the natural environment, and considering the results of events, perceptions and skills in their professional lives have been added to new curriculum of primary school science (TMNE, 2005). With the new curriculum in which the STS approach is also used, science and technology have been made more concrete by enabling the students to regard science as a way of coping with problems in their daily lives (Dindar & Taneri, 2011; Kaya, Yager, Dogan, 2009).

Reflections of reforms practiced in science education are also observed in teacher training programs. When the 2006-2007 Science Teacher Training Program is examined, it is observed that courses have been classified as field and field information courses, professional teaching knowledge courses and general culture courses. Courses like "History and Nature of Science, Evolution and Astronomy" have been added to the present courses (YOK, 2007). The understanding of scientific process skills of pre-service science teachers trained in the new curriculum, their science and technology perceptions, and higher order thinking skills each research subjects. However, in this study, the views of pre-service teachers, who continue with the new science teacher training program, on science-technology-society were investigated. It is thought that the results of this study will be helpful to curriculum developers and academicians.

2. Study Methods

2.1 Participants

Participants are pre-service science teachers of the faculty of education from a state university in one of the cities located on the west of Turkey. This study was conducted with 273 pre-service science teachers who had enrolled in the Primary Science Teacher Education Program (PSTEP) during the fall of 2012. All of them volunteered to participate in the study. The 273 participants included 68 freshman, 68 sophomores, 76 juniors, and 61 senior pre-service science teachers. The participants' demographics were similar to the general pre-service science teacher population in Turkey.

2.2 Instrument

In this study, preservice teachers' views and thoughts on Science-Technology-Society were elicited using the Views on Science-Technology-Society (VOSTS) questionnaire. There are 114 items in the VOSTS questionnaire developed by Aikenhead, Ryan and Fleming (1989). Kahyaoğlu selected 26 items from the VOSTS questionnaire that were in in seven sub-dimensions, and were translated to Turkish (2004). A pilot study of the adapted VOSTS questionnaire was conducted with 60 pre-service science teachers. At the result of pilot study, the test reliability coefficient was found to be 0.71 (Kahyaoğlu, 2004). In this study, of the 26 items in seven sub-dimensions selected by Kahyaoğlu, 23 items were used and these items were classified as "Realistic", "Acceptable" and "Inadequate" perspectives by using Rubba, Harkness and Bradford's (1996) categories. The seven sub-dimensions in the questionnaire were as following: 1. Science and Technology (3 items), 2. Influence of Society on Science/Technology (3 items), 3. Influence of Science/Technology on Society (4 items), 4. Scientists' Characteristic Features (2 items), 5. Social Construction of Scientific Knowledge (3 items), 6. Social Construction of Technology (2 items), 7. Nature of Scientific Knowledge (6 items).

The scale consists of 23 items, each a different number of alternative answers. The last three alternative answers are the same for each item. These are "I don't understand", "I don't have enough information to choose", "None of these choices represent my personal views". The percentage rate of information of pre-service teachers who chose these last three alternatives was not given in the explanations of tables, because the numbers of pre-service teachers having chosen these alternatives are not significant for the study and thus can be disregarded. The tables were developed to see clearly the percentage of the alternatives pre-service teachers chose for each item. Each item reveals preservice teachers' views on different dimensions of Science-Technology-Society.

One sample item from VOSTS is given as follows:

10111. It is difficult to define science because science is complex and does many things. But in your view, science is basically:

A. a study of fields such as biology, chemistry and physics.

B. a body of knowledge such as principles, laws and theories, which explains the world around us (matter,

energy and life).

C. to explore the unknown and to discover new things about our world and universe, and how they work.

D. to carry out experiments in order to solve problems of interest about the world around us.

E. to invent or design things (for example; artificial hearts, space vehicles).

F. to find and use knowledge so as to make this world a better place to live in (for example; curing

diseases, solving pollution and improving agriculture).

G. an organization of people (called as scientists) who have ideas and techniques for discovering new

knowledge.

H. No one can define science (Aikenhead et al., 1989).

2.3 Data Collection and Analysis

The VOSTS questionnaire was administered to participants within course hours under the researchers' guidance. Before the administration of the questionnaire, detailed information about the scope of the research and benefits, which it has been thought to provide to teachers, educators and curriculum developers in this field, was given to the pre-service teachers by the researchers. Besides, the VOSTS questionnaire was introduced to pre-service teachers by the researchers. The percentage distribution of data obtained by using the VOSTS questionnaire was calculated on the basis of classes using the SPSS (16.0) package software. Data were classified according to "realistic", "acceptable" and "inadequate" perspectives which are alternative answers of items on the scale by using Rubba, Harkness and Bradford's (1996) categories. Here, "realistic perspective" refers to modern perspective which is the most appropriate for the nature of science; "acceptable perspective" to the perspective which is proper for the nature of science, reasonable although it doesn't show realistic perspective; "inadequate perspective" to perspective which is incorrect, insufficient, weak (Rubba, Harkness & Bradford, 1996). Views on the 23 items of the VOSTS adapted to Turkish by Kahyaoğlu (2004) and used in this study were coded as "naive", "have merit" or "realistic" by two researchers and two domain experts. The acquired four different coding lists were compared and consistency was provided at the rate of 84%. Of the 23 items on the scale, the last three alternative answers like "I don't understand", "I don't have enough information to choose", "None of these choices represent my personal views" were evaluated as inadequate perspectives.

3. Results

Results were organized under the titles of subscales. Participants' responses to each of the 23 VOSTS items were categorized as naive, have merit, or realistic. The percentage distributions of these seven categories are presented in tables for the pre-service science teachers. Due to the limitation of space, selected results are discussed in detail.

3.1 Science and Technology

The adapted VOSTS survey includes three items for the science and technology subscale. The results of Science and Technology subscale are given in Table 1.

Table 1. Percentage distribution of preservice science teachers' responses to "Science and Technology"

VOSTS Subscales	**No.***	**VOSTS Items**	**Category**	**Percent Participants in Category**			
				Freshman	Sophmore	Junior	Senior
Science and Technology	10111	Defining Science	Naive	2,9%	1,5%	11,9%	4,9%
			Has Merit	58,9%	69,1%	48,6%	50,8%
			Informed	38,2%	29,4%	39,5%	44,3%
	10211	Defining Technology	Naive	38,1%	14,7%	46,0%	36,1%
			Has Merit	42,7%	33,8%	25,0%	24,6%
			Informed	19,2%	51,5%	29,0%	39,3%
	10411	Interdependence of Science and Technology	Naive	32,3%	32,3%	15,8%	21,3%
			Has Merit	16,2%	1,5%	7,9%	4,9%
			Informed	51,5%	66,2%	76,3%	73,8%

*The reference numbers to the VOSTS items correspond to those in the complete inventory (Aikenhead et al., 1989)

The first item of this scale refers to the definition of science. The data have stated that there is no consensus on the definition of science among freshmen, sophomore, junior, and senior preservice science teachers. A total of 38.2% of freshmen, 29.4% of sophomores, 39.5% of juniors and 44.3% of seniors have realistic views about the definition of science and they define science as exploring the unknown. On the other hand, most of the pre-service science teachers define science as improving the world, a body of knowledge, an organization of people and a field of study.

The second item of this scale is about preservice teachers' definition of technology. Unfortunately, a high percentage of preservice science teachers had naive views about technology and they defined technology as the application of science. While 19.2% of freshmen defined technology as ideas and techniques that help with the progress of society and a technique for doing things or solving practical problems, 39.3% of seniors defined technology in the same way.

The third item evaluates participants' views on issues concerning the interdependence of science and technology. Most of the pre-service science teachers stated that science and technology are seen as closely related because scientific research leads to practical applications in technology, and technological developments increase the ability to do scientific research.

3.2 Influence of Society on Science and Technology

This subscale is composed of three items. The results of the Influence of Society on Science and Technology subscale are given in Table 2.

Table 2. Percentage distribution of preservice science teachers' responses to "Influence of Society on Science/Technology"

VOSTS Subscales	**No.***	**VOSTS Items**	**Category**	**Percent Participant in Category**			
				Freshman	Sophmore	Junior	Senior
Influence of Society on Science/ Technology	20411	Ethics	Naive	35,2%	41,2%	22,4%	19,7%
			Has Merit	38,3%	19,1%	27,6%	31,1%
			Informed	26,5%	39,7%	50,0%	49,2%
	20521	Education Institutions	Naive	5,9%	7,3%	5,7%	-
			Has Merit	35,3%	32,4%	24,6%	23,0%
			Informed	58,8%	60,3%	69,7%	77,1%
	20711	Public Influence on Scientists	Naive	7,3%	10,4%	22,4%	9,8%
			Has Merit	64,8%	51,4%	35,5%	42,6%
			Informed	27,9%	38,2%	42,1%	47,6%

*The reference numbers to the VOSTS items correspond to those in the complete inventory (Aikenhead et al., 1989)

The first item of this subscale concerning the influence of Turkish culture on science and technology has revealed that there is no consensus among the pre-service science teachers with respect to the effects of religious and/or ethical views of the culture on scientists and scientific researches. Most of the pre-service science teachers thought that religious or ethical views do influence scientific research because scientists may unconsciously choose research that will support their cultural views. Another reason is that everyone is different in the way they react to their culture and these individual differences in scientists influence the type of research.

The second item of this subscale has examined the influence of educational institutions on science and technology. Most of the science teachers have realistic views and they supported their opinions with two different reasons. As the first reason, they believed that the more students learn about science and technology, the more informed the future public will be, and better contributions are made as to how science and technology should be used. The second reason is that they believed the more students learn about science and technology, the more the public will see that science and technology are important and they will understand the views of experts more, which will provide the needed support for science and technology.

The third item of this subscale concerning the influence of Turkish culture on science and technology has examined the effect of upbringing on students' choice of majoring in science. Many of the pre-service science teachers had a realistic view about this statement. They supported their thinking with two different reasons. One of them, the more family, school, and community give children the encouragement and the opportunity to become scientists, the more these communities train scientists. In the second view, although intelligence, ability and natural interest in science are mostly responsible for determining who becomes a scientist, upbringing has also an effect.

3.3 Influence of Science and Technology on Society

This subscale is composed of four items. The results of Influence of the Science and Technology on Society subscale are given in Table 3.

Table 3. Percentage distribution of preservice science teachers' responses to "Influence of Science/Technology on Society"

VOSTS Subscales	**No.***	**VOSTS Items**	**Category**	**Percent Participants in Category**			
				Freshman	Sophmore	Junior	Senior
Influence of Science/ Technology on Society	40111	Social Responsibility of Scientists/ Technologists	Naive	28,0%	14,7%	14,5%	14,8%
			Has Merit	63,2%	75,0%	69,7%	63,9%
			Informed	8,8%	10,3%	15,8%	21,3%
	40215	Contribution to Social Decisions	Naive	33,8%	30,8%	17,1%	11,5%
			Has Merit	50,0%	42,7%	38,2%	55,7%
			Informed	16,2%	26,5%	44,7%	32,8%
	40431	Resolution of Social and Practical Problems	Naive	17,6%	17,6%	15,8%	11,4%
			Has Merit	39,8%	42,7%	23,7%	27,9%
			Informed	42,6%	39,7%	60,5%	60,7%
	40511	Contribution to Economic Well-being	Naive	5,9%	1,4%	3,9%	-
			Has Merit	38,2%	66,2%	54,0%	52,4%
			Informed	55,9%	32,4%	42,1%	47,6%

*The reference numbers to the VOSTS items correspond to those in the complete inventory (Aikenhead et al., 1989)

The first item of this subscale explored pre-service science teachers' opinions about social responsibility of scientists/technologists. The results indicated that many pre-service science teachers have stated particularly two different views, which have merit. In one of them, scientists are concerned with all the effects of their experiments because the goal of science is to make our world a better place to live in. In another, scientists may be concerned, but that doesn't stop their making discoveries for their own fame, fortune, or pure joy of discovery. Only 8.8% of freshman, 10.3% of sophomores, 15.8% of juniors and 21.3% of seniors had a realistic view, in which they stated their views with two different reasons. One of the reasons was that scientists are concerned about the undesired impact of their practices but they cannot know all the possibilities. Another reason is that scientists are concerned but they have little control over how their discoveries are misused.

The second item of this subscale concerning the debate on science and technology related to decisions revealed that 16,2% of freshmen, 26.5% of sophomores, 44.7% of juniors and 32.8% of seniors had the realistic view in which the decision should be made equally; viewpoints of scientists and engineers, other specialists, and the informed public should all be considered in decisions which affect our society.

The third item addressed participants' views on the following statements: "Scientists can solve any practical problem best (for example, getting a car out of a ditch, cooking, or caring for a pet) because scientists know more science." The results showed that 42.6% of freshmen, 39.7% of sophomores, 60.5% of juniors and 60.7% of seniors had a realistic view in which they stated scientists are better at solving any practical problem because of their logical problem-solving or specialized knowledge.

In the last item, 55.9% of freshmen, 32.4% of sophomores, 42.1% of juniors and 47.6% of seniors had a realistic view in which they agreed science and technology bring greater efficiency, productivity and progress. Some of them stated that since Turkey could sell new ideas and technology to other countries for profit, science and technology will increase Turkey's wealth.

3.4 Characteristics of Scientists

This subscale is composed of two items. The results of Characteristics of Scientists' subscale were given in Table 4.

Table 4. Percentage distribution of preservice science teachers' responses to "Characteristics of Scientists"

VOSTS Subscales	**No.***	**VOSTS Items**	**Category**	**Percent Participants in Category**			
				Freshman	Sophmore	Junior	Senior
Characteristics of Scientists	60211	Standards/Values	Naive	26,4%	28,0%	10,5%	18,0%
		that GuidesScientists	Has Merit	11,8%	16,2%	7,9%	6,6%
		at Work and Home	Informed	61,8%	55,8%	81,6%	75,4%
	60511	Gender Effects on	Naive	61,7%	42,7%	39,4%	41,0%
		the Process and	Has Merit	13,3%	22,0%	11,9%	24,6%
		Product of Science	Informed	25,0%	35,3%	48,7%	34,4%

*The reference numbers to the VOSTS items correspond to those in the complete inventory (Aikenhead et al., 1989)

The first item of this subscale has explored preservice science teachers' opinions about characteristics of scientists. More than half of the preservice science teachers (61,8% of freshman; 55,8% of sophomore; 81,6% of junior; 75,4% of senior) have realistic view, in which the best scientists are always very open-minded, logical, unbiased and objective in their work and with these characteristics they also need other personal traits such as intelligence, imagination and honesty for doing the most favorable science.

Another item is about the gender and its effects on the process and products of science. About 25% of freshman, 35,3% of sophomore, 48,7% of junior and 34,4% of senior have stated that there is no difference between female and male scientists in the discoveries they make. They believe that the differences in their discoveries are due to differences between individuals and such differences have nothing to do with being male or female.

3.5 Social Construction of Scientific Knowledge

This subscale is composed of three items. The results of Social Construction of Scientific Knowledge's subscale were given in Table 5.

Table 5. Percentage distribution of preservice science teachers' responses to "Social Construction of Scientific Knowledge"

VOSTS Subscales	No.*	VOSTS Items	Category	Percent Participants in Category			
				Freshman	Sophmore	Junior	Senior
Social Construction of Scientific Knowledge	70412	Professional Interaction in the Face of Competation	Naive	44,1%	58,9%	59,2%	44,3%
			Has Merit	42,7%	23,5%	21,1%	31,1%
			Informed	13,2%	17,6%	19,7%	24,6%
	70511	Social Interactions	Naive	22,1%	11,7%	13,2%	9,8%
			Has Merit	52,9%	55,9%	60,5%	57,4%
			Informed	25,0%	32,4%	26,3%	32,8%
	70711	National Influence on Scientific Knowledge and Technique	Naive	10,4%	7,4%	9,2%	9,8%
			Has Merit	48,5%	60,3%	34,2%	44,3%
			Informed	41,1%	32,3%	56,6%	45,9%

*The reference numbers to the VOSTS items correspond to those in the complete inventory (Aikenhead et al., 1989)

The third item has addressed participants' views on following statements: "Scientists compete for research funds and for who will be the first to make a discovery. Sometimes fierce competition causes scientists to act in secrecy, to lift ideas from other scientists, and to lobby for Money. In other words, scientists sometimes break the rules of science (rules such as sharing results, honesty, independence, etc.)." The results have showed that just only 13,2% of freshman, 17,6% of sophomore, 19,7% of junior and 24,4% of senior have realistic view about this statement, in which they believe most scientists do not compete and they work just in collaboration by following the rules of science for success.

The second item has explored whether social contacts have an impact on the discoveries made by the scientists. About 25% of freshman, 32,4% of sophomore, 26,3% of junior and 32,8% of senior believe that social contacts influence the content of what is discovered because scientists can receive help from the ideas, experiences, or enthusiasm of the people with whom they socialize, which is a realistic view. More than half of preservice science teachers (52,9% of freshman; 55,9% of sophomore; 60,5% of junior; 57,4% of senior) have merit view and they support their opinions by means of three different reasons. The first reason is that social contacts can serve as a refreshing or relaxing break from work, thus revitalize a scientist. As the second reason, scientists can be encouraged by people to apply or change their research to a new area relevant to the needs of society. As the third reason, social contacts allow scientists to observe human behavior and other scientific phenomena.

The last item of this subscale has addressed preservice science teachers' views on following statements: "Scientists trained in different countries have different points of view in approaching a scientific problem. This means that a country's education system or culture can influence the conclusions which scientists reach." About 41,1% of freshman, 32,3% of sophomore, 56,6% of junior and 45,9% of senior have realistic view and they have explained their opinions with two different reasons. In the first reason, they have stated that education and culture affect all aspects of life, including the training of thoughts about a scientific problem. Another reason they have stated is that the way a country trains its scientists might make a difference to some scientists, but other scientists approach problems in their own individual way based on personal views.

3.6 Social construction of technology

This subscale is composed of two items. The results of Social Construction of Technology's subscale were given in Table 6.

Table 6. Percentage distribution of preservice science teachers' responses to "Social Construction of Technology"

VOSTS Subscales	No.*	VOSTS Items	Category	Percent Participants in Category			
				Freshman	Sophmore	Junior	Senior
Social Construction of Technology	80111	Technological Decisions	Naive	16,2%	14,6%	10,6%	14,8%
			Has Merit	41,2%	33,9%	23,6%	19,6%
			Informed	42,6%	51,5%	65,8%	65,6%
	80211	Autonomous Technology	Naive	3,0%	3,0%	3,9%	3,2%
			Has Merit	54,3%	61,8%	54,0%	62,4%
			Informed	42,7%	35,3%	42,1%	34,4%

*The reference numbers to the VOSTS items correspond to those in the complete inventory (Aikenhead et al., 1989)

The first item has examined the preservice science teachers' views about the factors that influence society's decision to adopt a new technology. The data have showed that 42,6% of freshman, 51,5% of sophomore, 65,8% of junior and 65,6% of senior have realistic view, in which they stated that the decision of using new technology depends on its cost, efficiency, usefulness to society, and effects on employment.

The next item has explored preservice teachers' views on whether technological developments can be controlled by citizens or not. Results have showed that 42,7% of freshman, 35,3% of sophomore, 42,1% of junior and 34,4% of senior have realistic view and they believe that technological control can be checked by citizens. They supported their opinions with two different reasons. As the first reason, the control depends on consumers' needs. The second reason is that if citizens get together and speak out, they can change just anything. More than half preservice science teachers who %54,3 are freshman, 61,8% sophomore, 54% junior and 62,4% senior have merit view on controlling technological developments by citizens and they have supported their opinion with some different reasons.

3.7 Nature of Scientific Knowledge

This subscale is composed of six items. The results of Nature of Scientific Knowledge's subscale were given in Table 7.

Table 7. Percentage distribution of preservice science teachers' responses to "Nature of Scientific Knowledge"

VOSTS Subscales	No.*	VOSTS Items	Category	Percent Participants in Category			
				Freshman	Sophmore	Junior	Senior
Nature of Scientific Knowledge	90111	Nature of Observations	Naive	13,2%	16,1%	3,9%	3,3%
			Has Merit	19,1%	30,9%	14,5%	18,1%
			Informed	67,7%	53,0%	81,6%	78,6%
	90411	Tentativeness of Scientific Kowledge	Naive	10,2%	4,4%	-	1,7%
			Has Merit	11,8%	10,3%	9,2%	3,2%
			Informed	78,0%	85,3%	9,8%	95,1%
	90511	Hypothesis, Theories and Laws	Naive	98,5%	98,5%	57,9%	62,3%
			Has Merit	-	-	-	-
			Informed	1,5%	1,5%	42,1%	37,7%
	90611	Scientific Approach to Investigations	Naive	95,6%	92,6%	88,2%	93,5%
			Has Merit	4,4%	7,4%	10,5%	4,9%
			Informed	-	-	1,3%	1,6%
	90811	Logical Reasoning	Naive	45,6%	27,6%	30,2%	21,3%
			Has Merit	-	-	-	-
			Informed	54,4%	72,4%	69,8%	78,7%
	91121	Paradigms vs. Coherence of Concepts across Disciplines	Naive	32,3%	45,6%	21,0%	34,4%
			Has Merit	45,6%	44,1%	72,4%	60,7%
			Informed	22,1%	10,3%	6,6%	4,9%

*The reference numbers to the VOSTS items correspond to those in the complete inventory (Aikenhead et al., 1989)

The first item has examined the preservice science teachers' views about the nature of scientific observation made by scientists. More than half of the preservice science teachers have a realistic view about the effects of the different theories on the observation made by the scientists and they have explained their opinions with two different reasons. One of them is that because of the fact that scientists will experiment in different ways and will discover different things; their observations will usually be different. The other one is that they think differently and this will affect their observation, thus their observation will usually be different.

The second item is about tentativeness of scientific knowledge. Most of the preservice science teachers have realistic view that scientific knowledge may change in the future. Some of them have indicated that changes result from new evidence which scientists will reach through new techniques or improved instruments, while the others have expressed that changes result from the reinterpretation in the light of new discoveries.

The third item has evaluated preservice science teachers' understanding about hypothesis, theories and laws. The results have showed that a vast majority of them has naive view that they have stated a hierarchical relationship between them in which hypothesis become theories and theories become laws after testing many times by different people and seems to be correct. Only other hand, just 1,5% of freshman, 1,5% of sophomore, 42,1% of junior and 37,7% of senior have realistic view, in which theories and laws are both different types of ideas, thus theories cannot become laws.

The fourth item has explored preservice science teachers' understanding of scientific method. Unfortunately, a vast majority of them has naive view. Some of them define scientific method as lab procedure or techniques, while some define it as recording results carefully and controlling experimental variables carefully. According to some, scientific method is getting facts, theories or hypothesis efficiently. Only 1,3% of freshman and 1,6% of senior believe that there is no really such thing as the scientific method.

The fifth item has addressed preservice science teachers' views on logical reasoning about facts. In this item, preservice science teachers were asked to remark their views about the following statements: "If scientists find that people working with asbestos have twice as much chance of getting lung cancer as the average person, this must mean that asbestos causes lung cancer." The results have stated that more than half preservice science teachers have realistic view that facts do not necessarily mean that asbestos causes lung cancer and they have explained their opinions with two different reasons. The first reason is that more research is needed to find out whether it is asbestos or some other substance that causes the lung cancer. The second reason is that asbestos might work in combination with other things.

The last item of this subscale deals with paradigms vs. coherence of concepts across disciplines. In this item, preservice science teachers were asked to remark their views about the following statements: "Scientists in different field approach the same thing from very different points of view. This means that one scientific idea has different meanings, depending on the field a scientist work in." While 22,1% of freshman, 10,3% of sophomore, 6,6% of junior and 4,9% senior have realistic view that scientific ideas can be interpreted more differently in one field than in another, 32,3% of freshmen, 45,6% of sophomore, 21% of junior and 34,4% of senior have naive view that scientific idea will have the same meaning in all fields. According to some of them, because of individual scientist's point of view, scientific ideas can be interpreted differently.

4. Discussion

At the present time, it is of importance to increase the number of conscious and responsible individuals, who have sufficient knowledge, are able to think critically and creatively, to use what they have learnt in the problems, to speak easily their thoughts about a scientific research, to interpret scientific studies, to use what they have learnt in their social lives, to be aware of the effect of science-technology-society on one another and to improve themselves. Teachers have great responsibility to bring up these individuals. Teachers' information on physics, chemistry and biology, educational pedagogy, beliefs and views in science affect their teaching and the students' learning (Bennett, Hogarth & Lubben, 2005; Rosario, 2009; Solbes & Vilches, 1996; Wilson & Livingston, 1996; Yager et al., 2009). Therefore, the major task of teacher training institutions is to produce qualified teachers. In this study, views of pre-service teachers, who continue with teacher training programs, on science-technology-society (STS) have been investigated; the findings have been interpreted according to the dimensions by comparing the findings of previous studies.

The results of the study stated that pre-service teachers' views on the definitions of science and technology differ like in many other studies (Doğan Bora, 2005; Haidar, 1999; Kahyaoğlu, 2004; Tairab, 2001; Yakar & Çekmecelioğlu, 2010; Yalvaç, Tekkaya, Çakıroğlu & Kahyaoğlu, 2007). Most of the pre-service teachers defined science as researching the unknown. In addition, it has been ascertained that while some of the pre-service teachers define technology as a technique for doing things or a way for solving daily problems, some define it as inventions for requirements. This rate has been determined to increase during the process. When other findings related to this dimension of the study are examined, it was revealed that pre-service science teachers continuing with the program are wrong about the definition of science and technology. While some pre-service teachers choose the option which defines science as a tool, some define science as information like principles, laws and theories and a considerable majority of them define technology as an application of science. When the findings are examined, it has been pointed out that especially a great majority of freshman pre-service teachers who attend the program have this misconception. The basis of that misconception that pre-service teachers have can be said to originate from the education which they received. Science education is emphasized more than technology education in science courses in the curriculum at primary and high schools. In this process, preservice teachers may be affected during the education they received by their teachers' science and technology perceptions. As Rubba and Harkness (1993) and Tairab (2001) mentioned in their studies, the teachers need to improve their perception of technology as well as perception of nature of science. Thus, their students are able to understand science and technology conceptions better and to correct existing misconceptions. The source of improvements observed in pre-service teachers during the program can be considered to be field courses, laboratory courses, courses such as History and Nature of Science, Scientific Research Methods and practices in these courses.

Other results of the research have shown that although pre-service teachers have inadequate points of view on "Characteristic Features of Scientists", they have developed a wider point of view on the basis of class. It has been observed that pre-service teachers have the opinion that in discoveries male and female scientists are the same in terms of what they want to discover; differences in the discoveries are because of personal differences. In addition, a great majority of pre-service teachers who participated in the study have expressed that a successful scientist must have characteristics of creativity, intelligence and honesty besides being open-minded, rational, unbiased and objective. It is possible that pre-service teachers may think that scientists, with these features suggest a different point of view in solving problems with regard to daily life.

One of the important results of the research is that because most of the pre-service teachers think competition results in success and science isn't different from other professions, scientists may break the rules of science. This may be because in Turkey, pre-service teachers occasionally take various examinations in order to achieve their aims during their education and in these examinations they are in competition with time and other candidates. Another reason may be the insufficiency of emphasis on functioning of science in the courses that the pre-service teachers have taken along their educational life. At this point, pre-service teachers may be led to conduct research about scientists' lives and the process of research, and their misconceptions on this subject may be eliminated with samples from the science world. Besides that, it has been determined that some pre-service teachers believe the best way for success of the scientists who have a wider point of view on social construction of scientific knowledge is to collaborate and to follow the rules. There is an increase in the number of pre-service teachers in this view according to basis of class. However, this increase is not sufficient. Pre-service teachers also think that scientists give importance to sharing ideas and that this sharing will contribute to the development of scientists' studies and developments to scientific and technological developments. In addition, their beliefs in which scientists' social relations and the educational and cultural systems that they have received education in will affect their studies. These findings are parallel with the findings of Dogan Bora (2005).

Another reason is that the pre-service teachers think, with increasing rates on basis of classes, decisions on whether or not technological developments are put into practice depend on cost of these developments, benefits for the society, whether they are practical or not, and their sufficiency and effects on the usage of manpower. These increasing views reflect a wider point of view on social construction of technology. One of the major reasons of that may be the science laboratory applications course that preservice teacher take at 3rd grade. This is because in especially this course, pre-service teachers have to prepare a project, to improve their prepared project and to display them in a Science Fest organized by pre-service science teachers twice a year in the fall and spring terms. In this process, they usually question profit/loss relations by accounting the costs of their projects. They also determine the requirements that their projects will serve. This is thought to be effective in pre-service teachers' developing a wider point of view.

The results have shown that there is an increase in the numbers of pre-service teachers who think that difference in mentality of scientists believing in different theories will affect their observations. The origin of these improvements may be field courses, courses like History and Nature of Science, Scientific Research Methods, Evolution, Astronomy and the practices in these classes. Pre-service teachers also think that scientists will make different observations related to the nature of observations because of the differences between the methods they use while experimenting. This result parallels with the results in the study Doğan Bora, Çakıroğlu, Çavuş, Bilican and Arslan (2011) had conducted. One of the significant results of the research is the increase in the numbers of pre-service teachers, who have a wider point of view and consider that scientific knowledge may change with new techniques and reinterpretation. That most of pre-service teachers' have a wider point of view about the tentative characteristic of scientific knowledge shows that STS has a positive effect on pre-service teachers' views. Another significant result is that the numbers of pre-service teachers who have the opinion that theories and laws are different concepts and cannot turn into each other have increased. Although there are pre-service teachers who have the opinion that a hypothesis develops towards theories and, if it is strong enough, towards laws; the decrease in the numbers of those having this view has shown that the STS approach has a positive role in eliminating the misconception on this subject. This result proves the effectiveness of the positive effect of emphasizing on scientific literacy. Although there are studies (Akerson, Abd-El-Khalick & Lederman, 2000; Doğan, Çakıroğlu, Bilican, Çavuş & Arslan, 2011) paralleling with these positive findings, there are also studies which show a misconception like theories can become laws (Kahyaoğlu, 2004; Doğan Bora, 2005; Mıhladız, 2010; Doğan & Mıhladız, 2012).

As it is seen, the results obtained clearly reveal the positive effects of the STS approach on the views of pre-service teachers. An important result of the research is that pre-service teachers think society influences science and science influences society; besides, technology influences science and society and is also influenced by science and society. In consequence, pre-service teachers' being in agreement with science-technology-society affect each other and are affected by each other is the positive effect of the STS approach on views of pre-service teachers These views of pre-service teachers on Science-Technology-Society are a result of improvements they have experience about the nature of science and technology.

5. Conclusion and Implications

It is an undeniable fact that we need primarily qualified teachers, who have these characteristics mentioned throughout the whole section, in order to produce scientifically and technologically literate students. At this point, although positive results have been obtained in this study, it is impossible to say that innovations made in teacher training programs whose importance is increasing day after day are sufficient. For this reason, Science-Technology-Society must be emphasized more in the current curriculum; scientific and technological developments and effects of these developments on society, and the effects of society on these developments must be frequently discussed in the courses. In addition, pre-service teachers can be provided to develop a wider point of view on functioning of scientific studies, and the nature of science by introducing the functioning of science and technology. Inclusion of the articles or books which tell about scientists' lives, documentaries about scientific and technological developments into the courses can help pre-service teachers to understand the nature of science and technology. In addition to this, project papers may be assigned more frequently. In these projects, pre-service teachers can be encouraged to study as a scientist and thus can be helped to understand the scientific process. In order to develop qualified teachers, qualified curriculums are needed and in order to increase the effectiveness of teacher training programs on this subject, the nature of science and technology must be emphasized more and social dimensions of scientific and technological developments must be frequently discussed in the courses.

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